14 APR 1999

THE

BENGAL SUGAR PLANTER:

BEING

A TREATISE ON THE CULTIVATION

OF THE

Sugar-cane and Date-Tree in Bengal,

AND THE MANUFACTURE OF

Sugar and Rum Therefrom.

By S. H. ROBINSON.

"Saccharum et Arabiâ fert, sed *laudatius* India;—est autem mel in arundinibus collectum, granulum, modo candidius, dentibus fragile, amplissimum, nucis avellanæ magnitudine, ad medicinum tantum usum."—PLIN. *lib.* 12, *c.* 8.

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1849.

TO

THE PRESIDENT, SECRETARY, AND MEMBERS

OF THE

Agricultural and Horticultural Society of India,

THIS VOLUME IS DEDICATED, WITH

MUCH RESPECT,

BY

THEIR OBEDIENT SERVANT,

S. H. ROBINSON.

PREFACE.

The author, in submitting the result of his labors to the public, solicits from them such indulgence in criticising it, as is usually accorded to those who are making their debut in a new character on the stage of public opinion. *Style* and polish in the composition having been less aimed at than the affording plain and practically useful information,—and the work having been altogether written in the leisure intervals of an active business, it is hoped that all defects and departures from the established rules of book-making, may be attributed to these drawbacks, and pardoned.

The materials for the work have been in great measure derived from personal observation, and a habit of noting down whatever appeared of interest and worthy of record, during a period of sixteen years in Bengal, which the author entirely devoted to this subject:—these he has corrected by a careful review of all that has been previously published bearing upon it; and he has been further assisted by local information contributed by friends in different parts of the country. The consciousness that few or none could have had such opportunities of collecting the materials here avail-

ed of; and the circumstance of the greater part of the descriptive portion, including the whole of that on date-tree sugar, not being found in any other work yet published, formed the chief inducements for submitting them to the public. The author is aware, that on these must rest the chief claims of his work to their patronage; and at a time when the attention of our Statesmen and Merchants is directed to the sugar statistics of the world, and with no slight degree of interest to those of India, he indulges the hope that the following pages may prove acceptable, as well by helping to afford a right estimate of the capabilities of Bengal for the production of this valuable staple, as by assisting those who are already engaged in it.

THE

BENGAL SUGAR PLANTER, &C.

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THE

BENGAL SUGAR PLANTER,

&c.

INTRODUCTION.

Nearly half a century has now elapsed since a Bengal Civilian, Sir John Colebrooke, published a short treatise* on the "Husbandry of Bengal," in which, while describing the richness of its natural productions, he makes the remark, that "sugar and indigo are common to the whole champaign of India."

From that period to the present, we may trace the gradual, though certain, march of improvement in the production of indigo: European skill and capital have been applied to its manufacture, and European superintendence and energy to its cultivation; and in spite of many drawbacks, the result has been, that the quality has been brought to a high state of *perfection; the Native manufacturer has been almost en*tirely superseded by his European competitor; and the total quantity of the staple annually exported from the country,

* It was printed in Calcutta in 1804, having been prepared for the press in 1803, though the original treatise was written some nine years previously

and its corresponding value, have been fully trebled: whilst this continued increase has been accompanied by a corresponding improvement in the revenue of the indigo-producing districts, and, excepting the fluctuations incident to the markets for all great staples of agricultural produce, by no ordinary measure of prosperity to the proprietors of the cultivation.

Previous to the year 1837, the causes were sufficiently obvious why the other great staple of Indian commerce—SUGAR, should not have participated in the same ratio of increase and improvement. Until that year, the unjust discriminative duties betwixt the produce of the East and West Indies, by which the sugars of the former were burdened with an additional duty of 8s. per cwt., and on rum the difference was even more oppressive, acted as an effectual check to the application of British enterprise to the growth of these articles.

Since that date however, the principle has been recognised by the Home Legislature of the *right* of British India to be placed on equally advantageous terms with our other Colonies in this respect; and a measure of justice has been granted to her, however grudgingly, and however still restricted by the vexatious provisions of the Act of 1846, which, with the view of protecting the home refiner and West India proprietor from the effects of the full development of skill in the manufacture of the East, still burdens with higher discriminative duties any sugar which we dare to import into Great Britain of a higher grade than the standard of *Muscovado or raw West India sugar.*

Still it appears that sufficient encouragement should have been afforded by the equalization measure of 1837 for the capitalist to enter on the field of Indian sugar cultivation; and to endeavour with the aid of European skill and machinery, backed by the abundance and cheapness of labor in India, to imitate the example of his successful predecessor,

the indigo planter. And on reviewing what has been done, it cannot, on the whole, be asserted, that there has been any want of enterprise in our countrymen during the last *few years, in endeavouring to avail of the promised benefits* opened up to them by these changes; yet it is a source of the deepest regret to all interested in Indian progress to observe the almost universal want of success which has attended these efforts. Steam engines, and the most improved apparatus of all descriptions, have been imported from home, and erected at great expence in several of the most promising districts for sugar-cane cultivation; but with scarcely an exception, the result has been loss and disappointment, and in many cases entire ruin, to the enterprising projectors.

To enquire into the causes of these unexpected and discouraging results, and to point to a more safe and certain path for the future sugar planter, form one of the ends aimed at in the following pages.

The foregoing remarks have reference only to what has been attempted in the cultivation of the cane and extracting its produce by the European planter. The plan which has been pursued with various success of late years, and gradually ripened into an extensive branch of trade in Bengal, of purchasing the raw material from the native cultivator, after he has produced it in the shape of goor, khaur, or other unfinished stage of manufacture, and refining it by an entirely separate process for the home markets, comprises a section of the subject distinct from the main object of this work. It forms however a part of my design, to submit to the public, the results of my experience in "Bengal Sugar Refining," should my labors in this first essay be received with sufficient favor to encourage such a step.

It cannot be doubted that the large supplies of raw sugars required by these refineries, and the British capital with which they have been supported, have greatly tended to

encourage and increase the cultivation of the article by the Natives of the Lower Provinces of Bengal; though even had these establishments not been introduced, it is evident that the production of the staple would have been stimulated to perhaps nearly the same extent by the demand from this country for the home markets, since the slave-emancipation measures gradually reduced the supplies from the West Indies, and aided by the equalization measure of 1837 raised up a great and enduring demand on all our Colonies, the effects of which on the native production here will again be adverted to.

As may have been inferred from the title of this work, it is not my intention to enter into a disquisition on the general subject of the origin and ancient history of the sugar trade: whether the sugar-cane was indigenous only to the Eastern or common also to the Western hemisphere; the rise, progress, and fall of the Colonial slave trade; and other interesting topics connected with its history, have been sufficiently and ably discussed by preceding writers. I believe there are no results of more recent enquiry in this country, that can throw additional light on the moot points of such discussions. The great similarity in the processes practised by the natives of China, of the Eastern Islands, and of India, in their respective modes of manufacture, naturally leads the observer to the conclusion, that they all own one common origin; though which country can claim the priority of antiquity in the art, appears to be a question as difficult of solution as it is immaterial, except as an object of research for the Eastern antiquary. Restricting our observation to the Native processes in use throughout the vast continent of India itself, the inference is even more strongly forced upon us that all have originally sprung from one common fountain-head of ingenuity, however varying in some details in different districts. The same simple, yet tedious system in the cultivation of the cane, the same rude and laborious character of

their mills or other contrivances for expressing the juice, and of the series of small earthen or metal pots for inspissating it into the first coarse solid extract, or goor, may be traced in every district from which descriptions of the process have been received, from Rungpore to Mysore, and from Lucknow to Backergunge.

This process may be not inaptly characterised as a burlesque on the more scientific and comprehensive manufacture of the European planter and refiner. Yet rude and imperfect though it be when so contrasted, we should by no means despise it as unworthy of our notice while seeking for the most beneficial modes of working in the same field with our larger capital and more scientific means and appliances. We cannot help admiring indeed how perfectly adapted the native contrivances are, in every way, for the ends they are meant to compass; in giving the poor cultivator, as regards the first process of goor making, the most effectual, cheap and economical means of producing a saleable commodity from the small patch of cane his labor is limited to; and to the Native refiner similar advantages in cleaning and whitening for the market the limited quantity of sugar he is, with his small capital, restricted to working upon. This may be better understood perhaps by the consideration, that the quantity of sugar refined by one of the most substantial of these re-manufacturers for a whole year is about the same as an ordinary European refinery, with a single vacuum pan of medium size, can turn out in two days; and that the extent of cane cultivated, or owned, by any single ryot, seldom or ever reaches an acre in measurement, and more frequently occupies less than half of that space.

In considering the subject in detail therefore, a portion of this treatise is devoted to a description of the native management of sugar in all its stages; assigning to the subject of date tree sugar a space proportionate to its growing importance.

In prosecution of my general plan, I purpose in the first place to describe the Native practise in the processes of both cane and date sugar production. The second part of the work will then refer to the cultivation and manufacture by Europeans, and the means best suited for their adoption in Bengal, chosen from the many modern improvements in the art of sugar-making, to suit the circumstances and climate of the country. Molasses and the distillation of rum will form the next subject for consideration; and the last division of the work will comprise such information, as I have been able to glean respecting the sugar-producing capabilities of each separate district of Bengal.

It may be appropriate however here to mention, that although the sugar production of the Bengal Presidency is the proper subject of this work, and that branch of it with which I am most familiar, occasion will frequently be taken to refer to the great sugar districts of the Western Provinces, Benares, Ghazeepore, &c., as well for the sake of comparing their capabilities with those of the lower districts, as to notice their influence on the sugar trade of their great shipping port for Europe—Calcutta.

My design therefore, it will be seen, is eminently practical. Far be it from me to undervalue the advantages of a more scientific enquiry into the vegetable economy and development of the cane, or to depreciate the importance of chemical research applied to the analysis of its products.

To such enquiries, both planters and refiners, already owe much, and who shall say how much more in the way of improvement may not ensue from similar investigations? I leave this department of the subject however to those who have better opportunities of prosecuting it; and amongst the most useful publications which have yet appeared with this object in view, I notice with pleasure that of Dr. W. J. Evans, published in London in 1867, and entitled "The Sugar Planter's Manual." What I would here take occasion

to deprecate is the too frequent error, more especially as regards sugar cultivation and manufacture, of advancing and recommending new theories and processes, however promising, without any test of their value by actual trial.

The following table of exports of sugar from Calcutta, compiled from the late Mr. Bell's, and from Mr. Wilkinson's well known and valuable publications, will demonstrate better than any more argument that can be advanced, the present and growing importance of India considered as a sugar-producing country: the more so if we bear in mind, that Calcutta was, until very recent years, the only place of consequence for the exportation of Indian sugar to Europe, and that the shipments from Madras and Ceylon are still of minor importance only.

Year.	Total Exports to Great Britain in Bazar mds.	Total Exports to other places in Bazar mds.	Total Exports in Bazar mds.	Total value of Exports in Rupees.	Average value per Bazar maund.	Total Exports to Great Britain in Tons.
1830-31,	2,17,371	40,802	2,07,173	21,25,027	7 0 3	7,085
1831-32,	1,20,027	58,783½	1,88,810½	15,10,011	8 0 0½	4,779
1832-33,	1,08,140	60,001	2,20,947	18,21,007	7 15 3	0,188
1833-34,	02,683	1,07,070½	2,00,303½	23,08,224	7 15 1½	0,405½
1834-35,	1,54,500	2,03,025	3,58,515	27,00,050	7 12 0½	5,070
1835-36,	1,05,587	1,73,173½	3,08,760½	40,42,208	7 11 0	7,185
1836-37,	3,01,801	2,52,100½	6,17,900½	51,38,400	8 5 2	10,103
1837-38,	5,05,850	2,18,015	8,14,771	07,18,011	8 8 11½	21,888½
1838-39,	7,31,898	1,37,200	8,00,107	74,03,088	8 0 4½	20,881
1839-40,	7,02,051	1,11,238	8,43,880	70,00,030	8 11 0½	20,014
1840-41,	17,17,200	07,501½	17,84,701½	101,08,808	0 3 7½	03,084½
1841-42,	14,53,502½	00,500	15,23,002½	130,10,420	0 2 0½	50,057
1842-43,	15,70,145½	02,085	10,05,030½	148,35,773	0 3 2½	57,787½
1843-44,	15,30,470½	0,104½	15,12,581	140,04,011	0 7 5½	50,442½
1844-45,	15,18,000	21,108½	15,30,117½	140,01,050	0 8 8½	55,704
1845-46,	18,81,203½	8,111½	18,30,074½	178,03,188	0 11 7	07,271½
1846-47,	16,85,000	20,881½	17,16,317½	107,08,055	0 12 0½	01,010½
1847-48,	16,30,5227	85,237	17,91,7593	160,28,524	0 10 0½	60,117½

We have, unfortunately, no means of ascertaining what proportion the sugars imported from the North-West Provinces for Calcutta shipment bore to those grown in Bengal Proper, in the total annual shipments comprised in this table: but it must be sufficiently obvious that the districts of the latter, *from their nearer* local position to the shipping port, must have participated most largely in the effects of so rapidly increasing a trade, and indeed the evidence that they have done so is sufficiently clear in *the very largely increased sugar* production well known to have taken place in many of them, and more especially in the date tree districts.

The column of average values per maund, calculated on the total yearly exports, has been inserted to show that the value of the staple has, on the whole, steadily increased, but it affords of itself little or no index to the general improvement in quality of the sugars exported, which has also taken place of late years. During the first years of increased export to Great Britain, commencing with 1810-11, a large proportion was shipped in the shape of khaur, which, as will be shown in the progress of this work, does not bear more than one-third the relative market value of white or *pucka* sugars. But since the passing of the Act of 1845 admitting *foreign sugars to competition with those of our Colonies* in the home markets, the shipment of khaur has been nearly abandoned, and the great bulk of the exports of the last four years has consisted of Benares sorts, the better kinds of date produce, and a large proportion of European refined or vacuum-pan sugar. The manufacture of the latter has been steadily increasing, and has probably formed one-fifth to one-fourth of the total exports to Great Britain for that period: so that had not the market value of all sugars fallen considerably, both here and in the home markets, it is probable that the averaged value of the exports over the last four years would have proved thirty to forty per cent. beyond what it stood at from 1840 to 1844.

From these statistics, considered in conjunction with the prices ruling for sugars over the period comprehended in the table, it is evident that in proportion as the West Indies fell off in their ancient province of supplying the mother country with sugar,—the natural and certain consequence of the abolition of slavery, however propped up for a time by the wealthy interests which had so long been enriched by that artificial system,—British India no sooner commenced throwing aside the trammels of the Company's Trade monopoly than she began, step by step, to assume possession of their lost ground, until at last, in conjunction with her younger sister Colony, Mauritius, she stands on the stage an equal competitor in point of quantity, and a superior as regards quality, in her share of this branch of commerce. It must be remembered too, that this wonderful progress has been made in despite of the partial protection awarded by the Legislature to the West India Colonies, which has been already referred to. I would ask what better proof than this can we have of the superior advantages India possesses in her abundant supply of free labor over her protected competitors?

Another struggle however, and a strenuous one it will be, she has yet to undergo with the foreigner who produces his sugar with the price of life of the wretched slave. For to those who watch the signs of the times it is sufficiently apparent, that the inevitable, onward march of free trade doctrine must continue to reduce the supplies of sugar from all the Colonies, British or Foreign, not possessing, as in India, abundant supplies of free labor, or a command of the compulsive labor of slavery; the race will then be left to the competition of these two great interests. The struggle may indeed be said to have commenced already by the importation of large supplies of slave-grown sugar into our home markets, and the prospect of its annual increase in proportion as the duties become equalized on Colonial and

Foreign sugars of all descriptions,—and great has been the stimulus imparted to the trade in the slave Colonies, in which it is even said that British capital has been largely invested to support and prolong the unhallowed traffic.

But who can doubt the ultimate issue who has looked closely and attentively at the progress of these changes? Without attempting to scrutinize too closely the ways of Providence, we can hardly err in allowing the impression to force itself upon us that the hand of a higher Power is guiding these events, and in permitting the hope to be indulged that, after the countless blood and treasure expended by Great Britain in her attempts to forcibly extirpate the abominations of slavery by the tedious blocade of an unhealthy and extensive sea-coast, the same great end is destined to be brought about by the agency of more natural and simple causes; that on the produce of slave and of free labor being allowed to meet in the European markets, and to come into consumption on equal terms, the great question, as regards sugar cultivation at least, will ere long be satisfactorily decided by proving that free labor is in fact the *cheaper* process of the two, and that slavery will, in consequence, be in time fairly *bid* out of the market.

In these bright anticipations let not the philanthropist be discouraged by the fact of 29,000 tons of slave grown sugars having been brought into English consumption in the very first year of its admission, or even of a much larger quantity *following in some few succeeding years.* It must be borne in mind, that the law of 1846 admitting this competition found all the Colonies quite unprepared for such a change. They, and indeed many of the best informed portion of the public at home, were taken aback by the reckless boldness of the measure, forming as it did an inconsiderate stride forward in the march of free trade, the ruinous effects of which, on Colonial interests, could hardly have been foreseen by its projectors.

One more change has yet to be made by the Legislature, the equalization, namely, of all duties discriminative of different degrees of quality, already more than once referred to, and India will then have the field for her exertions left fairly open; for then nothing can be left for her to desire in the way of change until the meeting progress of free-trade shall have finally swept away *all* duties whatever. It is hoped that the facts, and figures founded on fact, gleaned together in the following pages, will afford sufficient evidence of what can be done in this country for the production of cheap sugar to encourage all those engaged in the trade to persevere in their labors; and sufficient proof that both in its cultivation and manufacture we possess all the elements of ultimate success in competition with the whole world. Let India fairly prepare herself for the struggle, and a fair share of the victory is assuredly hers!

Part II.

ON THE NATIVE CULTIVATION AND MANUFACTURE OF SUGAR.

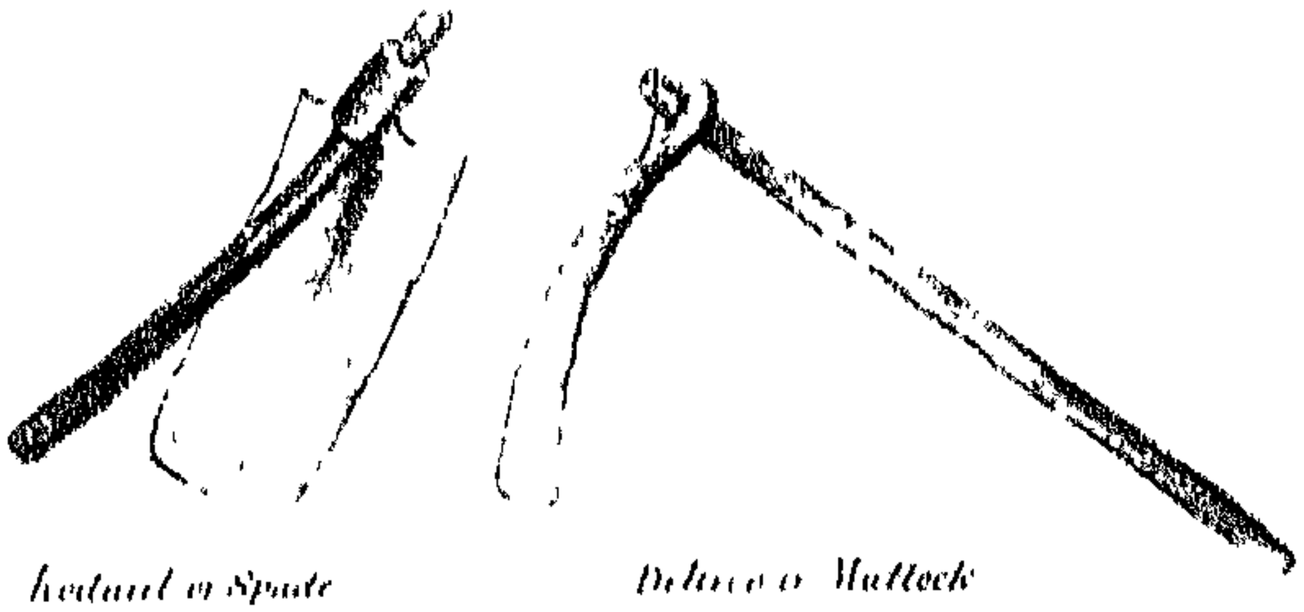
CHAPTER I.

ON THE NATIVE METHODS OF CANE CULTIVATION AND MANUFACTURE OF GOOR THEREFROM.

The following are the principal variations of sugar-cane practically found in cultivation in Bengal.

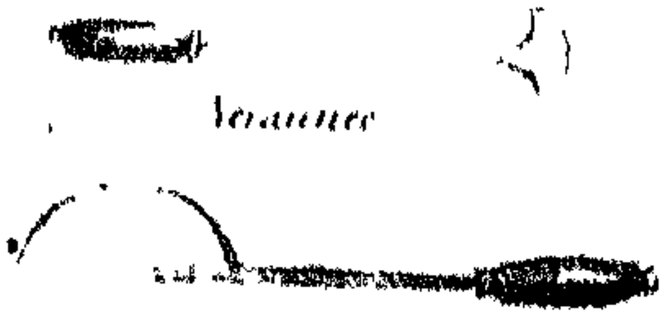
1st. The *Pooree* or yellow Native cane, which appears beyond all others to be a variety indigenous to Bengal, being found under cultivation in most of its districts, though occasionally under different names, and a little varied by the influences of soil and climate: to it is more especially applied the appellation of "*dasee*" or country cane. It grows in lower Bengal to the average height of seven or eight feet in the field, though as it leaves a great deal of top, the ripe portion when brought to the mill measures about two and a half feet less: in the districts North of the Ganges, as in Tirhoot, it rises to at least two or three feet higher; here however the juice is not so rich as in the smaller growth, in which the density is generally ten to eleven degrees of Baumé's saccharometer: the usual thickness of a full grown cane is one to one and a half inch in diameter at the thickest part. When ripe it is of a bright golden-yellow color, the leaves of a light green, straight, rather narrow, and pointed.

Scale 1 Foot to an Inch



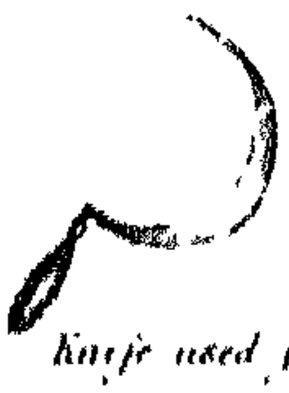
Kodaul or Spade

Dehra or Mattock

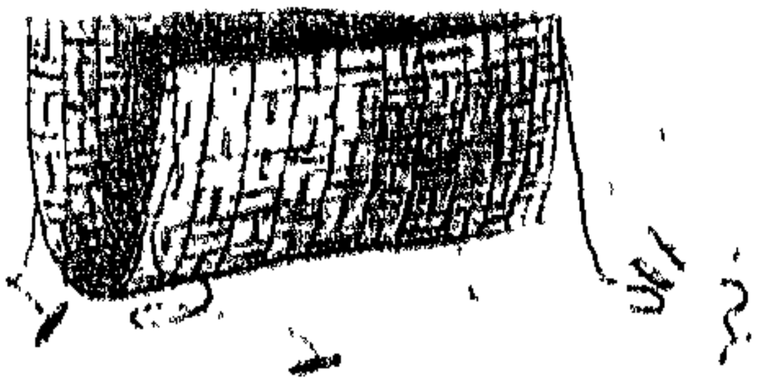


Nerauee

Dahra or Date tree knife

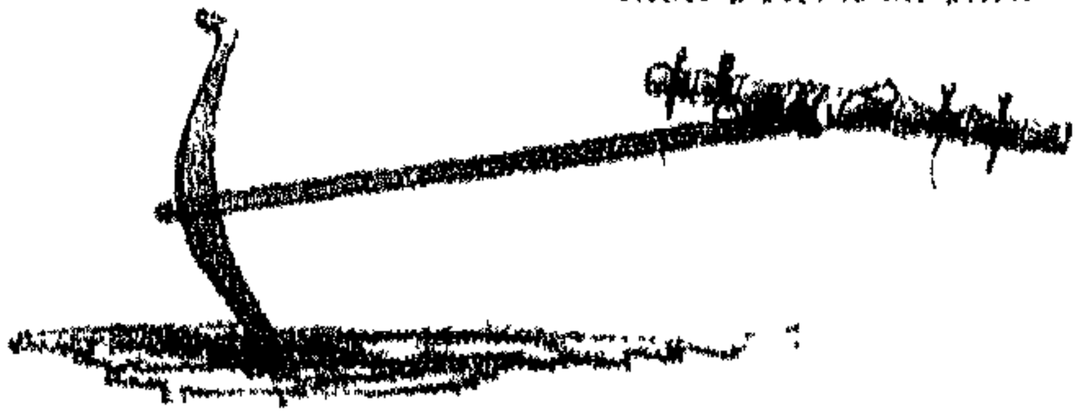


Knife used for cleaning Cane



Chaonee or Watering Basket

Scale 3 Feet to an Inch



Bengal Plough

2nd. The *Kajoolee* or purple cane; is of a dark purple color, the foliage of a darker green than the foregoing, the leaves broader and drooping; the height is also greater by one to two feet, and the stem somewhat thicker. It yields a rich juice, which is considered by the Natives to contain more saccharine matter than that of the Pooree; and is thought to make goor of a larger crystal: it is also esteemed by them for some supposed medicinal properties, but is much less cultivated than the Pooree, from its being so much more subject to the ravages of the white-ant; and it seems on the whole to be a less hardy variety. It is also more destroyed by the jackals than the preceding.

The description known as Bombay cane, and cultivated largely in Barasot, Hoogly, and other districts adjacent to Calcutta, appears to be identical with the Kajoolee, though perhaps more luxuriant, and it is difficult to imagine how it acquired the above appellation. The large or purple cane of Java appears also to be a kindred species. As a general character, it appears best suited for damp situations and requiring abundant moisture for its full development.

3rd. The *Koosee* or red cane, is of a light reddish-purple color, with traces of a striped appearance. The size is intermediate between the two preceding kinds, and it appears a hardier variety than the Kajoolee, and still more suited for low alluvial soil: it is the principal kind cultivated in the Kishnaghur, Jessore, and Furreedpore districts, and when healthy has a luxuriant appearance, with broad, light colored, drooping leaves; as I have proved by experience it does not flourish in the drier soils of the districts West of the Hoogly river. In Furreedpore the Natives are fond of planting a mixed crop of Pooree and Koosee, there called *dhal-soondree*, or "handsome-branched," mingled indiscriminately in the same field, though they are unable to adduce any reason beyond custom for this peculiarity. I am induced to refer the Batavian striped ribbon cane as a modification of this species.

4th. The *China* cane. This is a most valuable kind, from its very hardy character, withstanding the attacks of white-ants, jackals and other enemies, better than any other species, besides being less affected by drought and other vicissitudes of climate. It grows to the height of ten feet or more, and the average length of the prepared cane when stripped of its leaves and top, is five to seven feet; it has a thin stalk, the diameter in the thickest part seldom exceeding an inch to an inch and a quarter, with long joints and a hard rind, to which it no doubt owes its security from the teeth of the jackal; when ripe it is of a light yellow color.

In the hills of the Beerbhoom district, it is preferred from its withstanding the depredations of the wild animals, especially bears, abounding in those parts. It is said to have been introduced there many years ago by one of the Company's Commercial residents of the district. I believe also that the kind known as "Chinnear," and much cultivated in the Tirhoot and neighbouring districts, is the same variety; in Ghazeepore and Shahabad it is known as *Baar* cane, and there on the alluvial lands on the margin of the Ganges its hardihood is again frequently proved by its remaining half immersed for many days by the overflow of the river without sustaining damage. The name here given it of *Baar*, that is chur or alluvial, indeed sufficiently indicates its value in this respect, as probably no other species could outlive such immersion. It is thought by the Natives not to be so productive as the other varieties, and for this reason probably, has not become more generally preferred. In Burdwan, Hoogly, and the vicinity of Calcutta, it is never seen, owing to the wooden roller-mills, in general use in these districts, being of insufficient power to thoroughly reduce the hard rind and so extract the whole of the juice; but in all districts where the pestle and mortar-mills, hereafter to be described, are in use, this objection is not experienced.

Lastly, this cane is the only kind from which a good and profitable crop of rattoons can be obtained in Lower Bengal, the other varieties being unable to live through the long droughts and heat, with the attendant destruction from white-ants and other insects, prevalent through three or four months of the hot season.

The four plants above described I consider comprise all the species of cane cultivated by the Natives of India; and perhaps in the other Colonies also, however locally designated or influenced by the endless variety of soils and climates. These influences I have myself witnessed, and have been surprised at the rapidity with which their effects become apparent. As an instance I may mention, that some China cane which I introduced from the Agricultural Society's nursery into the Burdwan district, did not, for the first year of cultivation, exceed three-fourths of an inch in diameter, except at the joints, which were larger, giving the cane a knotted appearance; the rattoons from the next year's plant crop from these canes, being the third crop from the original stock, were thicker and with an uniform smooth stalk, approaching nearly in appearance to the Poorea cane. I am even inclined to consider the celebrated Bourbon and Otaheite varieties as modifications of the Poorea and Kajoolee canes of Bengal, greatly improved by their transplantation to another more favorable and distant climate: the fact is well known, and taken advantage of in the West Indies, that an improvement in the crop may be effected by planting the cuttings from any field in a distant part of the same estate. How incalculably greater an effect then may be expected from conveying the seed to a distant part of the globe, and to a soil and climate peculiarly favorable for its development; and perhaps a further corroboration of my opinion may be obtained from the fact of the deterioration of the Otaheite cane after the second or third crop when introduced into Bengal, as has been found in Tirhoot and elsewhere, except

extraordinary pains are taken by high and expensive cultivation to support its size and quality.

It may be appropriate here to notice, that the standard measure of a beegah of ground in Bengal, is 14,400 square feet, and that unless otherwise described, the beegah mentioned throughout this work is to be assumed as of that measurement.

The maund likewise which will be constantly referred to, is the Calcutta bazar or standard maund of 82$\frac{1}{7}$lbs. avoirdupoise.

As already remarked, the processes of cultivating the cane and manufacturing sugar therefrom throughout India differ but in slight details; therefore a description of the process in use in any one district will convey a pretty correct idea of the system universally practised. With respect to the section of India, which this work more particularly refers to, Bengal,—the district of Burdwan may be considered as one of the most generally productive, and highly cultivated, and probably also one of the most ancient sugar-cane growing districts of the Presidency. I have therefore selected the processes in use therein as a type of those of the whole country, and in describing them, which I purpose doing in detail, I hope to convey a succinct and general idea of India sugar-cane cultivation. I shall afterwards allude to the processes in use in other districts for the sake of noticing those points only where they differ from the Burdwan routine considered as the standard.

I. *Selection of the ground.*—The description of soil preferred is a brick-earth, that is, a mixture of sand and clay, or in native parlance a two part, or "doo-aongse," earth: that in which a stiff red clay predominates is considered the best of all descriptions. An excess of sand is avoided, as being generally infested with the great enemy of the sugar-cane in India, the white-ant; the black, cold and alluvial clays are also little valued as affording poor crops, unless very

highly manured. Next in importance to the quality of the soil is the situation of the ground; and it is indispensable that this should be chosen in a spot sufficiently high to be free from inundation in the rains, or at least sufficiently so as to ensure its never being more than two or three days subject to overflow in the extreme of an unusually high inundation from the rivers, as any stagnant water accumulating on the field is fatal to the crop. It must nevertheless be so situated as to be within the reach of irrigation, otherwise the long droughts to which it is sometimes subject, might prove equally fatal to it unless aided by an artificial supply of water. The high banks of the small creeks and rivers, which are generally sufficiently elevated to be above the reach of inundation, afford some of the best sites for sugar-cane in this district (Burdwan,) and indeed the same remark may apply to the greater part of Bengal. Such situations afford facilities for drawing away all superabundant rain water, and if the ground be slightly sloping, it is also preferred for the same reason.

Preparation of the ground. Six to ten, or often twelve ploughings are given previous to planting. A ploughing in this and neighbouring districts is considered as the work of one plough drawn by two bullocks over a single beegah of ground throughout a day's work, which commences at earliest dawn and lasts with little or no intermission until 10 or 10½ A. M., being about 5 hours of work, after which the cattle are allowed to rest for the remainder of the day. A single plough is however seldom or never worked alone, but two or three are set to work in a line, as the cattle draw more willingly in company, and these traverse two or three beegahs in the same space of time before described. The most usual course for cane lands is for ploughing to commence in October or November, whilst sufficient moisture yet remains in the ground from the previous rains for the plough to pass easily; two or three ploughings are given at this time, after which

an industrious ryot will throw in a dry-weather crop of mustard seed, teel, or gram, which they consider does not in any way injure the ground for the future cane crop, but is rather beneficial by helping to keep the land free from weeds: these crops are reaped about February or March, the time varying with the weather, and the first showers after that are taken advantage of to plough again at intervals, until sufficient rain falls, which usually happens between the 15th of April and 15th of May, to thoroughly moisten the ground and induce the ryots to prepare, by a final ploughing and harrowing, for planting. With the last ploughings also the usual manure for the ground is thrown in, being distributed with baskets regularly over the field and incorporated with the earth by the plough: cow-dung and the earthy sediment from the bottoms of dried tanks are the favorite manures; and occasionally the decayed indigo stalks or *seetee*, which are to be found accumulated near the vats of every indigo factory, are availed of, and form a rich manure, though if not fully decayed they are apt to attract the enemies of the sugar-cane, the white-ants. In this district no ground is planted with cane without manuring, and the impression is strong amongst the cultivators that the more manure they can give, the larger and better will the produce in goor result; so that the quantity they give is generally limited only by their means: the average quantity given may perhaps be estimated at 200 to 300 maunds per beegah.

Preparation of the seed.—The cane tops of the previous year's crop form the only description of seed ever used by the Natives: they place these tops, as brought from the harvest field in a nearly upright position, and closely packed in an oblong excavation made in the earth, and measuring about two to six square feet, according to the number of cuttings required to be packed in it: the excavation is about eight inches deep, and, as the cuttings vary from nine to eighteen inches in length, it leaves a good half of their

average length above the surface of the ground. After being evenly packed in this position, moist earth is placed close round them, a watering is given, and some of the dry leaves from the cane field are loosely piled over the whole to protect them from the sun: they are afterwards watered at intervals of two or three days, to keep them permanently moist, and in a week or two they begin to send forth green sprouts: the above process is called the *hauppur*, and is performed as soon as the cane of the previous crop is cut down in, January, February or March.

As soon as the green leaves have sprouted up from six inches to a foot above the cuttings, which usually happens in about a month from the time of setting, the period has arrived for the second process, of cutting into smaller pieces; in this each cutting is taken out singly from the *hauppur* and divided with a smart blow with a *daw* or bill-hook, into two or more smaller divisions, in such wise that each cutting shall now possess at least one or two healthy eyes, as the germs of the future plant in the field. These smaller cuttings are now replaced in the same order as before in the *hauppur* pit, and a solution composed of clay, cow-dung, and pounded oil-cake in about equal proportions, with sufficient water to form the whole into a very soft mud, is now poured equally over the whole, so as to envelope them in a thin coating or plaster of the composition; the dry leaves are now again thrown over all as a shade from the sun, and the seed is left, and moistened only by an occasional watering afterwards, should the weather be so dry as to render such necessary, until the day of planting. From any given number of large cuttings, double the number of good serviceable small cuttings is usually obtained.

The object of the above tedious process in the preparation of the plant cuttings is the certainty it affords the cultivator that he is placing healthy seeds, and no others, in the ground; and thereby ensuring with the greater confidence an even

and healthy crop. By placing the cuttings as they arrive from the field in a moist and sheltered situation, they survive safely through the hot and parching winds of February, March, and April; or until the first cooling showers of the equinox moisten the ground sufficiently for the preservation of their vegetable life in the field. Again, the process of dividing into smaller cuttings of one or two eyes to each, gives the cultivator the means of examining every single germ; as any decay or disease is apparent on dividing the cane by the cross section; and by clearing away the leaves of the former crop, enables him to examine and reject all that are tainted or injured by borers, ants, or other insects. The importance of this precaution becomes more apparent on remembering that gaps and deficiencies from defective seed in a cane field are not easily replaced here: the great object is to get the planting completed with the first good showers falling after the first day of the Bengallee month of Bysack, corresponding to about the 11th of April, and should the opportunity of doing this be lost, or a portion of the seed so planted decay and require replacement, if only two or three weeks later, the plants from these latter seldom attain the strength of those of the earlier setting.

Planting is now proceeded with as follows: the plants having been carefully removed from the *hamper* and carried to the field in light baskets; the laborers proceed in pairs, one man having a *kodaul* or Native spade, and walking along one side of the field in a straight line, lightly holing the ground as he proceeds, while his companion drops one or more of the cuttings into the holes so made at about 18 inches apart, the rule being that the cuttings contain together at least two good eyes to each hole; the distance between the plants is measured by the eye only, or sometimes by a piece of bamboo, eighteen inches (or one *haut*,) in length: on arriving at the end of the first row, the second is commenced at a distance of 18 inches from it; and so

on to the next and throughout the field to be planted, making the whole, when finished, with the cuttings 18 inches apart in both directions: the second laborer, or man who sets the plants, also covers them over, as he proceeds, with the earth that was taken out of each hole, and is followed shortly *after by another carrying a chatee or earthen water jar*, from which he throws about a quart of water, brought from the nearest tank or river, over each cane hole. In places where white-ants abound, a handful of pounded oil-cake is also thrown into each hole with the cane plants, which is often effectual in keeping these vermin off until the cane has assumed strength to withstand their attacks. The cuttings, after being covered in, lie about three inches below the surface of the ground. To a beegah of ground are allowed of small cuttings six *kowns* of 1600 each, or 9600 cuttings.

To the casual observer it would appear, that the above plan is defective in the placing the plants so near to the surface of the soil, where they are more exposed to the influence of the sun and drought, and their roots less likely to obtain a firm hold of the soil, than if set deeper: the reason assigned by the Natives for this shallow planting, *is the ever predominant fear of white-ants, which they* believe are more likely to attack the cuttings at a greater *depth from the surface.*

Digging is the next operation, and is performed first as soon as the plants have sprouted up a few inches above the surface in the field, which happens on the average about a week after planting: it is done by loosening the earth with the spade or *kodaul,* and throwing it up around the young plants, destroying at the same time all weeds: in addition to this, between every four rows the ground is cut rather deeper, so as to form a shallow drain, taking care that it is in the direction of the greatest fall or slope of the field: this is to afford a channel for the easy flowing

off of the water in anticipation of the coming rains. Cross channels are likewise marked out in the same way after every eight rows, to further facilitate the flow: and with every succeeding digging, occasion is taken to deepen them by degrees. Five to eight of these diggings are given during the growth of the cane, the last being when the plants are three to four feet above the ground, after which it is not deemed safe to disturb them with the *kodaul*, so that generally the digging is complete in two months from the date of planting.

With the second and third diggings it is usual to give additional doses of pounded oil-cake, mixing it into the loose earth around the roots of the plants: seven maunds is the average quantity of this material used per beegah of cane, of which two maunds are consumed in the first planting, and the remainder applied at the second and third diggings; as a fertilizer and antidote for white-ants and other vermin, it is highly esteemed by the Natives, and is no doubt of great value.

Tying up is the next process, and it is first done when the canes are one and a half to two feet high, by bending down the lower four or five leaves of each cane close to the stalk, and twisting them round all the shoots or canes that have sprung from one cane hole, thereby collecting them into a loose bunch. The second tying is given when the plants stand about three feet high, and is a similar process to the first: at the third time, when the plants are five to six feet high, those from three or four cane holes are bound together by their lower remaining leaves, twisted in the same fashion; and when the plants are unusually high, that is, ten to twelve feet, a fourth tying is given, by binding together three or more of the bunches collected by the third tying: this last is sometimes done with a wisp of paddy straw, the cane leaves being hardly of sufficient strength to support the weight of the plants in this latter stage.

This tying up is a tedious and troublesome process, but is never dispensed with in this district. The Natives consider its great advantages to consist, first, in promoting the growth of the canes, which is evidently in some degree the case, for by diverting the sap which would have gone to the further development of the lower and larger leaves, by breaking down the latter, to the growth of the cane itself and its green top, a new stimulus seems given to the plant, which becomes very evident to the eye, especially within a day or two after the first and second tyings have been given. The other reasons assigned for tying are the defence it affords against the attacks of jackals by the leaves being twisted tight round the ripe parts of the plant, and forming an obstruction to their teeth; and the affording a freer current of air through the cane field, and a more open passage for the operations of the cultivator in digging, weeding, &c. Lastly, it is considered as a protection against the casualty of the canes being laid down and broken by the wind and storms, to which these climates are so subject from March to October, and which the canes, by being bound firmly together, become so much the better able to resist.

Weeding is performed one, two, or three times after the cane has attained the height of three to four feet, according as the nature of the soil renders it requisite. In very wet seasons the weeds spring up in the best lands, and form a great drawback to the health and progress of the canes if not removed; the free open space between the cane rows, the rich soil, and the moisture necessary for the growth of the cane, afford every facility for the growth of these pests of the husbandman in the tropics: after the diggings are finished, they are removed by a small iron dibble or *neranee*, which picks out the roots of the weeds without disturbing those of the cane.

Watering is considered an essential part of Native cane cultivation in Burdwan and neighbouring districts; and as

before remarked, the ground is always chosen within convenient distance of means for availing of it, either from a tank or a river. The long droughts, to which this part of the country is liable, render this a very necessary precaution for the safety of the crop; for a continuance of three or four weeks of drought, accompanied by hot parching winds, is not unknown between February and May; and in such cases a good watering is indispensable to preserve the vitality of the plants, which would otherwise be scorched up or perhaps destroyed by the white-ants: these always increase wonderfully during the dry and hot weather, and disappear in proportion to the frequency with which the ground is flooded.

Frequently however, if not generally, the weather is more propitious after the usual planting period, and the ground is refreshed with benign and frequent showers, sufficient for the safe progress of the plant, in which case no artificial irrigation is required before the closing of the rains in October, or more frequently until November or December; sufficient moisture still remaining in the ground until those months for all purposes of sustenance for the plant: then however, should the returning dry wind and absence of rain for several weeks cause the ground to crack and open, the benefit of two or three waterings, sufficient at least to keep the ground moist near the roots of the canes, become necessary for their full growth; without this aid they would become stunted and in a measure dried up before the period of cutting in January or February. The white-ants too would inevitably renew their attacks at this season (October and November,) unless kept at bay by a moderate moisture in the ground; though as the cold weather advances, it aids in banishing them.

The method of watering most in use in this district is with the *cheeonee* or watering basket, which two men swing between them: it is suspended by a double string fastened to each side, and by alternately dipping it into the tank or

river, which forms the source of irrigation, and swinging it up with a jerk, which empties the contents at a higher level, they raise a fair and continued stream of water, sufficient to flood a beegah of ground in ten or twelve hours; for this however, at least five men are required to keep up a constant relief at the basket, as two get fatigued with the labor in half an hour or so, and require a similar period to rest themselves, whilst their two companions take a like spell, and so on alternately till the work is finished: the fifth man is employed in the field itself with a *kodaul*, conducting the water as it flows in between the canes by cutting channels here and there, in such manner that it is equally distributed over the field. In a large and uneven plot of ground great ingenuity and management are shown in this operation, in conducting the water along the higher ridges of the surface to be watered in the first instance, and thence distributing it gradually over the lower levels, so that the whole is watered without any unnecessary expenditure of labor. The lift of one *cheeonee* or basket as above described raises the water about two feet only, so that the number of these lifts must be increased and the same operation repeated, in *proportion to the height of the field to be watered above* the level of the supply. A hole is dug under the spot allotted for the dip of the second basket, into which the water from the first lift is conducted by a channel dug along the ground; the second lift in like manner supplies the third, and so on for the number of lifts required. It is sometime necessary to employ eight of these lifts to raise the w from the nullahs to the level of the cane on their banks, and less than two lifts is very seldom sufficient f the lowest fields.

Another simple contrivance for raising water for small heights, is much in use in the Western part of Burdwan and in the Beerbhoom district: it consists of the half of the hollow trunk of a cocoanut tree, divided lengthways, and

balanced with the hollow upwards on a pivot placed under it and nearly half-way from the broad or root end of the trunk; this pivot is fixed close to the bank of the water to be elevated, and about eighteen inches above the water level, over which the large end of the trunk projects: if the small end of the trunk is now elevated, the large end which acts as a scoop or spoon dips under the surface of the water sufficiently to fill it with several gallons; the small end is then pressed down again with a jerk till it is nearly in a horizontal position, and the impetus thus given causes the water so scooped up to rush along the hollow trunk and discharge itself with some little force at the other end: to balance the trunk correctly, as the base or scoop portion is heavier than the narrower part or the delivery side of the pivot, a lump of damp mud is heaped on a small piece of board placed across the latter, and the whole secured with a rough binding of rope or grass, and this acts as a counterpoise. This is not so effective or quick a mode of irrigation as with the baskets, but is more simple and easily managed, there being no weight to lift bodily, and the strength of one man's hands is sufficient to alter the equilibrium of the trunk, and throw up the water with very slight exertion.

Cutting.—The cane is fairly ripe never earlier than January under Native cultivation, and their usual time for cutting may be considered as ranging from the 13th of that month to the 13th March, varying a few weeks earlier or later according to the character of the season. The Natives seem fully aware of the importance, so much insisted on by West India planters, of allowing their crops to ripen well in the field, to ensure a good return in sugar as well as to shorten and facilitate the process of evaporation. They are also quite aware of the advantages of using their cane fresh from the field: they cut down early every morning a few bundles only, sufficient to keep their mill at work until the next morning's supply is brought in.

The instrument for cutting is the ever-useful *kodaul*, with which they divide the cane as close to the ground as possible, the workman holding it in his right-hand and striking it with force against the roots of the cane, while with his left he presses the bundle of cane aside to give room for the blow. As the canes are laid down by the cutter they are taken into other hands to be cleared from all leaves, which is done with a light circular knife or sickle; the small rootlets adhering to the lower joints are also quickly cleaned off by the same operation, after which a smart blow from the sickle *divides the ripe cane from the raw or green top*: the *latter* is then taken in hand again, and the lower twelve to eighteen inches containing four to six perfect cane-joints is struck off for cane plants for the ensuing crop: all the remaining green stalk and leaves are used only as food for cattle: the dry leaves are partly used to assist the fuel, that is the dried cane trash, for boiling the juice into goor; the remainder is left on the field to be burnt before the plough is applied to the land to prepare for the succeeding crop, or is sometimes sold as fuel to the potters of the next village.

As the cleaned canes accumulate they are collected into bundles of about a maund weight each, and are thus carried to the mill. *The produce from a beegah in cleaned canes*, with a fair crop, varies from 180 to 100 bazar maunds; 150 maunds per beegah may be considered a good average; and to cut down and clean the whole produce of a beegah with such a crop in a day would require the labor of thirty men working well for ten to twelve hours.

As may be inferred from the above description, the produce in cane is in great measure independent of the seasons, and varies more in proportion to the degree of care and trouble bestowed on the cultivation: in fact, on ground favorably situated for irrigation, and if attention and means are not stinted, the sugar-cane under Native management may be considered as an almost certain crop. After it is once

planted, the case is very rare indeed of a cane field being ploughed up and abandoned for another crop; though I have known this to happen in the case of very dry weather in April and May, when the cane has begun to wither or get partially destroyed by white-ants for want of moisture, and the expence of keeping it alive by irrigation at this peculiar season, when the rivers and tanks are usually at their lowest level, has been considered too formidable by the poor ryot.

A custom very generally adopted by the Natives is the sowing, just previous to the commencement of the rains, a single row of a sort of pulse called *urrhur*, round the margin of each cane field: it is of very rapid growth, and in four or five weeks rises to the height of the cane, and throwing out a number of light branches thickly covered with leaves, forms a good and regular screen or shade for the cane, in which its advantage is believed to consist; as the pea which is produced from this plant leaves a profit on the trouble and expence of sowing it, independent of its supposed advantage to the cane, the expence of cultivating the latter is not considered to be in any way increased thereby.

The expence to the Native ryots of cultivating their sugar-cane is difficult, or almost impossible, to estimate with any degree of correctness: the reason for this is their seldom or never employing hired laborers to assist them in it, depending almost entirely upon the members of their own family, of both sexes and all ages, to attend to its culture simultaneously with that of their other crops; for no ryot ever thinks of cultivating cane alone, but one holding twenty to thirty beegahs of land may devote one to three beegahs of it annually to cane cultivation, the rest being left principally to paddy, their favorite crop, as calling for the least exertion and being the most certain and useful in its results: or a portion probably to the different varieties of pulse and oil-seeds; a small patch being always reserved near their dwellings for vegetables. A ryot is frequently content to

cultivate as little as half or a quarter of a beegah of cane, and one who has two or three beegahs in this crop is looked upon as a man of no small substance amongst them. The *only way in which an approximate estimate can be formed of* the actual cost of cultivation to the ryot, is to calculate the time which the different operations in the field call for at a rate of wages to the number of persons engaged in it proportioned to what they could earn were they to hire their services to other parties, or devote a similar portion of their time to the raising of any other useful crop, as for instance, paddy.

In doing this we must take into account, that a laborer could afford to work for a lower return of wages per diem on his own farm in the vicinity of his house, than if engaged to work for another party at a distance therefrom, inasmuch as his food and lodging would in the latter case be more expensive than if residing with his family and feeding from the produce of his own fields, gathered in at the very lowest cost of production. Add to this, the stimulus which is naturally imparted to his exertions by the consciousness of working for his own sole and peculiar advantage, instead of as a hired laborer for others, for human nature works the same here as elsewhere; and we shall not over-estimate the difference between the value of the work obtained under the two different circumstances at one-third in favor of the ryot cultivating for himself: in other words, taking the ordinary rate of wages in the Burdwan district at three rupees per month for an able hired laborer, or one and a half anna per diem; two rupees per month or one anna per diem will be a fair equivalent to him working on his own ground for his own direct benefit.

The following calculation of the expence to the ryot of cultivating a beegah of cane is accordingly made on the above basis of value for the labor of himself and family: the term family, it may be observed here, should be taken in rather an extended sense; for it generally happens that the nearest

neighbours in any village community, though living in separate dwellings, are so closely connected by ties of caste or relationship, that should a ryot require at any moment more labor than his own immediate roof can furnish hands for, he has no difficulty in loaning the services of his neighbour, he of course reciprocating in his turn a like accommodation when required to do so.

	Rs.	A.	P.
Ground rent on the average per beegah, ..	2	0	0
Ploughing eight times, at 1½ anna per plough,	0	12	0
Manuring, 400 baskets of half maund each, or 200 mds., expence of carrying on fields, ..	0	12	0
Oil-cake, seven bazar mds. at 3 annas per md.,	1	5	0
Harrowing once, ...	0	2	0
Cane plant, including the *hauppar*, ...	2	4	0
Planting, ten men for a day, at 1 anna each, ..	0	10	0
Digging, six times, at four men each time for a day, or twenty-four men, at 1 anna each,..	1	8	0
Tying up, four times, eight men each time, or thirty-two men, at 1 anna, ...	2	0	0
Weeding twice, with eight women or children each time for a day, together sixteen, at ¼ anna each, ...	0	12	0
Watering, say three times with the *cheenee* and with two lifts, ten men for a day to each watering, in all thirty men, at 1 anna each per diem, ...	1	14	0
Cutting cane, thirty men for a day, for cutting, clearing and carrying to mill, at 1 anna each,	1	14	0
Hire of cattle, tools, baskets, &c. say, ...	1	3	0
	17	0	0
From which deduct value of cane plants reserved, and applicable for planting next crop or for sale, ...	2	0	0
Net cost of a beegah of cane delivered at the mill, estimated as weighing one hundred and fifty maunds of cleaned cane, ...	15	0	0

In the above estimate the manure is not valued, it being the produce of the ryot's own cattle shed, and costing him *nothing beyond the conveyance to the field*: *for the instances* of their purchasing manure, either that from cattle or tank earth, for this purpose, would be so rare as not to be worth including in the present account.

I can only repeat in conclusion, that throughout the whole of the foregoing operations, continued attention is called for on the part of the ryot, and each must be executed at the proper season; for if the favorable time for the different works of planting, tying, watering, &c. be allowed to slip bye, any subsequent attention is of little avail to recover the ground that has been lost by such inattention.

Having now traced the cane through its cultivation to the point of its carriage to the mill, I proceed to describe the Native process of transforming its product into goor.

Grinding.—The Native mill universally used in the Burdwan district is that composed of two horizontal wooden rollers, placed one above the other in close contact, and supported by their axes being passed through corresponding holes in two upright posts fixed firmly in the ground. Each roller has one end of its axis projecting several inches beyond the perforation in the upright post, and to those ends are fixed two pieces of bamboo, about three feet long, in the form of a cross, which are *used as handles or levers wherewith to turn the rollers* by hand; one such cross being at each end of the mill, and so allowing two men to work it at once. The rollers are about two and a half feet long and six inches diameter, and the axes about half the size: the rollers are corrugated by being turned with grooves on them to facilitate the crushing of the substance of the cane between them.

Four men are required to be in constant attendance on the mill, two to turn it as above described and two more to feed it with cane, one sitting at each side of the rollers; the first feeder takes four or five canes in his hand and passes them

through the mill; they are then handed back over the mill by his fellow on the opposite side to the first, who passes them through again, and so on for four or five times until the canes appear tolerably dry and flat; the first feeder then takes them collected in his right hand in a bundle, one end of which he introduces into the mill, and as the whole is drawn through, he twists them round with his hands in such way, that the whole passes through something in the form of a coarse rope; this is the finishing stroke, and generally little or no moisture can be observed in the cane-trash after this final pressure.

Any one who has seen this process in operation must feel satisfied that, notwithstanding its extreme tediousness, it affords a very effectual mode of extracting the greatest practicable proportion of sap from the cane; in this respect indeed, it may compare favorably with an ill-set or ill-regulated European mill, with its iron rollers and all improvements; but my belief is, that the latter, if well set, the motion properly regulated, and the canes evenly and carefully fed, is quite as effectual in its result of juice extracted, though it can hardly be more so, than that of the rude Native machine just described. For if the canes are tolerably long, so as to allow the Native a good hold with his hands, and to give them a close and compact twist as they finally pass between the rollers, I am of opinion, that no arrangement of iron rollers yet used could be *more* effectual.

As the juice is pressed from the canes it trickles down into a common earthen pot, sunk in the ground under the rollers, and neatly plastered with mud; this vessel holds about two quarts, and as often as it becomes nearly full the contents are ladled out with a smaller earthen pot, or with a spoon formed of the half of a cocoanut, into a larger vessel set on one side of the mill, of about ten to fifteen gallons' capacity; and when this is nearly filled, sufficient is collected to commence the operation of boiling.

This is conducted in a series of earthen pans, generally twelve in number, set in two rows over a long fire-place common to all: this structure is entirely of mud, with a common grass-thatched roof, supported on bamboo posts, to protect it from the weather. The furnace is about ten feet long by five broad, and the walls raised about four feet above the ground, the furnace pit being sunk about a foot deeper: it has also a hole at each end of about a foot square in size, one for feeding the fuel and the other for the escape of the smoke. The dried cane-trash and cane leaves generally afford sufficient fuel: wood however being occasionally used to assist in cases of the weather preventing the drying of the trash; or at the commencement of working before sufficient trash is accumulated. The earthen pans are of two descriptions: the first eight, reckoning from the mouth or feeding-hole of the furnace are broad and shallow, that is, about eighteen inches diameter, and nine or ten inches deep: into these the juice is first poured as brought from the mill, and their shape affords facility for skimming: the boiling is mostly performed in the remaining four pans, which are larger and deeper, and of a caldron-shape, which renders the contents much less likely to boil over when in violent ebullition. The heat is attracted more to the latter, or boiling end of the furnace, by leaving holes or notches in the earth-work round the pans where they are set, whereas in the first or clarifying pans, no such apertures are left, and the first four or six consequently get the effect of such heat only as is radiated from the fire below, unassisted by the attraction of any draft.

Thus a simmering only is kept up in the first pans, and but little boiling takes place until the juice gets into the third or fourth pair; and as skimming goes on throughout the eight flat pans, but little scum remains by the time the juice reaches the larger or boiling ones: these last are kept constantly about half full by ladling the juice from

the pans next behind them in the range, as fast as the contents diminish by evaporation, these again being supplied as continually from those next behind them, and so the process proceeds continuously, the inspissated juice or goor being ladled out from the last boiling pans of the series as fast as it arrives at the proof or granulating point, and its place immediately occupied without damping the fire from those next to them.

When once the furnace is lighted and the boiling commenced, it is the object of the ryot to keep up the supply of juice, and carry on the work if possible without intermission, until his whole crop is completed, both for the sake of economy in his fuel, more of which would be expended were the whole apparatus allowed to cool, as well as the probability of the earthen pans cracking and becoming useless by being cooled down after such use. His neighbours therefore, or other extra workmen, are called in to assist at this time, and the mill is kept at work night and day, with little intermission, until the whole is crushed. The working off of a beegah of ground in this way occupies from ten days to a fortnight of continued labor, and produces from ten to twenty bazar maunds of goor, according to circumstances of soil, weather, and attention bestowed upon the cultivation.

Some skill is called for in deciding when the juice is sufficiently boiled to form good goor, that is, to bring it to such a consistency, and no further, as will allow of a free granulation of the crystals, as well as for the separation of the molasses: if well boiled, after the goor is kept undisturbed for a few days, the crystallized portion separates and accumulates at the bottom of the vessel containing it, leaving the molasses to float on the top, from which it can be easily poured off if required. Good juice produces about one-tenth of its weight of goor.

The expence on labor required in the manufacturing process above described, may be calculated as follows—

On one beegah of Cane.

Two sets of four men each (two to turn the mill and two to pass the canes through and return them), for night and day work, is eight men; reckoned at two annas per day each, as the work is more than usually laborious, ...	1	0	0
Five men to bring fuel and attend to the boiling, skimming and firing day and night, at one anna *each, for twelve days,*	3	12	0
Hire of the mill for same time, ...	0	12	0
Value of earthen boiling pans and utensils, labor bestowed in erecting ditto, and shed, ...	2	8	0
	8	0	0
Add *cost of cultivation per beegah as per former* account, ...	15	0	0
Co's. Rs. ..	23	0	0
Produce ten to twenty maunds, or on the average fifteen bazar maunds of goor, at a cost of 1-8 per maund, ..	22	8	0
One bazar maund of skimmings, ...	0	8	0
Co's. Rs. ..	23	0	0

The skimmings are disposed of to the Native tobacconist, who uses them in the composition of hookah tobacco. These being excepted, the goor comprehends the whole produce of the sugar-cane; being analogous to the sugar of the West India planter when first put into the hogshead before the reeds or stops are withdrawn to allow the molasses to drain away. In this state it is always sold by the cultivator to the *Moyrah*, or Native sugar maker, whose province is always totally distinct from that of the cultivator, and who subjects it to various processes in forming it into as many different kinds of sugar, such as *khaur*, *dulloah*, *&c.* hereafter to be described.

Before proceeding to this subject however, it may be interesting to compare the above account of the production of goor with the statements given in the "Appendix to the Report on the Sugar Trade," published by order of the Court of Directors of the East India Company in 1822. In this work, full details are given, from the reports of the Company's Collectors of Revenue and Commercial Residents in Bengal, of the processes of Native sugar production, and the cost of the goor, in their respective districts; and at page 110, a short summary is made of the different calculations for Burdwan and the neighbouring districts, as follows,—the same having been framed from evidence furnished in the year 1792.

Cost of cultivating a beegah of Sugar-cane and boiling its produce into Goor.

In Beerbhoom, by the Resident of Sonamooky's account, ...	Sa. Rs.	20	14 6
„ Burdwan, by the Resident of Radanagore's account,..	18	0	0
„ Ramcchatty and Amboah, in Burdwan, by Seesoram Mojumdar's account, ...	19	14	0
„ Radanagore, in Burdwan, by ditto ditto, ..	18	3	0
„ Buro Pergunnah, near Sulkea, opposite Calcutta,	22	14	0
Total, ..	99	13	6

or in round numbers, twenty Rupees per beegah; but in the above estimates no allowance is made for the charge of watering except in that of the Beerbhoom district, a part of the business which is so essential, even in the most favorable years, to the success of the crop, that no estimate which does not include it can be deemed a fair one.

On comparing the net produce per beegah in goor, as stated in the evidence above referred to, with the result

as gathered from my own local experience and enquiries, there is found an apparent falling off in the average quantity now produced. By the official report to the Company it was estimated as follows :—

From Sonamooky,	.. ..	20 mds. of goor per beegah.
„ Radanagore,	.. ..	19 ditto ditto.
„ Ramcolatty and	Amboah,	15 ditto ditto.
„ Baro Pergunnah,	.. ..	14 ditto ditto.
Total,	.. ..	68 mds.

or, on the average seventeen bazar maunds per beegah, being two bazar maunds beyond what I have felt justified in stating the average to be. This, I think, from an examination of the "Reports," may probably have arisen from the evidence collected by the Company's Officers having had reference to the highest, or a comparatively high average of production, without taking into account all the variations of soil and seasons. I am of opinion, that the produce of twenty maunds per beegah is seldom reached in Native practise, and never so on the average of any number of fields taken indiscriminately in these districts; though under peculiarly favorable circumstances as much, or perhaps somewhat more, may be realized.

In so far however as we can be guided by the result of the enquiries made at these two distant periods of time, how little variation appears therefrom to have taken place in the actual expence and results of the cultivation during the *last 50 years* in these districts, (and there is no reason to suppose any greater variation in other parts of Bengal,) and how apt an illustration does this afford of the little improvement to be expected *from* the *undeviating* and *unaided* routine of the Native cultivator!

Before proceeding with the next division of the subject, it will be as well to conclude this by noticing the variations from the Burdwan routine observed in other districts, in

most of which much less care and attention are bestowed on the cultivation; and it is frequently proportionably cheaper, when reckoned on the beegah or on the maund of goor produced, though the produce may be inferior both in quality and average produce per beegah.

The ground rent varies greatly in different localities, being as much as 8 to 9 Rupees per beegah for the best land in the Benares district, 5 to 6 Rupees per beegah for the ground suited to the so called Bombay cane in the neighbourhood of Calcutta, and as low as 4 to 8 Annas per beegah in the northern parts of Tirhoot and elsewhere, so that a considerable variation in the gross expences of cultivation will result from this cause alone.

In *Ploughing*, little or no variation occurs in the method or implements used, though the number of ploughings varies in proportion to the care bestowed on the cultivation. In Benares, they frequently give sixteen to twenty or more ploughings between June and September, and again two or three times before planting in the beginning of the following year, when they are obliged to irrigate the ground from their wells to moisten it sufficiently for the plough to pass.

Manuring likewise varies, but principally in degree, and but little in the description of manure applied, except in Benares and other pastoral districts to the westward, where it is customary to lodge the sheep on the ground after it is ploughed, for three or four nights successively, their droppings forming a manure which is much valued.

Preparing the Cane plants and Planting.—In the preparation of the seed much less care and labor are bestowed in most districts than in Burdwan; in the Western Provinces, where planting takes place in January, February and March, before the previous crop is cut down, the plants are cut in the usual lengths, but undergo no other preparation beyond a steeping in water for one night previous to planting, and as they are merely cut down from the next field when wanted,

this part of the work is much simplified. In Benares as well as in Ghazeepore and the neighbouring districts, planting goes on up to April or May, though the earlier crop is considered the most productive; in the scale with the latter however, is to be placed the extra expence of irrigation to preserve the vitality of the plant during the hot months. In planting, throughout the Western Provinces, it is customary to drop the cuttings into the furrow made by the plough, and not to hole with the spade as in Lower Bengal. In Behar, where they frequently plant as early as November, the plan of sowing and watering is similar.

Digging and Weeding are operations less practised in many of the other districts than in Burdwan. In the alluvial soils of the more Eastern districts, Furreedpore, Pubna, and Burrisal, the plant springs up with such vigor as to effectually check the growth of weeds, and renders their removal unnecessary. In the Western Provinces, little trouble is taken to remove them, and indeed after the first two or three months' growth, the canes spring up so thickly, no alley or space being maintained between the cane rows, that it would be difficult to penetrate them for this purpose.

Tying up is also an operation that seems confined to the districts of Burdwan, Beerbhoom, Kishnagur, Jessore, Pubna, Hoogly, and the districts around Calcutta, though there appears no satisfactory reason for its not extending further, if productive of real benefit. In the Western Provinces, it is also partially practised, apparently following local custom as in Bengal.

Watering seems to be more or less indispensible in every district except in the damp alluvial soils of Furreedpore, Backergunge, Pubna, and some other districts of the Northern and Eastern parts of Bengal, where it is not resorted to, except occasionally in very severe droughts: the basket lift is the plan of irrigation most generally adopted throughout Lower Bengal; but in most of the Western districts, where

cane is cultivated at a distance from the rivers, recourse is had to irrigation from the numerous wells with which the country abounds: from these the water is drawn by bullocks yoked to a pole, by which a roller is turned, and round the latter is wound a rope having a large bucket suspended to each end; the bullocks moving in a circuit round the well bring the buckets to the top alternately, where they empty themselves by means of a catch into a wooden gutter, and this communicates with the channel to the field to be irrigated. The bullocks are so well used to this labor, that on the emptying of the bucket on its reaching the gutter, they are accustomed of themselves to turn round and reverse the motion of the roller, moving in the opposite direction without other guidance. One such well and apparatus, with four bullocks, two to work from daylight till near noon, and the other pair from 2 P. M. till sunset, is capable of watering two Bengal beegahs in three days, at an average expence of twelve annas per beegah.

The methods in use in the *manufacture of goor* from the cane, appear to vary no less than in the cultivation of the cane itself. The mill composed of wooden grooved rollers, described as general in Burdwan, is of limited use, being found elsewhere only in the Kishnaghur, Hoogly, 24-Pergunnahs, and Barasat districts. The mill of the pestle and mortar construction is in far more general use, though varying in size and in the materials of which it is composed, in different districts.

In the Benares and adjacent districts, it has the mortar composed of stone, the basin which forms it being cut out of one end of a stone cylinder which is set upright in the ground. This basin is cut in two chambers or divisions, one over the other; the upper being about a foot in diameter and the same in depth, with sides sloping inwards from the rim: the lower division, which opens from the upper, is of a hollow spherical shape, and about 6 inches diameter.

The pestle is made of hard wood, and of a shape to fit the mortar, being rounded into a ball at the lower end to fit loosely into the lower chamber, while the stem works round the inner surface of the upper basin, and crushes the pieces of cane, which are four to six inches long, and thrown under it by the attendant workman as it gyrates: the pestle-handle is a pole twelve to eighteen feet long, standing obliquely from the mortar, and from its summit is suspended, by a long bamboo hanging perpendicularly down, a horizontal pole or boom, one end of which works against the outside of the stone cylinder by means of a semi-circular wooden rest, in the same manner as the gaff of a ship: to the outward end of this boom, near to where it is suspended by the bamboo before described, are attached a yoke of oxen, which give the moving power to the machine by walking continually in a circuit round the mortar. A small hole from the base of the lower chamber conducts the juice out at one side of the cylinder, from whence it falls into an earthen pot placed to receive it.

This is identical with the common oil mill used by the Natives throughout India, and applied with a few modifications to the expression of cane juice in more than half its districts; and this it does very effectually, however tedious the process. Throughout Dinagepore, Rungpore, Purneah, Bhaugulpore, Behar, Patna, &c. it is of a smaller size than above described, and the mortar is composed of a block of wood of the jack or mangoe tree. The crushing power is increased by the weight of the bullock-driver sitting on the end of the horizontal boom behind the cattle, and additional weight is also frequently given by blocks of stone or earth piled near him or forming his seat.

This mill is said to express about thirty-two maunds of juice daily; which may be estimated as equal to sixty-four maunds of cane, or a beegah of the average productiveness of Bengal, to be worked off in two and a half days; proving it to be a much more effective machine than the roller-mill of Burdwan.

It is evident that in the construction of these mills the lever is the mechanical force most largely availed of. Query: Could not this principle be effectively applied to the crushing of canes worked by the great motive power of the age we live in—steam? And would not a mill so formed prove of more simple construction and less liable to derangement than the triple roller-mill now universally preferred? These are questions which may be not altogether unworthy the notice of those of our Engineers who have devoted their attention to improvements in sugar machinery. But this is a digression.

In Furreedpore, a description of mill is used made with rollers on the endless screw principle. Two upright rollers are strongly fixed by their axes in a wooden frame, one of them being attached to an upright pole, from the summit of which a diagonal rod is suspended, and to the lower end of this a bullock is yoked, which turns the rollers by being driven in a circuit round the mill; the rollers are cut with corresponding grooves forming the worm of a large, dingonal screw, so that the turning of one of them causes the other to revolve with it, and draws the cane as fed by the attendant through the screw, at the same time crushing it in its passage. The cane is passed through the screw several times, as in the horizontal mills, and extracts the juice, which as usual falls into an earthen pot placed under the mill, with similar effect. A mill on this principle is also said to be in use in some districts of the Madras Presidency.

The *boiling* of the juice into goor in Benares, Ghazeepore, and neighbouring districts, is performed on the same principle as in Burdwan; the only difference being, that in those districts one long row of earthen pots is used in lieu of two shorter ones; and that the end or last pan, in which the boiling is completed, is made of iron instead of earthenware: the number of earthen pots or clarifiers attached to it is uncertain, varying from five or six to a dozen, according

to local custom in different districts. Considerable advantage on the score of safety is gained by having this last pan, where the greatest heat is applied, of metal; as no loss can then ensue from its breaking and precipitating the whole of its contents into the fire below, an accident which occasionally befals the earthen utensils. In some parts of Benares all the pans are of iron.

In some districts it is customary to boil the goor to a very stiff consistency, which causes the molasses to separate with great difficulty unless some water is used to liquefy it. In other places after it is taken from over the fire and set in an earthen vessel to cool, it is beaten with a flat stick constantly, until by cooling it gradually becomes too solid to move the stick through it: the effect of this is, that the crystal becomes so comminuted that the molasses is thoroughly incorporated with it, and it has the appearance of one uniform mass, very much resembling cheese to the touch and eye: this is known by different names, as *bhèlee*, *pattilee*, &c. At Rajmahal, and most of the districts North and West of it, the grain goor is known by the name of *Raah*; but many other local names are given to it in various parts of India. The Ghazeepore *bhèlee* goor is made by beating the inspissated cane juice, with a bamboo rod, in the manner above described, in the same pans in which the boiling has been conducted: on the goor arriving at its proper consistence, the pans are lifted from over the fire and placed on the ground, where the beating is continued until the goor is too stiff to be further moved; when cold, the mass is turned out of each pan, and may be kept for a considerable time without any molasses separating from it.

It has been mentioned, that no *rabbee* crop is ever obtained by the Natives in the Burdwan district: this may be said to be the case throughout India, with little exception, the ground being ploughed up for the reception of some other crop as soon as practicable after the cane is cut. In parts of

Behar however, one very inferior ratloon crop is taken off in the second year. Some of the more prominent peculiarities of the cultivation in different districts will be hereafter noticed in the last portion of the work, which refers to the sugar capabilities of the districts taken in detail.

CHAPTER II.

ON THE NATIVE MODE OF CULTIVATING THE DATE TREE AND THE PRODUCTION OF GOOR FROM ITS JUICE.

The production of date tree sugar is a branch of industry which, with reference to the usually slow progress of native exertion in any new channel, has increased wonderfully during the last fifteen years; but more especially so since the impulse given to sugar production in India through the modification of the sugar duties in 1837, and through the encouragement thereby afforded for the embarkation of British capital and the application of British machinery to sugar production. A more than ordinary increase in this description of sugar was under such circumstances to be looked for, as a natural consequence of its cheapness, good aspect as to grain and color, and the contiguity of the date tree districts to Calcutta, the grand mart for its sale, and the outlet for its exportation to Europe.

The tract of country more particularly occupied by this cultivation extends nearly due East and West, from Kissengunge in Kishnagur, to a little beyond Nollehit in the Backergunge district; and North and South, from the vicinity of Comercolly in the Pubna district, to the borders of the Sunderbunds; thus occupying on the map a surface of about 130 miles long, East and West, by about 80 broad, North

and South. Its principal districts are therefore Jessore, Furreedpore, and Backergunge with portions of Nuddeah, Barraet and Pubna;—but beyond this tract, little or no date tree sugar is manufactured; although the tree is often cultivated in other districts, and may be occasionally met with in most parts of India.

This one species of palm only, *Phœnix sylvestris*, is availed of for the production of sugar, though many others of this tribe possess in their sap highly saccharine properties, from which there is little doubt sugar might be profitably obtained. I may instance *Cocos nucifera*, from which good goor is commonly made in Province Wellesley, and *Borassus flabelliformis*, or the Fan-palm, from which, throughout Bengal, a saccharine juice is obtained and used for intoxicating purposes, and frequently as a substitute for yeast in making bread; but which is said by the natives to yield also a sugar of good grain and greyish complexion.

The date palm requires a humid soil and climate, and flourishes best in the vicinity of water; though it must be above the reach of the annual inundations from the rivers. Like most of the palm tribe, it seems to prefer the vicinity of the sea-shore, and is less often found on the high grounds of the Western Provinces; though on the Southern bank of the Ganges, extending from Rajmahal to Monghyr, a great many trees are met with: their valuable juice is here misused by being fermented and drank as an intoxicating beverage, and its conversion into sugar is unknown.

The trees are never planted with much regularity by the Natives, many of them being set in the hedges surrounding their fields appropriated to rice and other grain. Nevertheless, since the cultivation has so greatly increased of late years, plantations have been formed to no small extent, and some attempts have appeared at planting the trees in rows and at regular distances: yet it is evident, the aid of the measuring rod or line is never considered as at all required in the

work. In such plantations the trees are placed 10 to 15 feet apart; so that sufficient space is left for cultivating an oil-seed or other dry crop between them, without its being injured by the shade of their leaves: indeed, I have never heard of any crop so grown being less productive than in the open field; except that of indigo, which I have been informed by an experienced planter who tried it, suffered through not obtaining the full benefit of the sun's rays. As the modes of planting, extracting the juice, and boiling the same into goor, differ but in trifling details throughout the date tree tract, I purpose giving a detailed description of the routine as practised in the principal date district, Jessore, as a fair example of the whole.

The trees attain a height of 15 to 25 feet when full grown, according to the nature of the soil they grow in. The annual abstraction of their sap evidently stunts their growth very much; a very plain proof of this is occasionally afforded in the date districts by the owner of a plantation leaving one tree sacred and untouched by the knife; he is prompted to this by a superstitious notion, that by so devoting one tree to his *Dèb* or favorite deity, a greater productiveness will attend the rest of the plantation, and it consequently may be seen towering above its companions to twice their height, or more.

Planting.—The trees are always raised from seed. The fruit ripening in June or July, the seeds are collected and sown shortly afterwards a few inches apart, in a moist spot selected for a nursery, near the cultivator's house. They soon vegetate, and become strong plants; are weeded and watered occasionally during the following dry season; and are ready for being planted out in the field in the succeeding April or May, after the first showers of the season. The ground destined for their reception is well ploughed, and without any assistance from manure, the plants are then placed in the ground, each in an extempore hole made with the hoe or *kodaul*. By the time the rainy season closes, about the

following October, they are strong young trees, the leaves three to four feet high; and any accidental vacancy occasioned by any of them having been destroyed by cattle or other cause, is then filled up.

The roots are occasionally cleared of weeds; and should the ground not be in yearly crop, a ploughing is sometimes given *for the benefit of the trees*, as this improves them by loosening the earth around them and allowing more scope for the roots. With these exceptions, no other expence or trouble is incurred in their cultivation. The trees arrive at full growth at about their seventh year; but the cupidity of the Native cultivator seldom allows them to reach beyond five years before he commences extracting the juice; and should the growth of the young trees be forward, he frequently commences at two or three years old; though this early exhaustion no doubt injures the after-productiveness of the plant, and probably shortens its term of life. I have frequently seen the trees tapped when the stem was less than a foot in height from the ground, a hole being dug in which to suspend the earthen pot that collects the juice. When not weakened by too early tapping, the average age the trees arrive at is about thirty years, being twenty-five years for sugar production after allowing the first five for their undisturbed development. On the borders of the Sunderbunds however, where the trees grow in strong marshy soils impregnated with salt, it is said that their excess of vegetation causes the trees to exhaust their strength sooner; and that their age in such places does not exceed the average of seventeen or eighteen years.

The quantity of juice obtained before the trees have reached their fifth year is small and uncertain: if allowed their full five years for growth, and first cut in their sixth year, the juice for that year is found to be yielded in the proportion of about one-half the yield of a tree of full maturity; in the seventh year three-fourths of the full quantity; and

it is not until their eighth year that the tree is found to give its full average yield of juice.

The expence of planting one beegah of ground is estimated as follows: the Natives reckon a beegah to contain one hundred and sixty trees, or two puns of eighty each, which allows of their being planted about ten feet apart, then—

Cost of one hundred and sixty plant-trees in sowing, watering, &c., say			1 0 0
Carrying to field, planting and re-planting deficiencies, ...			1 0 0
Half-yearly* rent of one beegah of ground, at 2 Rs., ...	1 0 0		
Ploughing twice per annum, at two annas, ...	0 4 0		
Weeding ditto ditto, at four annas,	0 8 0		
Yearly expence, ..	1 12 0		
Which for five years, is			8 12 0
			10 12 0
Add compound interest on the above yearly account at the rate of twenty-five per cent. per annum, is			10 7 2
Net expence on the beegah of trees when ready for producing goor,	Co's. Rs.	21	3 2

Cutting the trees and collecting the juice.—The trees are first cut about the 20th of October: this is done by stripping off the lower leaves of the branching head of the tree on one side, so as to leave a denuded space of about a foot long, and from this a piece of the bark is removed in the shape of a triangle, each side of which is about eight inches long, and having one angle pointed downwards: for the

* The other half being chargeable on the oil seed or other crop grown between the trees.

next eight or ten days after the above operation, the cut part is left to harden, and what little sap exudes from it, is allowed to run to waste, as not being sufficient for use. Collecting the juice therefore does not commence before about the 1st of November, a few days earlier or later, according to the season, the first cold nights causing the sap to run freely. As soon as this is observed by the *Gauchea* or date tree laborer, he ascends the tree in the evening and slices away a further portion of the tree, cutting deeper this time so as to divide the sap-vessels and from the centre of the triangle towards its sides, in such way that along the latter a sort of channel is formed, which conducts the juice to the lower point of the triangle; here in a notch is inserted one end of a piece of reed or grooved stick, about six inches long, its other end hanging over the earthen pot which is suspended by a string close under it, and into which the juice trickles as it flows from the tree.

The instrument used for cutting the trees is a *daw* or bill-hook, of a peculiar shape, and is figured in Plate 2. The *Gauchea* ascends the tree by the aid of a thick rope, which he fastens loosely encircling the tree and his waist before ascending: then, by pressing his feet against the trunk, leaning back against the rope, and alternately raising the latter with his hands, and stepping upward he quickly gains the summit, where supporting himself against the rope, he leans with his arms free for work: the *daw* is used by pressing the wooden handle tight under his arm, and grasping the back of the blade with both hands, which enables him to cut firmly into the wood. *See Frontispiece.*

A man having less than eighty trees does not himself convert their produce into goor, but lets them out, at a yearly rent for their use, to any neighbour who has more; for the reason that a less number than this would not yield a sufficient quantity to compensate for the expence of the necessary arrangements for managing the work, as the con-

struction of the furnace for boiling the goor, &c. The number worked by any one ryot or family varies from 80 to 300 or 400; but for the greater facility of calculating the expence attending this department, I shall assume as before, a farm of 160, the number proper to one beegah of ground, as about to be worked upon: and that these are all full grown, and *capable of yielding the full average quantity of* juice.

Whatever number of trees the plantation or farm may comprise, they are lotted off into seven distinct divisions, all containing as nearly as possible an equal number of trees. The trees of one of these divisions are cut by the ryot every evening in succession, so that the whole number is cut regularly once in seven days. We may assume the first division to be twenty-three trees, on which the work proceeds as follows—The *Gauchea* having cut or pared this number in the manner above described, and suspended the pots to them the previous evening, obtains in the morning, as their first day's produce, an average of ten seers of juice from each tree. On the second morning an average of four seers of juice, and on the third morning an average of two seers of juice; after which the reed and pot are removed, and for the fourth, fifth, sixth and seventh days the trees are left to recover themselves, and what little juice still exudes during that time is allowed to run to waste, as not worth the labor of collecting. On the evening of the seventh day it again comes to the turn of these twenty-three trees to be cut, which is done by peeling off a further portion from the already open cutting, which again divides the sap-vessels, and the juice recommences flowing; the reed and pot are placed as before, and the same process is repeated, and so on regularly throughout the season. It will be seen from this description, that the ryot by newly cutting a one-seventh division of his trees every evening in succession, will have every succeeding morning to gather the juice from

three such divisions yielding respectively ten seers, four seers, and two seers of juice from each tree: and that by this system, an uniform quantity of juice is daily procured, and the labor is equally distributed over the time given for it.

The ryot therefore having 160 trees, would divide them as per margin, and would collect daily the juice of sixty-eight or sixty-nine trees, yielding juice as follows, for trees of full growth and bearing :—

1st Division	23
2nd Ditto	23
3rd Ditto	23
4th Ditto	23
5th Ditto	23
6th Ditto	23
7th Ditto	22
	160

Twenty-three trees first day's runnings, at ten seers each, ...	5	30
Twenty-three ditto second ditto ditto, at four ditto,..	2	12
Twenty-three ditto third ditto ditto, at two ditto, ..	1	0
Total juice per diem from sixty-nine trees, ..	9	8

The above refers to the juice exuding during the night only, and collected early in the morning, from which alone sugar is made. It is sometimes customary likewise, with trees which bear well, to collect in the same manner what may run from them during the day; but as rapid fermentation takes place immediately the air is warmed, that is, soon after sunrise, the day juice is thereby unfitted for crystalization into goor, and is boiled up only for sale as molasses: as this practise however is far from general, and at the ordinary market rate for molasses barely repays the labor required to produce it, I have not included it in the calculations of yield and cost about to be given.

The *Gauchea* commences collecting the juice a little before daybreak: he ascends each tree in succession, having the empty pot for collecting the day juice slung at his back, if it is his intention to collect it also, to be exchanged for that containing the night's produce: with the latter he carefully descends and places it near the foot of the tree, proceeding in this way regularly through the trees that may be

yielding. A second man collects the juice by merely filling as many spare pots as the quantity obtained may require, and these he places together in some central spot of the plantation; and as soon as a sufficient number are collected to commence a boiling, a third carries them away to the boiling hut. The emptied pots from the trees are then ranged on the ground in rows of about twenty each, with their mouths downwards over a layer of straw or dry leaves: the latter is then set fire to, and gives the pots a thorough smoking, covering their inner surface with an even black coat: the object of this is to prevent the acidity which would no doubt set up a fermentation in the fresh juice, were any of the previous night's allowed to taint the vessel through being absorbed by it, but which is neutralized by the alkaline salts contained in the smoke.

As an additional slice is pared from the face of the incisions in the trees once every seventh day, this forms towards the end of the season a very deep notch, reaching sometimes nearly half through the trunk. Each succeeding year the trees are cut on opposite sides of the bark, so that they have, when a few years old, a deformed zig-zag appearance. It follows, that numbering these notches, will, in ordinary cases, tell at once the age of the trees: in some localities however, the ryots are accustomed to newly tap the trees *twice* in each season, once on each side of the bark, in preference to cutting so deeply on one side; in this case of course half the total number of notches will give the number of years the tree has been tapped, and adding in all cases three to five years for its growth previous to tapping, will give the age of the tree.

Boiling the juice is conducted in a mode characteristically simple. Four shallow earthen pans, about two feet diameter and one foot deep, are set in a square furnace, formed by digging a hole in the ground, and raising a mud structure over it, about six feet square, in the dome of which are cut the

four holes in which the pans are set: a hole cut at each side, one for feeding the fire and the other for the escape of the smoke, completes the arrangement of the furnace; over which a light roof is usually thrown, supported by bamboos and thatched with the dried leaves of the date tree, as a partial shelter from the sun and rain; though the latter is unusual during the season when the work is in progress.

The fuel used is the *soondry* wood, with which the date districts are all more or less easily supplied from the neighbouring Sunderbunds, assisted by the dried leaves of the date tree itself.

The four pans are kept about half full of date juice, and as the contents diminish by evaporation, fresh juice is supplied, until each is sufficiently filled to complete the boiling into goor without further addition: up to this point skimming goes on; and about a foot in length, cut from the small end of a date tree leaf, is kept floating in each pan, which is believed to assist the clarification, though it is difficult to see the rationale of this practise. No lime or alkali in any shape is used in the process: the juice is simply boiled until it arrives at its proper granulating consistency, which is known to the Natives by long practise, from the appearance of its tenacity when allowed to drop from the end of a stick, and from its color and appearance while boiling. The juice, as brought from the trees, is clean, white, and transparent, resembling the juice of the cocoanut, both in appearance and taste, though with an evidently sweeter taste to the palate. These qualities give it a decided advantage over the juice of the sugar-cane, it being quite uncontaminated with feculencies, chlorophylle, and other deliterious substances, the separation of which, from the cane juice, causes so much trouble to the planter. The skimmings from the boiling of date goor are in consequence very trifling, and probably consist principally of albumen congulated and thrown to the surface during the process. They are turned to no useful purpose.

The boiling occupies from five to six hours each pan, and as soon as it is complete it is ladled into a vessel set ready near the furnace. If the goor is intended for immediate sale to the *Moyrah* or sugar maker, this vessel is a long jar-shaped earthen pot holding from two seers to half a maund weight, the size and form varying much according to local custom. If the pots are large they are not filled at once, but the boilings of several days are poured in successively, so that three, four, or more pots are filled simultaneously, and contain layers slightly varying in quality though the average in all is of course the same. A great deal of goor is however converted by the ryots themselves into a description of sugar called *naund dulloah*, in which case the boiling is not carried to so high a point; and this allows it to form a larger crystal, and to part with its molasses more freely; in such case it is ladled at once from the boiling pans into a large *naund* or conical-shaped vessel, holding two to three maunds, and in this it is cured and treated by the process to be described in the next chapter.

The weather that is at once dry and cold is that most favorable for the date juice, both as to its quality and yield; and this is the prevailing character of the climate throughout Bengal for the greater part of the time occupied by the goor manufacturing season, which extends on the average over three and a half months; that is, from the 1st November to the 15th February. But little is ever made earlier than the former date, and any such is generally of small grain and inferior: on the other hand, any that is made later than the middle of February is of soft grain, and containing an undue portion of molasses. Occasionally the warm weather sets in a week or two earlier, and effectually cuts short further goor making; though if the atmosphere be relieved by a good fall of rain in this month, as is not unusual, this is always followed by a temporary return of cold nights, and the goor season may be said to commence anew, and

very fair produce is obtained for mother week or two, extending frequently into the first days of March. But the finest produce is yielded in December and January, that is, during the coldest part of the season;* but on the whole, the above estimate of three and a half months, or 107 days, may be considered the time occupied by an average productive season. In this period however are included all the days in which the yield is diminished by rain, or by fogs, which are frequent in Jessore, and are very inimical to the production of good goor, though they do not diminish its quantity. In estimating the yield of good goor for a season therefore, one-fifth of the total quantity should be deducted from what would have formed the result of an uninterrupted full yield throughout, to compensate for the deduction from casualties of the weather. Thus, on the estimate of production given in a former page, 160 trees were reckoned to yield when in full bearing an average of 9 maunds, 8 seers of juice per diem throughout the season: this multiplied by 107, the total number of days, and allowing one-fifth deduction for loss by variations of the weather, leaves bazar mds. 787-20-13 as the net produce in juice for the season, and this being divided over the 160 trees gives mds. 4-30-4 as the average total produce, in juice, from each tree.

The *proportion of goor obtained from date juice averages* one-tenth by weight, and the density of the latter does not appear to vary nearly so much as that of cane juice. At this average, the yield by the above calculation from 160 trees would be bazar maunds 78-30 of goor, or nearly 10¾†

* The Natives of Jessore have a common saying, with reference to date goor, that it is *Seeter Sonaee*, or the gold of the cold weather.

† A correspondent of the Calcutta Agricultural Society, in a letter published in the 6th volume of the Society's transactions, and dated from Jessore in July 1816, gives the average yield from a healthy date tree for the season at thirty seers of goor, and from an indifferent tree at ten seers, and thence assumes fifteen seers per tree as a fair average for the ordinary run of trees in that district. After very careful investigation however, the rate of yield I have given for a good date plantation, I feel assured is rather under than over rated.

seers from each tree, or 49 maunds, 8⅗ seers per 100 trees per annum.

The expence to the Native ryot of extracting and collecting the juice and converting it into goor is calculated as follows: taking for example, as before, a cultivation of 160 trees in full yield.

The expence of cultivating this number on one beegah of ground was before calculated at Co's. Rs. 21-3-2; and assuming these trees to yield in full bearing for the average of twenty years, the expence under this head would fall at per annum, ... Co's. Rs.	1	0	11
Add half the annual rent at 2 Rs. per beegah, the other half being chargeable on the annual crops raised between the trees, ...	1	0	0
For the labor of collecting and boiling the juice; it is computed, that two men or *Gaucheas* at 3 Rs. per month each, and one headman at 4 Rs. per month to boil the goor, can fully manage 200 trees; on which their wages for 3½ months will amount to 35 Rs. By the same rule 160 trees would require an expence in labor, of .. .. Co's. Rs.	28	0	0
Earthen pots for holding goor say 200, of 10 seers each, and costing 12 annas per 100, is	2	3	6
Earthen pans for boiling, extra jars, &c. say ..	6	0	0
Soondry wood fuel (in addition to dried date tree leaves) for boiling goor, 400 mds., at 5 Rs. per 100 mds., ...	20	0	0
Knives, ropes and boiling utensils, ...	1	0	0
Setting up furnace and *chopper* roof, ...	1	0	0
	60	4	5
Deduct value of *soondry* wood charcoal from the furnace, ...	1	0	0
Leaving as the net cost of 78¾ bazar mds. of goor, at the average rate of 12 annas per maund, ... Co's. Rs.	59	4	5

In the foregoing account the *yield* of trees in full bearing only has been computed, that is, their produce after the seventh year of growth. It has previously been explained that for their first two years of bearing, that is, for the sixth and seventh years of growth, the trees yield respectively only one-half and three-fourths of their full yield, and this would consequently enhance somewhat the cost of the goor made in these two years: to compensate for this, the total duration for the period of yielding is estimated in the above account at twenty years, in lieu of the fair average of twenty-five years, so that the return of the cost of twelve annas per maund for the goor may be considered as not much affected by this irregularity.

It has been already mentioned that it is customary for a ryot having a few trees only, to lease them to any neighbour who has a larger number. Wealthy owners of large plantations also frequently lease them for the season to ryots who engage themselves specially in the business of goor making. Before the value of sugars rose in the date districts under the influence of competition for the supply of the English markets, engagements of this nature were generally made at the rate of sixteen to twenty trees per rupee as their yearly rental. But since the increased demand alluded to, the rate has gradually risen to more than double the former standard, and eight or ten trees per rupee per annum has of late years been a common bargain. Even at the first-mentioned rate it will be seen, that the return per beegah to the cultivator would be eight to ten rupees per annum, being a very remunerative return on the expence of cultivation, and at the rates current of late years the profits must have been enormous. It is true that the Zumeendar has, in most cases, stepped in and claimed his share of the profits by a tax on the trees, whether legally or not is a question that would be irrelevant here to discuss, and in this manner has curtailed the profit to the ryot. Yet even with this

drawback, after looking at the above details, we shall cease to wonder at the enormous and rapid increase in the cultivation of late years, and the traveller through Jessore and the neighbouring districts will be less surprized at the interminable groves of date trees in all stages of growth which surround him in every direction.

CHAPTER III.

ON THE NATIVE MANUFACTURE OF SUGAR FROM GOOR.

Having traced the progress of cultivation and primary manufacture until the produce of the sugar-cane and date tree appears in the form of goor, I shall next proceed to describe the operations of the *Moyrah* or Native sugar refiner, in converting this substance into the several descriptions of sugar found in the markets of Bengal. These are known by a great variety of names, some referring to the processes by which they are produced, and others variously denominated according to local usage, though produced by the same process. They may all however be conveniently divided into five qualities, as follows—1st *Khaur*: 2nd *Dulloah*: 3rd *Pucka cheenee*: 4th *Dobarrah*: 5th *Candy*. Each of these, and its sub-varieties, I shall consider separately.

Khaur.

Khaur is nothing more than the goor after the molasses has been mechanically pressed, or allowed spontaneously to drain from it when placed in a favorable position for its so doing. Cane goor usually parts with its molasses much more readily than date; the crystallized portion collects in the lower part of any vessel into which the new goor has been

poured, and allows the molasses to float on the surface; this is taken advantage of, by pouring off the supernatant molasses, as the first step in khaur making from cane. It must not however be understood, that this practise is always possible, as in many places the goor is boiled to such a consistency as to render the separation of the molasses much more difficult.

Common cane khaur is then made by placing about ten to fifteen seers of goor in a coarse cotton cloth, previously wetted: the cloth is next tied with a string in the form of a loose round bundle, and six to eight of these bundles are piled one above the other on a plank slightly hollowed in the middle, so as to form a channel which opens at one end of the plank, and under this an earthen vessel is placed to *receive the molasses as it drains away from the cloth bun*dles; on the top of the pile of these a smaller plank and a weight, usually a large stone, are placed; and this weight added to that of the goor itself, presses out the molasses through the cloth. After remaining in this position three to four days, the cloths are opened and the contents spread in the sun on mats, and dried for a few hours, the *Moyrah* frequently turning it over and breaking the lumps with his hands during that time: it is then packed in bags for sale.

This is the usual process in the Burdwan district, where the crystal of the goor is large and the molasses separates readily. In most other districts however, its separation is more difficult and the usual plan adopted is as follows: one to four maunds of goor are put in a fine gunny bag, suspended by its mouth from a horizontal bamboo, supported by upright posts at each end, and underneath the bag an earthen pan is sunk in the ground to receive the molasses as it falls: the bag is well wetted and the goor sprinkled with water as it is filled in: pieces of bamboo or narrow boards, about four feet long each, are next applied: they are tied in pairs with the bag between them, and their ends being connected with strong ropes, these are gradually tightened as the

Date khaur, common or single-pressed,

Made from goor yielding 62½ per cent., or 25 seers from the maund, will require md. 1-24 of goor to make one maund of khaur; which at 12 annas per Br. maund, will cost Co's. Rs.	1	3	2¼
Wear and tear of gunny bags, bamboos, pans, &c., and house-rent, ...	0	2	0
Labor and superintendence, ...	0	4	0
	1	9	2¼
Add interest on Co's. Rs. 1-9-2¼, at 12½ per cent., for ten days, ...	0	0	1¼
	1	9	3½
Deduct value of molasses 32½ per cent. from the weight of goor, or seers 20-14, at 7 annas per maund, ...	0	3	7½
Net cost of a maund of khaur, .. Co's. Rs.	1	5	8

Cane khaur, double-pressed, or Kucha Boora,

Made from goor yielding 57½ per cent. or 23 seers from the maund, will require md. 1-20-9 of goor to make one maund of khaur; which at 1-8 per Br. maund, will cost .. Co's. Rs.	2	0	0
Wear and tear of cloths, bags, molasses, pans, &c., and house-rent, ...	0	3	0
Labor and superintendence, ...	0	6	0
	3	2	0
Add interest on Co's. Rs. 3-2-9, at 12½ per cent., for fifteen days, ...	0	0	3½
	3	3	0½
Deduct value of molasses 37½ per cent. from the weight of goor, or seers 26-3, at 12 annas per maund, ...	0	7	10½
Net cost of a maund of khaur, .. Co's. Rs.	2	11	2

Date khaur, double-pressed or Neem-phool,

Made from goor yielding 55 per cent. or 22 seers from the maund, will require md. 1-32-11 of goor to make one maund of khaur; which at 12 annas per Br. maund, will cost Co's. Rs.	1	9	10
Wear and tear of gunny bags, bamboos, pans, &c., and house-rent, ...	0	3	0
Labor and superintendence, ...	0	6	0
	2	2	10
Add interest on Co's. Rs. 2-2-10, at 12½ per cent., for fifteen days, ...	0	2	3
	2	5	1
Deduct value of molasses 10 per cent. from the weight of goor, or seers 20-1, at 7 annas per maund, ...	0	5	1
Net cost of a maund of khaur, .. Co's. Rs.	2	0	0

In the above estimates the relative values of cane and date molasses are set down as nearly as possible, to accord with the average selling rates in the district markets, in the absence of any extraordinary demand. There is perhaps no article the current value of which is subject to greater fluctuation, arising from the difficulty of storing it for any length of time, and the comparative high cost of transporting it from one market to another, more especially where water-carriage is not available: in such cases, the best cane molasses is frequently obtainable for as low as 4 annas per bazar maund.

The valuations I have assumed of 12 annas per maund for cane, and 7 annas per maund for date molasses, will be found also to correspond closely with their relative value to the distiller, who reckons it by the proportion of spirit obtainable from each, as will be further explained in the chapter on rum distillation.

The *Moyrahs* or others engaged in khaur manufacture have seldom capital of their own to work upon, but borrow from some more wealthy neighbour at high rates of interest; ten to twenty, or sometimes twenty-five per cent. per annum is paid on such loans, but in such cases the capitalist himself exercises a surveillance over the proceedings of his debtor. I have assumed the comparatively low rate of twelve and a half per cent., my object being in these calculations to show at what cost the sugar can be produced, to give a fair return to the manufacturer for his labor in preparing it, and superintending the work: and on the supposition that he obtains the goor at its fair cost price to the cultivator. All beyond this, I conceive, should be set down under the head of "profit," a part of the subject of sugar making I do not, in this place, intend to enter upon. In some parts of the Furreedpore district, the date goor ryots themselves prepare the khaur for sale.

Very large quantities of these khaurs have of late years been sold for the use of the European refiners, and no inconsiderable quantity was formerly shipped for England. For the latter purpose it is not well adapted, owing to the loss on the route occasioned by drainage, the portion of molasses always remaining in the substance of the sugar being readily pressed out when it is stowed as cargo in the damp heat of a ship's hold. A sort of fermentation also takes place under these circumstances, by which the color and strength of the material are very much injured, and the value proportionally depreciated: such loss varying in extent with the quantity of molasses left incorporated with the sugar.*

* This fermentation, when the cargo contains a large portion of khaur, has frequently been so great as to cause a suffocating vapour to escape from the hold whenever the hatches were opened, and which, from its discoloring the paint in all parts of the vessel exposed to its influence, probably contains a larger proportion of carbonic acid gas. Many shipmasters are prohibited altogether from taking khaur as cargo by their owners, owing to the disputes arising from its damaging other cargo in contact with it.

When fresh, khaurs are no doubt well suited for refining, and constitute indeed the primary preparation to which the goor is subjected by the Natives in the manufacture of the great bulk of their white sugars; but they are so well aware of the loss by deterioration of quality, which must arise from their keeping it as khaur, in addition to the loss of interest they would incur on its value by so storing it, that they never prepare it from the goor until they are ready to continue the process at once, by boiling it, for converting it into sugar.

Dulloah.

Dulloah, or as it is frequently spelt, *dowloa*, is the next perfect state of preparation in which Native sugar is found. There are two varieties of it, the *pehtea* or basket *dulloah*, and the *naund* or mould *dulloah*.

Cane *dulloah* is always of the first-named description, and as its name imports, is made in baskets. The mode is as follows: a round-bottomed basket, of closely wove bamboo-work, and holding a maund to a maund and a half of goor is supported over an earthen pan or *gumla*, of the same diameter as the basket, by means of a triangular bamboo frame. The goor in Burdwan and elsewhere, though not universally, undergoes a preliminary preparation by being tied up in cloths, and the first molasses allowed to drain from it, in the way described as for cane khaur making, for twenty-four hours: it is then filled into the baskets placed as above described, and allowed to drain for one or two days longer. A thick layer of an aquatic weed called *seala*, in a fresh wet state is next laid over it. This weed, the 'Vallisneria spiralis'* of botanists, is found in all tanks or other stagnant water throughout Bengal; it imparts its moisture slowly to the goor, and thereby liquefies the molasses portion of it,

* *Rowb.*—This author and some others have attributed some supposed alkaline properties to the weed in its action on the sugar, but I have not been able to find any good grounds for this hypothesis.

and so promotes its separation from the crystal. At the end of a week the weed becomes pretty dry, and its effects are found to have penetrated three or four inches deep into the contents of the basket, which become thereby considerably whitened: the weed is now removed, and the surface of the goor is found to be covered with a dark film, technically called the *gaud* or scum, though it is evidently nothing more than the earthy particles which were combined with the water of the weed; this is also scraped off with a knife and set aside; the whitened portion or *dulloah*, is now removed with a knife, and to the remaining goor a layer of fresh weed is applied, the old or dried weed being sometimes placed over all, to assist in preventing the evaporation of moisture from the new supply. At the end of the second week this also is removed, and the further stratum of sugar, whitened by its effects, is again collected. As to what may now remain uncleaned, the contents of several baskets are collected into one, so as to fill it, and the same process of weeding is repeated with this until the whole is whitened.

As the whitened sugar is removed from the baskets, it is spread in the sun on a coarse gunny sheet or *chat*, to dry; the whole being broken up and mixed with the hands occasionally during the progress of its drying to render all of one uniform quality. When nearly dry it is usually beaten thoroughly with wooden mallets, which bruise the grain and render the whole whiter and cleaner looking. It is then packed in bags for sale.

The molasses which runs from the cloths and baskets up to the time the weed is applied to the latter is sold at once in the market: that which collects after the application of the weed is of a less density from having imbibed the water from it, and is consequently very liable to fermentation unless boiled quickly after it has been collected. These drippings also contain a small portion of the grainy part of the goor in solution, carried down with the liquefied

molasses; it is therefore boiled to a thick consistency, and set to rest in an earthen jar containing three to four maunds. After fifteen or twenty days a firm granulation appears in it, so that the whole has the character of a dark colored goor: this is treated in the same way as the original goor for the process of *dulloah* making, above described, and an inferior description of *dulloah* is prepared from it, which is generally mixed by degrees with the original produce. The molasses boiling just referred to is performed in a single iron or earthen pan, holding about half a maund of molasses at a time: the dirty scrapings from the surface of the *dulloah*, after the weed is removed, are usually thrown in during the boiling to assist the granulation; and with the same object an alkaline solution, made by filtering water through the ashes of the plantain tree, which contain a large portion of potash, is also occasionally thrown in during the process, and this acts beneficially by correcting any acidity already formed in the molasses: all dirt or scum as it rises to the surface is removed with a skimmer, and sold to the tobacco maker.

All the molasses running from this re-boiled goor, whether before or after the weed is applied, is not again boiled, but is sold by the *Moyrah* as molasses; that which is collected after the weed is applied, is however of less value than the first runnings, owing to the portion of water which it contains.

In the above processes the usual yield of *dulloah* is 43 to 47 per cent., being equal to 17 to 19 seers from the maund of cane goor: 18 seers from the maund or 45 per cent. may be considered a fair average from good goor, of which 16 seers would be from the original goor, and 2 seers from that made of the re-boiled syrup: 10 seers or 47½ per cent. would remain in the shape of molasses, and 3 seers or 7½ per cent. would be waste or loss. This applies to the Burdwan and Beerbhoom districts, where cane *dulloah* is principally made.

Date *dulloah*, as before observed, is of two kinds; that made in baskets by a very similar process to the one above

described, and called *pehtea* or sometimes *choopree dulloah*; and that made in moulds, or *naund dulloah*.

The former is made largely at Chandpoor and other markets in the Jessore district, where the process differs in some few details only from what has been described for cane *dulloah*. Thus the goor is not subjected to any previous pressing process, but as it is taken from the earthen pots in which it is brought to market for sale, it is broken up on a board with choppers so as to reduce all the lumps, and is thence transferred at once to the baskets, where, after being allowed a day or two to part with any molasses that separates easily, the weed is applied: these baskets are made of a size to hold 2½ maunds of goor, and it is reckoned they should yield on the average 30 seers of dry *dulloah* each, or one-third the weight of goor, by the first process, in addition to what may be obtained by re-boiling the molasses which may drain from them.

The rate of yield however varies very much according to the period of the season, and the quality of the goor from which it is made: during December and January it usually yields above the average produce just stated, and even the first molasses which runs from the baskets is re-boiled into goor, and a portion of sugar extracted from it; but later in the season that only which drops from the baskets *after* the weed is applied is re-boiled; and towards its close, that is after February, none of the molasses is re-boiled with the view of obtaining more sugar from it.

The total produce of dry sugar obtained from the maund of goor by the basket process, is on the average one-third or 13⅓ seers of original *dulloah*, and 2⅔ seers of that made from molasses, being in all 16 seers, or 40 per cent. from the maund of goor: three seers more are lost or wasted in the process, and 21 seers remain in the shape of molasses. As the *dulloah* is removed from the baskets it is dried and beaten in the same manner as described for the cane *dulloah*.

For the description of *naund dulloah*, I must first refer the reader back to the account I have given of boiling the date juice into goor, where it is mentioned that the latter, as soon as boiled to the granulating point, instead of being filled into small pots for sale to the *Moyrah*, is poured at once into a *naund* or mould, for the purpose of making *dulloah*. This *naund* is a round earthen vessel, about two and a half feet in diameter and two feet deep, slightly pointed or shaped into the form of a cone at the bottom, and holds 4 to 5 maunds of goor. It is filled by degrees, a stratum being daily added, as the goor is boiled over the furnace before described, until it is full; the number of days occupied in filling it being according to the number of trees the ryot is working upon: it sometimes occupies as many as ten days, and the surface of each preceding day's stratum is lightly broken up with a knife before the new liquor is added, to facilitate the amalgamation of the whole. As soon as the *naund* is full, a hole is pierced at its apex, and it is set on a bamboo frame-work or *machan*, about two feet from the ground, with an earthen pan placed underneath it to receive the molasses as it drops from the aperture. Wood is now applied, and the contents of the *naund* are treated in the same way as has been described for the basket *dulloah*; three successive woodings however being requisite for the *naunds*, to whiten the greater depth of sugar contained in them as compared with the baskets. The *dulloah*, as it is cut from the *naunds*, is at once spread in the sun to dry: in some few localities, it is not customary to bruise the grain, but the *dulloah* is sold in a crystallized state, and is generally of a dull greyish hue; but it is far more generally whitened by being highly dried and pounded.

The molasses, as it runs from the *naund* is collected every two or three days, and mixed up with the fresh juice from the date trees as it goes into the pans to be boiled: and so long as the former is derived from goor that is well granulated and

original, that is, in the boiling of which no molasses has already been mixed, the produce is little or nothing deteriorated by the mixture. As the season advances however, and the molasses gets "worked over," that is, when incorporated with fresh juice, and the molasses derived from the goor thus made again mixed with fresh juice, after three or four repetitions of this process, the goor greatly deteriorates in color and grain. The first runnings from the *naunds* in the contents of which molasses have already been mixed, are sold by the ryots, as not worth re-boiling; but all that drops after the wood is applied is boiled up with fresh date juice, as above described.

From the above details it will easily be understood why the *naund dulloah* brought to market at the beginning of the season, or say up to the 15th February, is always of the best quality, a fact well known to all dealers in it, as up to that date little or none of the portion made from molasses-mixed goor is ready to be cut from the *naunds*.

There can be no doubt that this plan of *dulloah* making is a very economical one, and admirably answers the end of extracting the maximum proportion of sugar that could be obtained from the juice by the means available to the Natives. It is a long established maxim with all sugar manufacturers, that nothing is more injurious to the yield from any solution of sugar than its long exposure to high temperatures, an evil which is greatly counteracted by the admixture of the molasses or syrup with the fresh juice, considerably shortening as it does the duration of the boiling process. The evaporation of the water from the droppings of the *naunds*, and their reconversion into goor without any loss of time, likewise effects a further direct saving by checking all incipient fermentation in the molasses, which, if left to its own action, quickly depreciates the saccharine qualities that may still be left in it. And lastly, no loss of time, or consequently of interest on the capital employed, is incurred in the converting the whole available strength

of the juice into sugar. It must not be forgotten too, while on the subject of its economy, that the ryot is in this case both the producer of the goor and the manufacturer of the sugar; and that no *Moyrah* or second proprietor being employed, but the sugar being produced "at first hands," one profit will suffice for him, and hence a further saving is effected when comparing this with the basket process.

It is apposite here to mention, that many of the *dulloah* ryots are not content with the above advantages of their occupation, but sell a portion of their produce at once in the shape of goor, reserving the rest for the making of *dulloahs*; and the molasses derived from the latter they are accustomed to boil up with the goor intended for sale, in such large proportions as to cause a serious adulteration, greatly reducing its grain and strength, and causing it to assume a dark burnt color. Very great discrimination is therefore required on the part of such *Moyrahs* as purchase goor for sugar making in the localities where the *naund dulloah* is prepared, to enable them to fix the true value on such adulterations.

The actual weight of solid extract obtained from a given quantity of juice by the above method of boiling will, of course, be the same as if the juice were boiled simply to the consistence of goor without the mixture of molasses; nevertheless, we may infer from the reasons already given, that a larger proportion of *dulloah* is obtained from the maund of goor by this than by the double or basket process. I am not aware that any experiment has ever been made to test the advantage obtained in this way, and Native opinion, though clearly in favor if its superiority, is too vague to be guided by. I shall however hazard the opinion, that 5 per cent. more of *dulloah* from the weight of goor is obtained than by the basket plan, and the average yield I have therefore set down at 45 per cent., or 18 seers of *dulloah* from the maund of goor, leaving 10 seers as molasses, and 3 seers as before, for loss and waste.

On comparing the qualities of the two above described kinds of date *dulloah,* it is found that that made in the *naund* is of a larger and stronger crystal than the other, and generally of a brighter color: on the other hand, it does not keep so well, being more apt to imbibe moisture from a damp atmosphere, which causes a gradually increasing acidity in it, than that which is made in the baskets: the prevailing color in all date *dulloahs* is greyish-white, falling into dull reddish-grey in proportion as the molasses or syrup-sugar in their composition prevails.

The following calculations of the original cost price at which *dulloahs* may be produced, are made on the same basis as already adopted for ascertaining the cost of khaurs: that is, by assuming the goor at its original cost valuation to the cultivator, and the expences of manufacture, &c., on a fair average rate of wages for the labor employed.

Cane dulloah,

Made from cane goor yielding 45 per cent., or 18 seers from the maund, will require bazar mds. 2-8-14¼ of goor, to make one maund of *dulloah;* which at 1-8 per maund, will cost .. .. Co's. Rs.	3	5	3
Wear and tear of baskets, knives, earthen pans, &c., and house-rent, ...	0	5	0
Weed, ...	0	0	6
Wood for boiling molasses, ...	0	4	0
Labor and superintendence, ...	0	6	0
	4	4	9
Add interest on Co's. Rs. 4-4-9, at 12½ per cent., for a month, ...	0	0	9
	4	5	6
Deduct value of molasses 47½ per cent. on the weight of goor, or mds. 1-2¼, at 12 annas per maund, ...	0	12	3
Net cost of a maund of *dulloah,* .. Co's. Rs.	3	9	3

Date dulloah, (basket or choopree.)

Made from date goor yielding 40 per cent., or 16 seers from the maund, will require mds. 2-20 of goor to make one maund of *dulloah*; which at 12 annas per Br. maund, will cost .. .. Co's. Rs.	1	14	0
Wear and tear of baskets, knives, earthen pans, &c., and house-rent, ...	0	5	0
Weed, ...	0	0	6
Wood for boiling molasses, ...	0	4	0
Labor and superintendence, ...	0	6	0
	2	13	6
Add interest on Co's. Rs. 2-13-6, at 12½ per cent., for a month, ...	0	0	6
	2	14	0
Deduct value of molasses 21 seers or 52½ per cent. from the weight of goor, is mds. 1-12½, at 7 annas per maund, ...	0	9	3
Net cost of a maund of *dulloah*, .. Co's. Rs.	2	4	9

Date dulloah, (naund or mould.)

Made from goor yielding 45 per cent., or 18 seers from the maund, will require mds. 2-8-14¼ of goor to make one maund of *dulloah*; which at 12 annas per Br. maund, will cost Co's. Rs.		1	10	6
Wear and tear of moulds, knives, pans, &c., ...	0 5 6			
Less value of goor pots not required in this process, ...	0 1 6			
		0	4	0
Weed, ...		0	0	6
Wood for boiling in addition to what would have been used for boiling the simple juice, ..		0	4	0
Labor and superintendence, ...		0	5	0
Carried over, ... Co's. Rs.		2	8	0

Brought forward,.. .. Co's. Rs.	2	8	0
Add interest on Co's. Rs. 2-8, at 12½ per cent., for one month, ...	0	0	5
	2	8	5
Deduct value of molasses 19 seers, or 47½ per cent. from the maund of goor, is mds. 1-2½, at 7 annas per maund, ...	0	7	2
Net cost of a maund of *dulloah*, Co's. Rs.	2	1	3

Dulloah making is rarely practised in the Western Provinces of India, and seems confined to certain localities in Bengal. Burdwan, Beerbhoom, Midnapore, Bancoorah, and Kishnaghur, are the principal districts for cane *dulloah* manufacture; local custom or demand has caused it to be produced very generally throughout the date districts, except in Furreedpore and Backergunge, and there appears no good reason why it should not be produced equally well in these districts also.

The production of *dulloahs*, like that of most other Native sugars, has wonderfully increased during the last ten years, it being moreover a favorite material with most of the European sugar refiners. This is more especially the case with the date produce, and in some markets of the Jessore district the annual production has more than quadrupled during the period referred to. The qualities are necessarily very varied in strength and color, and the value of the genuine article made at the commencement of the season, from the best goor and unalloyed with syrup or molasses intermixture, is more than double that of the later production in which such mixture predominates. *All* kinds are much injured by damp, as already noticed, and if kept throughout the rains in Bengal, even in a tolerably dry situation, they are nevertheless deteriorated in strength and color, apparently from

the action of some slow fermentation, imperceptible except in its effects. Cane *dulloahs* suffer less than date from these influences; but they render both kinds far less valuable, if not altogether unfit for exportation by sea to Europe; the depreciating effects alluded to being felt with greatly increased force in the damp close heat of a ship's hold.

PUCKA CHEENEE, OR BOILED SUGAR.

This head comprehends most Native sugars that have undergone a second boiling process to that which brought them in the first place to the state of goor, from which latter they are all manufactured.

The first stage of the process is to convert the goor into khaur by one of the methods already described under that head, only that it is not dried in the sun or otherwise, but after the abstraction of the molasses is treated as now to be described.

I shall commence with the cane *pucka cheenee*, as made more or less in most districts of the Bengal presidency, though much more largely in Benares, Ghazeepore, and other of the Western Provinces.

A quantity of the khaur, varying from one to ten maunds, according to local usage, is melted over a slow fire in an iron or earthen pan, in about one-half of its weight of water: the pan is set over a hole dug in the ground to hold the fire, and supported on mud-work in the usual fashion, as already described in the chapter on goor manufacture. The khaur solution is kept simmering over the fire, and as the scum rises to the surface it is taken off with a skimmer formed of a piece of gunny stretched over a round bamboo frame, about eight inches in diameter, with a handle at its back. The scum adheres to this, and is scraped off into another vessel with a thin bamboo lath: during the simmering an alkaline solution, prepared by straining water through the ashes of the plantain tree, is from time to time thrown in, which

assists in throwing up the scum: a little milk is also sprinkled in with the same object by means of a rag tied to the end of a bamboo rod, which also checks the rising of the liquor in the vessel should it show symptoms of boiling over. After simmering for about an hour, and when no more scum is seen to rise, the fire is withdrawn, and the liquor is ladled out and poured through a coarse cotton cloth, spread on a bamboo frame over an earthen vessel sunk in the ground, and of capacity to hold the entire contents of the simmering pan. This may be called the clarifying process. The clear liquor, after being allowed about an hour for any impurities still floating in it to subside to the bottom, is next ladled into the boiling pan, which is usually of iron, and capable of holding, in the Western Provinces, 5 to 10 maunds of melted sugar. In Burdwan it is much smaller, and frequently made of earthenware, holding not more than 25 to 30 seers of sugar in solution. It is now kept boiling briskly to evaporate the excess of water, and as soon as it arrives at the proper granulating point, which is known by its appearance as it drops from the stirrer when held up, and the liquid allowed to drop from it, it is ladled out into the *naund* or earthen vessel similar to that described under the head of *naund dulloah*. During the progress of the boiling it is constantly watched by the *Moyrah*, who keeps it at a steady ebullition, throwing in milk and stirring it whenever it threatens to boil over, and removing any remaining scum that may occasionally rise to the surface. Where large boiling pans are used, the *naunds* are of course filled at once from one boiling, but with the small pans two, three, or four boilings are required to fill them. When full they are supported on bamboo *machans*, the layer of *seala* or weed is applied, and the bottom of the *naund* being pricked, the syrup drains from it as already described under the *naund dulloah* head. The first runnings are sold as molasses; but as soon as the weed is applied, all that may drop afterwards is collected as syrup

and re-boiled with fresh khaur. The sugar thus obtained, is mixed with such tips of the *naunds* as may remain uncleansed at the close of the season, and is sold under the name of *dumma*.

As the sugar becomes cleansed by the wood, it is scraped from the *naunds*, and spread on a gunny cloth in the sun to dry: people are now employed to tread it with their naked feet with little intermission during the progress of its drying; this effectually bruises the grain, and gives the sugar that uniform dead white or yellow appearance, which distinguishes all sugar from the Benares or adjacent districts.

In the Beerbhoom and Midnapore districts a different plan is observed with the sugar after it is scraped from the *naunds*; inasmuch as no pounding or bruising of the grain is given, but it is merely mixed up with the hands when laid out to dry, so as to reduce the lumps and make all of one uniform color and appearance, leaving the crystal unbroken. This is especially the case in Beerbhoom: in Midnapore a slight bruising is given when the sugar is nearly dry, though not sufficient to efface the crystallized appearance: this latter is known in Calcutta by the name of *chooneh* sugar. The crystallization of these sugars is also aided by treating them with a strong alkaline temper: this is applied in the shape of wood ashes, principally of the dwarf *saul* tree, which abounds in these districts: it is first used in the making of the goor; and in the boiling of the khaur liquor for *pucka cheenee*, about half a seer of the ashes is thrown into every maund of khaur in solution: they are again used in the re-boiling of the syrup collected from the *naunds*, being always however separated in the clarifying process before the liquor is transferred to the boiling pan.

The qualities of these *pucka cheenees* must necessarily vary greatly, influenced as they are by the different modes of preparation, the greater or less admixture of syrup, and the ever varying quality of the goor from which they are made;

the latter being in its turn subject to great diversity of quality, following the influences of soil and climate under which it is grown.

The yield of cane *pucka cheenee* from good goor varies from 22 to 28 per cent. according to the quality of the product: 25 per cent. may be considered a fair average, of which three-fourths will be original white sugar; one-fourth yellow or syrup sugar; about one-eighth or five seers per maund will be waste and loss; and the remaining 62½ per cent. or 25 seers per maund, will be left as molasses.

In Ghazeepore, and other places in its vicinity, *pucka cheenee* is frequently boiled direct from the description of goor known as *bhèlee*, and already adverted to in the chapter on goor making, without its undergoing any preparation into khaur, or otherwise freeing it from its molasses: the process in other respects is the same as in making ordinary Benares sugar, and the result is a sugar of an inferior quality as to color, but with more grain than the ordinary Benares, and is known as *bagga*.

Date *pucka cheenee* is made by a routine differing but little from that of the cane. Great economy is practised in boiling up the syrups daily as they drop from the *naands* with fresh goor, so that no unnecessary delay or waste can occur in extracting the whole available strength in sugar from the goor. Care is also taken in most places to skim and clarify it well, and the result is a clean, bright looking, yellow, and rather grainy sugar. Some few years ago, before the demand for these sugars for exportation to England, it was the universal custom to reduce them all by beating them on a board with heavy clubs to a fine white powder, the apparent object being to make them resemble Benares sugar as nearly as possible; but of late years the contrary custom has grown up of leaving the crystal nearly unbroken, a partial beating or mixing with the hands only being given, and the great bulk are now brought to market for sale in this

state, and known in Calcutta under the name of *gurpatta* (or unbeaten) sugars. The markets where the best qualities are manufactured are Kessubpoor, Nareoolbarree, Barykolly, and Mustaphapoor, all in the Jessore district, at which places and their vicinity not less than 100,000 maunds are now made annually. Large quantities of these have been shipped of late years for the English markets, and the lower or syrup qualities have been used for re-manufacture in the European refineries.

It may here be observed however, that the great bulk of what is brought to the Calcutta market and sold as *gurpatta* sugar, is largely adulterated by the Native dealers, who purchase from the *Moyrahs* and bring it to Calcutta for sale, by mixing with it the better kinds of *naund dulloah*. The latter, when newly made, are of a fair grain and color, and when judiciously mixed with the *pucka cheenee* it requires a very practised eye to detect the fraud. Owing however to the far greater liability of the *dulloah* to imbibe moisture and depreciate by fermentation, the effects of the cheat become very apparent after the sugar has been subjected to the voyage homeward, and many inexperienced shippers have been greatly disappointed at the results of their consignments of it.

Generally throughout Furreedpore and in some parts of Jessore district, an inferior description of date *pucka cheenee* is made as follows. The process is conducted as usual until the clarified liquor is brought to the boiling pan. A quantity of dry goor, which is formed at the mouth of the goor pots when brought to market, (owing to the greater gravity of the molasses having caused it to subside at the bottom part of the pot, and leave the upper portion comparatively dry,) is then collected and broken up, and this is thrown at intervals into the boiling liquor: when dry goor of the above description is not at hand, raw khaur is thrown in in the same way, and in this manner about one-third the weight of sugar in the pan

is introduced: the effect of this is of course greatly to hasten the thickening and granulation of the sugar; and in so far cheapens the process by a saving of fuel, and obviates a part of the loss from long exposure to heat in the boiling: on the other hand, owing to the portion of khaur thus introduced being unclarified, it imparts a dull greyish color to the produce, which renders it more nearly resembling *dulloah* in appearance; and is on this account less suited for shipment to Europe, though it forms a good material for the refiners and Native confectioners, among whom, owing to its comparative cheapness, it finds a ready sale.

The average yield of date *pucka cheenee* from the maund of goor is considerably more than with cane produce; apparently owing to some quality in the former which renders the crystallizing power less subject to injury from the frequent application of heat than with the cane; a property, the value of which becomes very apparent in the frequent reboilings of the syrup in the *pucka cheenee* manufacture. Including all qualities, the product of *pucka cheenee* from date goor may be reckoned at *one-third* as an average, and this is of three qualities, viz. half of the original sugar unmixed with syrup, one-fourth of good syrup sugar but little inferior to the above, and one-fourth red or inferior. In comparing the yield of cane and date *pucka cheenee*, besides the larger proportion of syrup kinds from the latter, it must also be remembered that the color of the whole product is somewhat inferior; having in all, except the finest qualities, a slight greyish tinge, which contrasts unfavorably with the bright white or yellow of the cane produce; and lastly, it is more liable to deterioration by being stored, from damp and other causes, than the cane. All these drawbacks must be balanced against the greater yield in weight obtained in the production of date *pucka cheenee*; though, when the refining process is carried a step farther, and date *dobarrah* sugar is made, they entirely disappear.

I now proceed to give the calculation of the cost of both kinds to the Native producer, taking as the basis thereof, as in the calculations for *dulloah* and *khaur* already given, the prime cost of the goor to the cultivator, and a fair average rate of wages to the *Moyrah* and his assistants employed in the subsequent manipulations.

Cane pucka cheenee.

Made from goor calculated to yield 25 per cent. of its weight, or ten seers to the maund, will require four maunds of goor to make one maund of *pucka cheenee*; which at 1-8 per Br. maund, will cost .. .. .. Co's. Rs.			6 0 0
Expences of manufacture per maund of sugar.			
Wear and tear of iron or other pans,	0	1 0	
Wood fuel, ...	0	8 0	
Wages for labor and superintendence,	0	6 0	
Seala or weed, ...	0	1 3	
Rent of houses, and gunnys or drying *chots*, ...	0	1 9	
Milk and plantain ashes, .. .	0	0 9	
Naunds and earthen pots, ...	0	1 9	
Cloth, baskets, &c., ...	0	1 6	
			1 0 0
			7 0 0
Add interest on Co's. Rs. 7-0 for 1½ month, at 12½ per cent., ...			0 2 0
			7 11 0
Deduct value of molasses 62½ per cent. from the weight of goor, is mds. 2-20, at 12 annas per md.			1 14 0
Net cost of a maund of sugar, .. Co's. Rs.			5 13 0

Divided as follows :—

¾ or 30 seers of white, at 6-4 per maund,			4 11 0
¼ or 10 seers of inferior, at 4-8 per maund,			1 2 0
Co's. Rs.			5 13 0

Date pucka cheenee.

Made from goor calculated to yield 33⅓ per cent. of its weight, or 13⅓ seers to the maund, will require three maunds of goor to make one of *pucka cheence*; which at 12 annas per Br. maund, will cost .. .. Co's. Rs. 2 4 0

Expences of manufacture per maund of sugar.

Earthen pans for boiling, ...	0	4	0
Wood fuel, ...	0	7	0
Wages for labor and superintendence, ...	0	7	0
Seala or weed, ...	0	1	0
Rent of houses, and gunnys or drying *chots*	0	1	6
Milk and plantain ashes, ...	0	1	0
Naunds and earthen pots, ...	0	1	6
Cloth, tools, &c., ...	0	0	6
		1	7	6
		3	11	6
Add interest on Co's. Rs. 3-11-6 for 1½ month, at 12½ per cent., ...		0	1	0
		3	12	6
Deduct value of molasses 56⅔ per cent. from the weight of goor, is md. 1-28, which at 7 annas per maund, ...		0	11	11
Net cost of a maund of *pucka cheence*, Co's. Rs.		3	0	7
Divided as follows :—				
½ or 20 seers white sugar, at 3-5-2 per maund,		1	10	7
¼ or 10 seers white inferior, at 3 per maund,		0	12	0
¼ or 10 seers red inferior, at 2-8 per maund,		0	10	0
Co's. Rs.		3	0	7

Dobarrah and Ekbarrah.

Dobarrah is the highest state of refinement, excepting candy, to which Native sugar is brought, and is made only from *dulloah* sugar, which the *dobarrah Moyrah* generally purchases as he requires it from the *dulloah* maker, though at Santipore, in the Kishnaghur district, one of the largest marts for this description of sugar, the manufacturers also frequently purchase the goor and prepare their own *dulloah* therefrom. Excepting the substitution of *dulloah* for khaur, the process of manufacture differs only in some details from that already described for *pucka cheenee*.

The boiling is generally conducted in small earthen pans, and milk is liberally used, which assists in throwing up all scum, and great cleanliness is observed throughout the process. The liquor is not boiled to so stiff a consistency as in *pucka cheenee* making, and this allows a freer granulation to follow, which is never disturbed by stirring or beating after the sugar is once poured into and settled in the *naund*. A seer of good grainy *dulloah* is however mixed into each *naund* to assist the crystallization. The *seala* wood is applied in the usual way, and when this is dry, the whitened sugar is carefully cut from the mould, so that none of the red or uncured portion may be mixed with it, and spread to dry in the sun. The *naunds* are calculated to hold 1¼ maund each of boiled *dulloah*, being smaller than the generality of those used for *pucka cheenee*; the syrup drains quickly from the moulds, so that a stratum of whitened sugar can be cut from the *naunds*, and fresh weed applied at intervals of four days each.

Good *dobarrah* is of a clean white appearance, and of a good crystal, resembling crushed loaf-sugar of second quality.

The syrups are all reboiled with a small proportion, generally about one-fourth, of fresh *dulloah* liquor, to give them

a consistency in grain; the clarifying, boiling, and weeding are conducted in the same way as when first boiling the *dulloah* alone, and the result is a grainy sugar of a rather smaller crystal than the *dobarrah*, and of a bright reddish-yellow color. This is the *ekbarrah* sugar, which is usually reckoned as about equivalent in value to good *pucka cheenee*. The first syrup from the *ekbarrah* is sold as molasses, but the subsequent drainings after the weed is applied are mixed off with the next boilings of *ekbarrah*.

The *dobarrah* manufacture is confined to a few localities, though most of the Native confectioners are acquainted with the process; but it is too expensive an article for them to make where there is any uncertainty as to the probable demand for it. It is to be found however in most of the large Native towns, and in Burdwan a very good quality is made from the cane *dulloah*, which is whiter than that made from date: here it is also frequently sold under the name of *olah*, a preparation of it made by rolling the *dobarrah* into balls of about 2 inches diameter and ¼ of a seer weight each; the damp sugar, as taken from the *naunds*, is pressed into a firm lump with the hands, and with the aid of a little water, is rolled about in both palms alternately until it assumes a tolerably smooth and round surface: these balls, as finished, are set in the sun to dry. The *dobarrah* from date produce is usually sold in a crushed state.

The yield from both cane and date *dulloahs* is reckoned at about 60 per cent., or 24 seers from the maund of *dulloah*, of which 20 seers is *dobarrah* and 4 seers *ekbarrah*; the only difference in favor of the cane produce being its whiter and cleaner color, as already observed; about 10 per cent. or 4 seers in the maund is waste or loss in the process, and the remaining 12 seers is sold as molasses.

Taking the value of the *dulloah*, at the rates already calculated in the section of this chapter devoted to them, and reckoning the actual additional expence incurred in the refin-

ing, we shall find the cost of the *dobarrah* and *ekbarrah* to stand as follows :—

Cane Dobarrah and Ekbarrah.

Made from *dulloah* yielding 65 per cent., or 24 seers from the maund, will require 1 maund, 26 seers, 1½ chittack of *dulloah* to make one maund of *dobarrah*, which at 3-9-3 per Br. maund, will cost .. .. .. Co's. Rs.	5	14	6

Manufacturing expences per maund.

Earthen pans for boiling molasses, &c., ...	0	8	0
Fuel, ...	0	4	0
Wages for labor and superintendence,	0	4	0
Seala or weed, ...	0	1	6
Gunny *chols*, tools, and house-rent, ..	0	2	0
Milk and plantain ashes, ...	0	1	0
Naands and syrup pots, ...	0	2	0
	1	1	6
	7	0	0
Add interest on Co's. Rs. 7, at 12½ per cent., for one month, ...	0	1	2
	7	1	2
Deduct value of molasses 30 per cent. from the weight of *dulloah*, is 19 seers 13 chs., at 12 annas per maund, ...	0	5	11
Net cost of a maund of *dobarrah* and *ekbarrah*, ... Co's. Rs.	6	11	3
Divided as follows :—			
$\frac{5}{6}$ or 33 seers 5⅓ chs. of *dobarrah*, at 7-4 per maund, ...	6	0	7
$\frac{1}{6}$ or 6 seers 10⅔ chs. of *ekbarrah*, at 4 per maund, ...	0	10	8
Co's. Rs.	6	11	3

Date Dobarrah and Ekbarrah.

Made from *dulloah* yielding 65 per cent. or 24 seers from the maund, will require md. 1-26-1¾ of *dulloah* to make one maund of *dobarrah*, which at 2-3-3 per maund, (the average of the cost of *pehtea* and *naund* date *dulloah*, as shown at page 73,) will cost .. Co's. Rs.	3	10	3
Add expences of manufacture, &c., the same as for cane *dobarrah*, per maund, ...	1	1	6
	4	11	9
Add interest on Co's. Rs. 4-11-9, at 12½ per cent., for one month, ...	0	0	8
	4	12	5
Deduct value of molasses 19 seers, 13 chittacks, at 7 annas per maund, ...	0	3	4
Net cost of a maund of *dobarrah* and *ekbarrah*, ... Co's. Rs.	4	9	1
Divided as follows :—			
$\frac{5}{6}$ or seers 33-5⅓ *dobarrah*, at 4-14 per maund, ...	4	1	0
$\frac{1}{6}$ or seers 6-10⅔ *ekbarrah*, at 3-0-6 per maund, ...	0	8	1
Co's. Rs.	4	9	1

Boorah, or *pucka boorah*, is a description of sugar which may be conveniently comprehended under the head of *dobarrah*, inasmuch as it is made by the reboiling of *dulloah*. The process is conducted precisely in the same manner as for *dobarrah* until the boiling is completed, when in lieu

of its being transferred to a *naund* to be drained of its molasses, it is poured into an earthen vessel capable of holding about a maund of melted *dulloah*, and is here beaten with a wooden oar for an hour or more, which breaks the crystal as it forms, and incorporates the molasses with the grain; when the mass is cooled it is taken out in small portions at a time, and further mixed by being broken with a wooden roller on a board, until the grain is completely reduced, and the whole has a white flowery appearance when dried in the sun. In this operation about 10 per cent. is lost in scum and waste, but as no molasses is separated, the *boorah* is only lessened by that per centage from the original weight of the *dulloah*, and the cost of its manufacture may therefore be easily calculated; but is not given here, inasmuch as it appears to be a kind of sugar that has now gone quite out of use, and is seldom or ever met with in the markets: indeed, it never seems to have been in much esteem as an article of large consumption or export, though made occasionally by the confectioners.

At Santipore, where supplies of both cane and date *dulloah* are easily available, the *dobarrah* is sometimes made from a mixture of the two. It may also be observed, that since the passing of the Act of 1815, levying a higher rate of duty on all sugars exceeding in quality the standard of Muscovado adopted by the English Customs, the good white *dobarrah* I have described, is seldom met with. The bulk of what is now made has the *dobarrah* crystal, but is of a yellow quality, made by cutting the sugar from the *naunds* before the weed has had time to cure it perfectly, so that a portion of the syrup is left combined with it to give it the desired hue, enabling it to pass the home customs below the higher rate of duty fixed for "white clayed" sugar. What stronger proof can we have of the unfair working of this measure of our Legislature than the above instance affords? This is indeed a practical example of its illiberal character;

for were the weed allowed time to take its usual effect in curing the sugar, which might be done at an additional cost on the sugar of two annas per maund, or *4d.* per cwt. at the most, the product would be worth 1*s.* 6*d.* to 2*s.* per cwt. more in the home market, but would be subject to an extra duty of 2*s.* 4*d.* per cwt.; again, were it by an additional weeding and clarifying to be brought to a more perfect state of whiteness, at a cost of six or eight annas per maund more to the *Moyrah*, so as to be worth 3*s.* to 4*s.* per cwt. more in the home market, it would be taxed with an additional duty of 4*s.* 8*d.* per cwt., and thus entail a loss on the manufacturer, or on the exporter of his sugar, in nearly an exact proportion to the extra skill and care exerted in its preparation. Protection to our West India Colonies may perhaps be urged as an argument in favor of this anomaly: it certainly is *not* justice to the Natives of our Indian Empire.

Candy.

This is the last stage of refinement to which sugar is brought, and its consumption in Bengal is confined to the wealthy classes, Native or European: the duties on its importation into Great Britain being so high as to prohibit any call for it in that direction. It is generally met with in small quantities in all large Native bazars, where it is sold in the small earthen conical-shaped vessels in which it is crystallized. The quality varies but little, being of a dull yellow color, and not very large crystal: it is inferior to the China candy in both respects, and more resembles the second quality of English manufacture.

It is made as follows: good *dobarrah* sugar is melted over a slow fire in one-third its weight of water; milk and water are then thrown in at intervals to assist the raising of the scum, as soon as this is removed the fire is quickened, and the sugar is boiled to its proper granulating consistency,

which is considerably less than that for *dobarrah*, to allow of a more slow and perfect crystalization. The liquid sugar is then poured into the small *naund* or cone: this is about 11 inches deep and 6 inches in diameter, and has 12 holes of about ¼ inch diameter each, all at its apex, within a space of about 3 inches diameter: it holds five seers of melted *dobarrah*. Light pieces of bamboo are now placed across the mouth of the cone, and from these to the small holes described are connected 12 light threads of twisted cotton, distributed pretty equally through the *naund*: the holes at the apex are now closed with a piece of stiff moist clay, and it is then ready for the melted sugar to be poured into it hot from the boiling pan. The mouth is next closed with a sheet of paper tied tight round the neck of the cone, the latter being made with a lip or groove for this purpose. The *naunds* are next placed in a hole filled with *bhoosee*, which is the bran of rice, and with which the cones are completely surrounded and covered: this seems to act as a non-conductor of heat, and by preventing the dissipation of that contained in the recently boiled sugar, serves, instead of the candy stove used in England, for keeping the contents of the *naund* at a high temperature until the crystals have had time to form. In about ten days the holes at the apex of the *naunds* are opened, and the uncrystalized syrup allowed to drain away into a pot placed underneath each, and in a day or two more the candy is ready for sale.

It is calculated that two maunds of *dobarrah* sugar make one of candy: the syrup is used by the confectioner in the preparation of sweetmeats, being seldom or ever made in sufficient quantities to render its re-conversion into sugar profitable. It is of about equal weight with the candy it is derived from, and to assist in finding the cost of the latter, the syrup may be roughly estimated as worth two Rupees per maund.

Then, assuming the cost price of *dobarrah* to be as already given, that of candy will stand as follows :—

From cane dobarrah.

Two maunds of *dobarrah* at 7-4 per maund, ..	14	8	0
Manufacturing expences, wood, milk, *naunds*, &c., ...	0	8	0
Labor and superintendence, ...	0	4	0
	15	4	0
Interest on Co's. Rs. 15-4 for 15 days, at 12½ per cent. per annum, ...	0	1	4
	15	5	4
Less value of one maund of syrup, ...	2	0	0
Net cost of a maund of candy, .. Co's. Rs.	13	5	4

From date dobarrah.

Two maunds of *dobarrah* at 4-14 per maund, ..	9	12	0
Expences as before, ...	0	12	0
	10	8	0
Interest on Co's. Rs. 10-8 for 15 days, at 12½ per cent. per annum, ...	0	0	11
	10	8	11
Less value of one maund of syrup, ...	2	0	0
Net cost of a maund of candy, .. Co's. Rs.	8	8	11

I have now traced the processes of the Native cultivator and manufacturer in the preparation of the various descriptions of sugar they are accustomed to produce, and I have valued the same at the minimum cost of production to them, without any allowance in the shape of profit, but with a return only of a fair rate of wages for the labor they have employed, and on the spot where the cultivation and manufacture are conducted.

I purpose completing this part of the subject by estimating at what rates these sugars should be sold in the markets where produced, to constitute their production an encouraging one to those engaged in it. For this it is not requisite that any extraordinary rate of profit should be looked for, nor anything beyond what is derived from other branches of Native industry: but we may assume, that the production will continue at its present extent, or perhaps gradually increase, so long as a steady demand continues at such average prices as will secure to the cultivator and manufacturer a return *as profitable* as any other crop or occupation which they are accustomed to engage in:—on the other hand it cannot be expected, although the cultivation may show a profit on the cost of production, that it will be persevered in, much less increased, unless such profit continue as good and certain, or nearly so, as the average of other Native crops. Among the latter, rice cultivation is perhaps that with which it may be most readily and fairly compared; this being the most universal and favorite cultivation with the Bengal ryot: it calls for little exertion, is pretty certain in its returns, and the produce is an article of vital importance to him in his household expenditure.

The following are the estimated expences and return of cultivating a beegah of rice in the Burdwan district, collated from particular local enquiry, and by calculating the several operations of manual labor therein, at the lowest rate of wages, at which the ryot would work in his own field in preference to hiring his labor to another party:

Seed, ...	0	4	0
Ploughing and harrowing, ...	0	8	0
Sowing and digging, ...	1	0	0
Weeding, ...	0	12	0
Rent, ...	1	8	0
Reaping, ...	1	0	0
Co's. Rs. ..	5	0	0

Produce 9 maunds of *dhaun*, or rice in husk, at an average rate of 10 annas per md., Co's. Rs.	5	10	0
Value of *straw*, ...	1	0	0
Co's. Rs. ..	6	10	0

leaving a profit on outlay of about 32 per cent. The market value of 10 annas per maund here assumed, being taken as a fair average over a series of years. Colebrooke in his essay "On the Husbandry of Bengal,"* has estimated 12 annas per bazar maund as the lowest rate at which clean rice can be produced, without positive loss to the *ryot*; and as he also estimates three-eighths of the value of the *dhaun* or rice in husk, is expended in the process of husking, cleaning, &c., it follows that the cost of the *dhaun* is 7½ annas per bazar maund, a calculation which accords pretty closely with that above given. Without prosecuting the enquiry further, it may be perhaps deduced from the evidence above offered, taken together with the consideration of the high rates of interest current in all Native transactions connected with agriculture, in which the ryot often borrows the seed, and takes an advance from his landlord on the security of his growing crop, at the rate of 37½ per cent. or higher: that 33⅓ per cent., or one-third of the bonâ fide outlay on the crop, in the value of material and manual labor expended thereon, must be looked for to encourage the continuance of this or other cultivation in Bengal; and perhaps this will continue to be the case so long as the country remains with a population not much more dense than at present, and the abundance of productive land under a genial climate and mild Government, affords facilities to the ryot of raising his crops with so little trouble as in these provinces. It is true that the rapacity of the Zumeendars in many parts of the country induces them to exact, under various pretences, part of the produce of the field which should have fallen to the share of the ryot as

* See Colebrooke, page 101.

profit: but this does not affect the general argument for finding the portion which should be, and in the majority of cases is, left to the latter, after the fair claim of the Zumeendar in the shape of rent has been allowed to him.

Applying the above principle therefore of an estimated profit of one-third to the cultivation of sugar, I have constructed the following table; in which the first column shows the various rates per maund, brought forward from the several calculations throughout this chapter, of the prime cost to the cultivator and manufacturer, yielding them nothing beyond a mere return, on the average ratio of wages in Bengal, for their labor expended on each. In the second column one-third of the value of labor expended on its remanufacture is added for each quality, to find such rates per maund as would form an inducement for the production to be continued or increased for the future. Occasion is also taken, by giving the produce of cane and date sugars separately, to show the difference of cost at which the two descriptions, when brought to the same stage of refinement, can be offered for sale:—

	Cane Produce.		Date Produce.	
	Prime cost to the cultivator and manufacturer per md.	Remunerative price per md. to the cultivator and manufacturer.	Prime cost to the cultivator and manufacturer per md.	Remunerative price per md. to the cultivator and manufacturer.
	Co's. Rs. A. P.	Co's. Rs. A. P.	Co's. Rs. A. P.	Co's. Rs. A. P.
Goor, ...	1 8 0	2 0 0	0 12 0	1 0 0
Khaur, single prossed,	2 5 0	3 3 8	1 5 8	1 10 5
Ditto, double prossed,	2 11 2	3 11 0	2 0 0	2 10 7
Dulloah, ...	3 0 3	4 13 0	2 3 0	2 14 0
Pucka Cheenee, 1st quality, ...	0 4 0	8 0 0	0 5 2	4 4 0
Ditto, 2nd ditto, ...	4 8 0	6 10 0	3 0 0	3 14 0
Ditto, 3rd ditto, ..	0 0 0	0 0 0	2 8 0	3 0 0
Dobarrah, ...	7 4 0	9 6 0	4 14 0	6 9 0
Ekbarrah, ...	4 0 0	5 10 0	3 0 0	4 0 0
Candy, ...	13 5 0	18 4 0	8 0 0	11 14 4

From the statement above given, it should not be inferred, that were the prices to fall considerably below those given in the second column for one, two, or even three years, the production would at once be seriously reduced: when once an extensive branch of profitable agricultural industry has been established, capital is always found to sustain it even for some time after the profits which induced it have ceased to be realized: yet no doubt such reduction of prices *continuing* for two or three years would occasion a gradual falling off in the annual production; and this more especially with the cane cultivation, owing to its being an annual crop and the land and labor devoted to it so easily diverted to some other cultivation. With the date tree produce however, the case would be somewhat different, for though any increase in planting the trees would be at once checked by a fall in prices to below a remunerative return, the produce would not probably be materially affected in quantity for several years after such reduction of price had been established.

CHAPTER IV.

ON THE COST OF NATIVE SUGARS IN THE CALCUTTA MARKET.

Having shown in the preceding Chapter, as far as data and reasoning will admit, the average prices at which sugars can be brought to market in Bengal, at the places of their growth and manufacture; it will form a fitting sequel to this part of the subject to estimate, taking those prices as a basis of calculation, at what rates the same sugars can be delivered for sale in the Calcutta market, by adding thereto the expences per maund incurred in the packing, transport, &c.

The great bulk of the sugars imported from the interior of the country to Calcutta are conveyed by water carriage, a small proportion only being subjected to land carriage for a part of the route, until they reach the nearest navigable stream in communication with the great river highways of the country. In the portion of this work on the capabilities of sugar production in each district, separately considered, their facilities for transport will be further adverted to. In this place therefore, I merely propose referring to the average expence of the same, to assist the planter or merchant in arriving readily at the approximate price of any sugar in the Calcutta market, by the addition of these and all other contingent expences to the estimated original cost at the place of production, incurred up to the time of its sale in Calcutta.

These expences may be classed as follows: 1st, packing charges; 2nd, transport charges; 3rd, insurance; 4th, commissions on purchase or sale.

To exemplify the nature and extent of the first two heads of expence, I shall give the current rates charged on sugars imported into Calcutta from some of the principal sugar marts, and have selected for this purpose, Benares and Burdwan for cane; and Kossubpore in Jessore district, Sodepore in Furreedpore ditto, and Nollehit in Burrisaul, for date sugars.

1*st.*—*Benares or Mirzapore: estimate of expences on* 100 *maunds of pucka cheence imported into Calcutta.*

45 gunny bags, at 10 Rs. per 100, ..	4	8	0
Ditto ditto sewing, at 1 Rs. per ditto,	0	7	8
45 cloth bags, at Rs. 18-12 per ditto,	8	7	0
Coolies packing, per 100 maunds, ..	0	12	0
Carried over, .. Co's. Rs.	14	2	3

Brought forward, .. Co's. Rs.	14	2	3
Coolies weighing, per 100 maunds,..	0	4	0
Marking, string, &c., ...	0	12	0
Total packing charges, ...	15	2	3
Coolie hire, loading on boats, at 8 Rs. per 100 bags, ...	1	5	8
Boat hire, including mats, &c., per 100 maunds, ...	27	0	0
Churandars, per ditto, ...	3	0	0
Landing charges, 8 Rs. per 100 bags, ...	1	5	7
Total transport charges, ...	32	11	3
Co's. Rs.	47	13	5

being at the rate of annas 7-8 per maund.

2nd.—Dinapore or Patna: estimate of expences on 100 *maunds pucka cheenee imported into Calcutta.*

Packing charges, same as above,..	15	2	3
Coolie hire, loading on boats, at 3 Rs. per 100 bags, ...	1	5	8
Boat hire, including mats, &c., per 100 maunds, ...	20	0	0
Churandars, per ditto, ...	2	0	0
Landing charges, at 3 Rs. per 100 bags, ...	1	5	7
	24	11	3
Co's. Rs.	39	13	6

being at the rate of annas 6-5 per maund.

3rd.—Burdwan : estimate of expences on 100 *maunds of khaur or dulloah imported into Calcutta.*

50 gunny bags, at 9 Rs. per 100, ..	4	8	0			
String and sowing, at Rs. 2-8 per ditto, ...	1	4	0			
Coolies for packing and weighing, per 100 maunds, ...	1	4	0			
Weighman and marking, ...	0	6	0			
Total packing charges, ...				7	6	0
Cart hire to Muggra Ghaut, at Rs. 1-3 per maund, ...	7	13	0			
Boat hire from Muggra Ghaut to Calcutta, per 100 maunds, ..	3	0	0			
Churandars, mats, &c. per ditto, ..	2	0	0			
Landing charges, at 3 Rs. per 100 bags,	1	8	0			
				14	5	0
Co's. Rs.				21	11	0

being at the rate of annas 3-9 per maund.

4th.—Kessubpore : estimate of expences on 100 *maunds of dulloah or khaur as above.*

66 gunny bags, at Rs. 6-12 per 100,	4	8	0			
String and sowing, at Rs. 2-8 per ditto, ...	1	10	8			
Coolies packing, per 100 maunds, ..	0	12	0			
Weighing, marking, &c., per 100 maunds, ...	0	6	0			
Total packing charges, ...				7	4	8
Carried over, .. Co's. Rs.				7	4	8

Brought forward, ... Co's. Rs. ..				7	4 8
Coolies loading boats, at 2 Rs. per 100 bags, ...	1	10	8		
Boat hire, per 100 maunds, ..	9	0	0		
Mats, &c. per ditto, ...	1	0	0		
Churandars, per ditto, ...	1	0	0		
Landing charges, at 3 Rs. per 100 bags, ...	2	0	0		
				14	10 8
Total, Co's. Rs.				21	15 4

being at the rate of annas 8-6 per maund.

5*th.*—*Sodepore or Nollchit : estimate of expences as above.*

66 gunny bags, at 6 Rs. per 100, ..	4	0	0		
String and sewing, at Rs. 2-4 per ditto,	1	8	0		
Coolies and packing, per 100 maunds,	0	12	0		
Bags and marking, per ditto, ..	0	6	0		
Total packing charges, ...				6	10 0
Coolies loading boats, at 2 Rs. per 100 bags, ...	1	10	8		
Boat hire, per 100 maunds, ..	12	0	0		
Mats and Churandars, per ditto, ..	2	0	0		
Landing charges, at 3 Rs. per 100 bags,	2	0	0		
				17	10 8
Total Co's. Rs.				24	4 8

being at the rate of annas 8-11 per maund.

These expences will necessarily vary to the extent of two or three annas per maund over or under the rates above calculated, in proportion as the distance of the market may be greater or less from Calcutta than the places for which these calculations are made; their distance from a navigable stream; or the higher or lower rate of wages for

labor, &c. that may be current thereat. To form an average out of such materials is difficult: nevertheless, we shall not greatly err if we reckon in round numbers 4 annas per maund as a sufficient average rate to cover the expence from all markets within 200 miles from Calcutta, embracing all the districts East of the Hoogly river, and bounded by that, the Ganges, and the Burrampooter rivers, as well as all localities within 50 miles to the Westward of the Hoogly: and 8 annas per maund as the average for all sugars brought down the Ganges river and its tributaries, and from beyond the districts comprehended in the above boundary.

The third charge, that of river Insurance, is usually effected at the rate of 2 per cent. on the value of the cargo for all distances beyond 100 miles from Calcutta, or 1 per cent. for places within that distance. This is a charge which is seldom incurred by the Native merchant, but should nevertheless be taken account of in estimating the expences of importation; as the risk is not diminished when in his hands, and must consequently be covered by a corresponding increase of profit to the importer.

Commission, or profit on the importation, is the last charge to be noticed. In most cases the Native manufacturer does not himself consign or bring his sugars to Calcutta for sale, but a second party, or *mahajun*, purchases them at the up-country mart, and imports them at his own risk and expence: but in either case it is clear, that a commission or profit must be derived by one or the other from the traffic, to compensate for the attention and trouble bestowed upon it: and a further charge of at least 2½ per cent. must be allowed under this head before we can arrive at the Calcutta net selling rates, which will leave a remunerative return to all parties engaged in producing it, and bringing it for sale to that market.

In accordance with the foregoing estimates of expence, I have computed the following list of the principal kinds

of Native sugar imported into the Calcutta market of late years, showing the prices at which they can be brought to sale there after allowing a fair return, whether as profit or commission, to the cultivator, the manufacturer, and the Importer.

	Cost per md. at the up-country mart.	Packing and transport charges per mannd.	River insurance per mannd.	Importer's commission at 2½ per cent.	Remunerative rate of sale per md. in Calcutta.
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Cane *puoka cheenee*, 1st quality, or fine white, ...	8 6 0	0 8 0	0 2 11	0 3 7	9 4 6*
Ditto 2nd ditto, yellow, ..	6 10 0	0 8 0	0 2 3	0 2 11	7 7 2*
Date *puoka cheenee*, 1st quality, ...	4 4 0	0 4 0	0 0 0	0 1 10	4 10 7
Ditto, 2nd ditto, ...	3 14 0	0 4 0	0 0 8	0 1 8	4 4 4
Santipore *dobarah*, ...	0 0 0	0 4 0	0 1 0	0 2 0	0 13 0
Burdwan cane *dulloah*, ..	4 13 0	0 4 0	0 0 10	0 2 0	5 3 10
Jessore date *dulloah*, ...	2 14 0	0 4 0	0 0 6	0 1 3	3 3 9
Burdwan cane khaur, 1st quality, ...	3 11 0	0 4 0	0 0 8	0 1 7	4 1 3
Ditto, 2nd ditto, ...	3 3 2	0 4 0	0 0 7	0 1 5	3 0 2
Sodopore date khaur, 1st quality, ...	2 10 7	0 4 0	0 0 0	0 1 2	3 0 9
Ditto, 2nd ditto, ...	1 15 5	0 4 0	0 0 5	0 0 10	2 2 8

* These two qualities of cane *puoka cheenee* will comprehend all that appears in the Calcutta market, and known as good Benares sugar; but will not include the kinds known as *dumma*, the quantity of which brought to Calcutta has very much increased of late years, under the influence no doubt of the high prices which all sugars have attained, the tendency of which has been to induce the frequent re-working of the syrups from which these *dummas* are produced.

Part II.

ON THE EUROPEAN MODES OF SUGAR CULTIVATION AND MANUFACTURE.

CHAPTER I.

ON THE ENDEAVOURS HITHERTO MADE TO ESTABLISH CANE CULTIVATION AND MANUFACTURE SUGAR DIRECT THEREFROM BY EUROPEANS.

Even since the sugar trade of India attracted the notice of the European merchant, and its importance as a valuable branch of commerce was recognized, the idea has been entertained of the feasibility of improving on the rude methods of Native manufacture by assimilating the process to that used in the West Indian and Foreign Colonies. To all intelligent observers who have turned their attention to the subject, it has appeared almost self-evident that the substitution of *a single process*, by which the sugar is brought from the field, its juice expressed, and converted at once, and under the same roof, into a good and marketable sugar, must possess many advantages over the tedious and divided course of Native manufacture described in the preceding pages; by which the *goor*, or crude inspissated juice, is produced by the grower of the cane, and this passes into the hands of a distinct class of operators, to be re-melted, clarified from its impurities, and re-boiled into sugar.

It has been contended that this *single process* of manufacture would not only effect a saving of time in bringing the sugar to any required state of purity, but that it would be attended with other advantages. It is a fact well known to all sugar manufacturers, that the quality of sugar greatly deteriorates in proportion to the length of time it is exposed to high temperatures when in a liquid state during the boiling, to evaporate its superfluous water: and whereas by the double process in use in Bengal, the whole is twice subjected to high boiling temperatures, once to evaporate the water present in the cane juice, and the second time to evaporate that used to re-melt the crude sugar for the purpose of reducing it to such consistency as will admit of its clarification and filtration,—by the single process recommended, one such boiling would answer for both purposes, whereby it would suffer such deterioration to only half the extent, and much less expence in fuel and labor would be required for the purposes of evaporation.

And this more simple mode of operation is far from having been confined to theory. Experiments on a greater or less scale have been made at intervals from the period of the first enquiries into the subject, with the object of testing its practicability; and of late years outlays have been incurred in cane cultivation and erection of machinery in some of the most promising districts of Bengal for carrying out the theory into practise, and with a liberality and spirit of enterprize that deserved a better fate than has befallen them.

As early as the year 1791, the East India Company, being desirous of encouraging an experiment of this nature, entered into an agreement with one Lieut. Paterson, to cultivate 600 *beegahs* of 100 cubits each with sugar-cane in Bengal: the land was to be leased to him on favorable terms, and the sugar to be delivered to the Company's Agents in India, of quality equal to a sample previously furnished by him, and at the rate of 7 Rs. 8 annas per cwt. Lieut. Paterson was said to have

had great experience in the West Indies in the cultivation of the cane. In 1794,* we find by an extract from the Court of Directors' Despatches to the Bengal Government, that they "approved of the proceedings of the latter with respect to this gentleman, and that he had at length fixed himself in a situation favorable for his pursuits," which situation, as appears from a subsequent Despatch,† was in the Beerbhoom district. About two years subsequent to this however, another Despatch informs us, that the Bengal Government had been obliged to assist Lieut. Paterson in the prosecution of his undertaking, and that the Court of Directors began to complain that "he had not distinguished himself with that warmth of zeal equal to their expectations," and soon after we find the Government advancing him 25,000 Rs. "to enable him to fulfil his engagements to the Company." We have no record of the proceedings in detail of this interesting experiment, but its failure is fully apparent by an extract‡ from the same Despatches a little further on, wherein the Court of Directors have resolved not to comply with the request of one General Stibbert, praying that the said debt of 25,000 Rs. might be remitted to him; the loss of it having been incurred through his partnership with Lieut. Paterson in this undertaking: the latter died in 1797.

In January 1798, Mr. W. Fitzmaurice, who possessed sixteen years' experience as a sugar planter in Jamaica, addressed a letter to the Court of Directors from Calcutta, strongly urging on them the policy of introducing and encouraging in India the more efficient mode of sugar cultivation he had practised in the West Indies, and offering his services for forwarding that object. He states, that he left England with

* Dated 2nd July 1794, vide papers on the cultivation of sugar in British India.

† Dated 15th April 1795, vide same.

‡ Dated 27th July 1796, vide same.

Lieut. Paterson under engagement to superintend the factory to be established by him, but that the latter thought fit, on their arrival out, to reject his services. The Court acknowledged the receipt of Mr. Fitzmaurice's address, but it does not appear they ever otherwise replied to it or availed of his services, and were probably deterred from doing so by the unfortunate issue of Lieut. Paterson's experiment.

This Mr. Fitzmaurice soon after published in Calcutta, a short treatise on the subject of sugar cultivation and manufacture as adapted for India, which is replete with useful information and intelligent remarks on the subject; and however great the improvements that have been made since the date of its publication, this little work still merits the attentive perusal of all interested in sugar cultivation in India: but it seems never to have reached a second edition, and is now rarely to be met with.

In 1799, the Court of Directors advised the Madras Government of their having permitted Mr. Edward Campbell to proceed to that presidency for the purpose of establishing sugar works. It appears he established a sugar estate at Dindigal, in the district of Coimbatore; but two years afterwards, in 1801, we find the Madras Government reporting to the Court of Directors that Mr. Campbell had failed in his engagements as to the time stipulated for a supply of sugar from him: a further failure in his enterprise is reported in 1804, and it appears from a subsequent Despatch, dated in 1806, that this gentleman was diverting his attention to indigo cultivation, from which his failure in that of sugar may be inferred; and his decease shortly afterwards terminated his speculation in both articles.*

For upwards of twenty years after the failure of these experiments, there appears no record of any further attempts to effect improvement in the cultivation of East India sugars.

* Vide papers on the cultivation of sugar in British India; "correspondence with the Madras Government."

The discouraging restrictions of the British tariff which imposed so much higher rates of duty on sugars imported from India for the purposes of protection to our West India Colonies, added to the jealous monopoly of the East India Company, which induced them to suppress to the utmost all independent enterprize in their territories, and looked upon all European settlers therein as "interlopers," seem to have acted as an effectual bar to all attempts at improving this article.

In 1829, however, Mr. C. H. Blake proceeded to Bengal, with the sole purpose of developing this branch of the productive resources of India. This enterprizing gentleman established the Dhoba sugar works in the Burdwan district, the first in India in which steam power was applied for the purpose of extracting the juice from the cane. The plan of operations adopted by him was to advance to the native ryots or other landholders in the vicinity of his factory, for the cultivation of sugar-cane, under a contract from them to deliver a certain return of cane in weight per beegah advanced for, it being in fact the same system, with slight modifications, adopted by the indigo planters for the cultivation of their plant by their ryots. But here again failure* attended the experiment, and after the first two years the cane cultivation was abandoned, the mills were closed, and the factory was converted into a refinery for bringing the native sugars into the finest descriptions admissible in the home markets; and this system was persevered in against the discouraging and unequal imposition of 8 shillings per cwt. additional duty upon Indian sugars over those from the West Indies and Mauritius, until the equalization measure of 1837 placed all upon an equal footing in this respect. The refining business, to which this factory has been since devoted, it is foreign to the subject under consideration to refer to further.

About this period, 1830-32, also, another enterprizing gentleman, Mr. T. F. Henley, embarked in a somewhat similar

* For remarks on the causes of the failure, see page 112.

experiment, on a minor scale, at Barripore,—a locality bordering on the Sunderbunds, in the southern part of the district of 24-Pergunnahs. He cultivated the native canes and manufactured sugar from them on the old West India principle. The result as usual was failure:—the sugar produced was sold in the Calcutta market at 3 to 4 Rs. per bazar maund, and must have entailed considerable loss on the proprietors. The soil was pronounced to be not adapted for the growth of sugar-cane, and the works were soon after abandoned.

The failure of Mr. Blake's experiment, under the manifest advantages he possessed in the most approved machinery, capital to invest, enterprize to attempt, and courage to prosecute the undertaking, so long as it afforded grounds for him to anticipate success, appeared to have acted as a damper on any further endeavours of the same nature for the next ten years. By degrees however, the subject began again to draw the attention of the public, and of private individuals interested in the resources of the country, and others acquainted with the art of producing sugar. The emancipation of the slaves in all British Colonies in 1833, and the equalization of duties on East and West India sugars in 1837, were indications sufficiently clear to the far-seeing amongst the West India planters, that the days of their prosperity were numbered; and many of them turned a wistful eye towards India and the Mauritius, as more encouraging fields for their future labors. About this period not a few of them found their way to the shores of Bengal, and the subject was again discussed and written upon; experiments in cane cultivation began to be tried in various parts of the country; foreign varieties of cane were introduced; the Calcutta Agricultural Society once more took up the subject as deserving the attention of its members; and lastly, the high prices of sugar, both at home and in India, caused by the great falling off in West Indian production, acted as a further stimulus to the

new movement; and at this time experiments in cane cultivation were instituted in nearly every district in India.

The fruits of this agitation were soon developed in more important measures. Among the districts from which the most successful experiments were reported, Tirhoot and Kishnaghur were distinguished for the luxuriance of their cane crops, and the low estimates of cost at which they could be raised. The indigo planters became most zealous in the new path to profit thus opening to them with such flattering prospects. They introduced the finest varieties of cane, and manufactured therefrom small quantities of sugar by the native process, and from the data furnished by these experiments, calculations and estimates were laid before the public, and in the validity of which no doubt the planters themselves reposed entire confidence, that good sugar could be produced, even by the aid of the inferior means of Native manufacture then available to them, at extremely low rates of cost. Good marketable yellow sugar was said to be produced at rates varying from 1 Rupee 4 annas to 3 Rupees per maund, and it was therefrom argued, how much *better* results might not be expected with the aid of European mills and machinery, and the superior system of manufacture in use in the West Indies. It was ascertained by careful experiment, that a beegah of ground in Tirhoot, equal to about three Bengal beegahs or one English acre, produced on a low average 26 maunds of dry sugar; and under favorable circumstances, and from Otaheite cane, as much as 60 maunds, being upwards of 2 tons, from the same surface; and of this the cost of cultivation was estimated at 15 Rupees.

Accordingly, the value of indigo factories rose, lands were eagerly secured in the supposed fruitful districts, and associations were formed for developing their resources in this new and inviting branch of cultivation: capital was largely embarked, and mills and machinery imported for carrying it out with skill and spirit.

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But the evil genius which had presided over all former attempts of the same nature seemed still to prevail, and sadly disappointing to all concerned have been the results of these enterprizing speculations. Four years had not elapsed since the promulgation of the flattering estimates of profit above referred to when all engaged in carrying them out confessed their disappointment, and the history of the sugar works that have been established on the faith of them comprises one uninterrupted catalogue of losses and disasters;—mills broke down in the midst of crop—the white-ants dealt destruction to whole tracts of cane, preferring always the finest varieties—in one year drought stunted or entirely destroyed the crop—in the next an inundation, such as had not been known before for many years, swept the lower parts of the district and buried at once the canes and the hopes of the planter: such Tirhoot sugar as arrived in Calcutta for sale during these years was generally of an inferior quality, and from the results of some shipments of it made to England it acquired the character of deteriorating greatly on the voyage home: other parcels were bought by the Calcutta refiners and were pronounced by them to be weaker than native sugars of a corresponding degree of refinement; and opinions now began to circulate, that Tirhoot especially was not adapted from the nature of its soil for sugar-cane cultivation, owing to the abundance of nitrous and other salts in its composition, causing a weakness in the crystal of the sugar, and a great tendency in it to deliquesce, to which causes its inferiority of quality was in great measure attributed. It may be remarked finally, as a peculiar characteristic of these failures in the Tirhoot district, that scarcely two of the planters who were most deeply interested in the cultivation were found to agree as to the *prevailing cause* to which they may be attributed: for however much minor disadvantages, local or otherwise, may have operated in particular instances, yet where the failures were of so general and wide-spread a nature

as in this instance, some primary influence to which they were mainly to be attributed, was naturally looked for.

Probably some of the gentlemen referred to may consider it an instance of presumption, for one but little acquainted with their districts to offer an opinion as to the real nature of this prevailing cause of failure: *yet this should not deter* me from stating it to them, and to all others interested, as the result of a pretty general enquiry into the history of their progress, aided by the valuable opinions of some of their body who have been most deeply engaged in the cultivation, and by my own practical experience of some of the difficulties they have had to encounter, and rendered more earnest by the deep interest I have all along felt in their success.

Briefly then, my opinion is, that this prevailing cause has been a *want of calculation*. My reasons for this conclusion I will endeavour to explain.

First, the estimates of profit were generally framed from the experimental results of a small patch of cane, never exceeding 30 to 50 beegahs, and generally much less, grown near the planter's residence. This was carefully watched by the planter himself through every stage of its cultivation, plentifully manured from his bullock house or stables, or with the rich refuse from his indigo vats: it was kept carefully weeded, dug, and watered, and in short, made a sort of pet cultivation: it was then crushed in due season, and yielded a good rate of produce in sugar per beegah, say 20 maunds: it was thence argued, that as 20 times 50 is equal to 1,000, a thousand beegahs of cultivation would yield in the same proportion, or 20,000 maunds: but it was *not* calculated that it would be difficult or impossible to cultivate the larger surface with the same proportionate attention as the smaller, to supply the same proportion of manures per beegah, nor to devote that equal share of superintendence from the personal and almost daily visits of the individual most interested in its success, the planter himself: its management was more frequently left to

the assistant, European or Native, who had no direct interest in the out-turn, and had generally a too wide-spread cultivation to supervise efficiently. One instance came to my knowledge, where the manager of sugar works with 1,500 beegahs of cultivation, had to ride nine miles in a direct line between its two extremities to visit all.

The necessity of irrigation for the growth, or in some cases, for the very vitality of the plant through a dry season; or when its necessity was recognized, the expence of applying it to many situations appropriated for cane, were not sufficiently calculated. In other cases, it was not considered that the ground was subject to inundation, and that the submersion of the cane for weeks together was certain destruction to it; and consequently sufficient care was not taken to select lands beyond the reach of such casualties.

The expence in the shape of rent seems also to have fallen very heavily on the cultivation of some factories: many thousand Rupees were advanced to the Zumeendars on the security of Talooks, that is, the privilege of collecting the rents in certain villages, the planter thereby acquiring such power in the villages so held by him as to enable him to appropriate for his own cultivation such of their lands as might suit his purpose, on allowing a fair rent for the same to the ryots: but it was not sufficiently calculated, that as no interest was allowed to the planter on these advances, and that he had, meanwhile, to incur heavy charges thereon, in the way of interest and commissions to the Calcutta agent advancing the funds to him, the expence of the annual land rent to the planter was greatly enhanced thereby.

The consequence of these misapprehensions was, that both the actual cost of the cultivation far exceeded, as the yield both in quantity and quality of the sugar produced fell below the estimates on which the profits were reckoned. The interest on the block, which comprised the expensive machinery imported from England, being divided over the

small quantities of sugar produced at each factory, tended further to heighten the evil. There needed only a season or two of unfavorable weather for the growth of the cane, and a re-action bringing low prices in the selling market, to complete the discomfiture of the planters: those misfortunes too they have had to bear, and their losses have been so general, that it is now reported the cultivation is to be abandoned by most of them.

The above remarks, though principally referring to one or two districts, are applicable with nearly equal force to what has befallen in all. In Tirhoot alone, however, it has been computed that about a million sterling has been sunk during five years, to cover the losses incurred by this cultivation, including the outlay on machinery and factories; and with not one instance of profit accruing as the result of the speculation over that period.

I have discussed these matters at some length, because so universal a course of failures has naturally given rise to the question whether, in fact, the two divisions of the art of sugar making in India, namely, the production of the crude extract or goor, and the conversion of the latter into dry sugar, *can* be successfully amalgamated into a single process. Arguments, founded on the recognized principle of the advantages derived from the "division of labor" in other great branches of industry, have been adduced in support of the system hitherto pursued in India, of leaving the production of the crude materials, goor, khaur, &c., in the hands of the Native cultivator, and the task of manufacturing the latter into fine sugar to the refiner: and it cannot be denied, that this system has in its favor the *prestige* of success hitherto, whether we consider the general prosperity of the Native refiners, or the fortunate results to some of their European competitors in Bengal, who have brought experience and prudence to unite with the advantages of the scientific process and improved machinery of the home refiners.

Yet there seems no good reason why these advantages of the "division of labor" should be incompatible with those manifestly to be derived from the concentration of the several processes to such extent, as will admit of their being begun and completed under the same proprietorship and management, from the cultivation of the cane to the last stage of refinement of the sugar; of carrying through the manufacture from the cane-crushing to the refining by one process; and of applying European capital and machinery for the perfection of the whole: and this, I believe, is to be effected by giving to all the parties employed a direct interest in the success of their respective branches of the business, by a judicious scheme of task-work to be applied throughout. If we enquire into the regime of our mines, our cotton factories, and other great systems of industry at home, we shall find this plan of task-work in almost universal operation: the workman has a certain portion of daily labor allotted to him, and its completion in an efficient manner ensures him a corresponding return in wages at the end of every week. The labor of the farm is conducted on similar principles, and were they more generally introduced into India, in place of the pernicious system of advances on ryotty cultivation, or the uncertain employment of laborers by the day, their benefits would soon become apparent in sugar, as in all other branches of Native production.

As I purpose, in a separate chapter, entering into the details of the system I would recommend for carrying out these principles, I need not pursue the subject further here beyond stating my conviction that the profitably combining the cultivation of the cane, and the manufacture of the very best sugar therefrom, is not only practicable in India as well as elsewhere, but that it will yet, notwithstanding all the abortive attempts hitherto to carry it out, be ultimately not only successful, but will be found the most economical mode of operation, if set about with sound views and sober calculations as

of the "means to an end" to be employed throughout its multifarious details.

To enter into any description of the modes of cultivation and manufacture hitherto pursued by the European planters in the districts above referred to seems unnecessary, inasmuch as there is no appearance of their having assumed any regular system of proceeding,—any one plan which has been recognized as a standard or guide for the operations of the rest; on the contrary, opinions differ widely on most points connected with the subject. The Otaheite cane was, at its first introduction, highly prized, and the produce it yielded per beegah so far surpassed that of any other variety, as to establish a pretty general opinion that any extra expence incurred in its cultivation was more than compensated for by the results of its yield. *A year or two after its introduction however, its virtues were* found to have much degenerated, and its greater liability to the ravages of white-ants, and the high cultivation it required as compared with other varieties, now lost for it its character as the favorite, and the China and Native kinds came more into request as being hardier and involving less risk in their returns. All conceivable methods of planting have been tried in turn, and little or no unanimity of opinion has yet arisen as to which claims the preference. Mills of various descriptions have been adopted, worked by steam and by cattle, but the former are of course universally preferred. As to the vast superiority of the vacuum pan in the concentration of the sugar there is no difference of opinion; though many question whether the great expence incurred by its adoption is compensated for by the improved quality of the sugar it produces over what is obtained by the old West India plan *of a series, or "battory," of open pans. Its great drawback* is no doubt its expence, and it is urged with much reason, that so costly an apparatus entails a heavy burthen in the shape of interest on block to be divided over the small quantity of sugar that can be boiled in it during the gathering

in of a cane crop which lasts for two, or at most three months, while for the remainder of the year the whole machinery lies unemployed; and that a very great improvement in quality must be established to warrant the adoption of such means in preference to the open pan process, for which much less outlay of capital is required. As a partial remedy for this great drawback in expence, it has been proposed by some of the planters, in addition to their full crop in the vicinity of the factory where the vacuum pan is set up, and which should be sufficiently extensive to employ it throughout ordinary crop time, to erect outworks, comprising merely a mill and open pans, in the midst of an adjacent cultivation, where the cane juice could be extracted and partially boiled, bringing it to such a density as to obviate all risk of its deteriorating from fermentation, yet not so much as to injure it by too long exposure to a high boiling temperature: this semi-liquid sugar was then to be kept in casks or other vessels until the vacuum pan was available to complete the process by crystalizing it and evaporating the remainder of its water: and it was computed, that the produce of two of these outworks in addition to the crop in the vicinity of the vacuum pan, would suffice to keep the latter in full work for 8 or 9 months of the year. This plan however has not, I believe, had the test of experience, and there are so many apparent objections to it, in the expence of casks to contain the semi-liquid sugar, and of its transport to the main works in that state; besides the interest on the capital sunk in such raw material for several months, beyond what would be requisite were it boiled at once into marketable sugar; as well as in the outlay for the outworks themselves, and other disadvantages in the risk of deterioration of the sugar, &c., which will readily strike any person experienced in such matters, that I believe few will be found to risk their capital in the experiment.

A more obvious means of overcoming this difficulty of the great expence of vacuum apparatus, is to choose the site of

the intended sugar plantation in the vicinity of some established mart for native raw sugars, or at least on some navigable stream, which would admit of such material being conveyed to the works by water-carriage throughout the year; so as to enable the proprietor to convert the sugar house into a refinery during the months it is not occupied in taking off his own cane crop.

CHAPTER II.

ON THE BEST METHOD OF CANE CULTIVATION BY EUROPEANS.

The advice offered in this chapter I do not wish to be considered as laid down with any great degree of dogmatism: the subject is one on which I believe we have still a great deal to learn, and to gather from further experience: the following instructions however may be received as the result of no small degree of study devoted to it, assisted by practical experiments, extending over several years, and more or less successful in their results: and though these experiments were conducted in one district of Bengal only, Burdwan, they were sufficient to afford a practical knowledge of such general principles of the cultivation as are applicable to all parts of the Presidency.

Plan and size of cultivation.

A sugar estate of the present day should never be established without the aid of all the improved means in machinery, aided by steam power, for extracting the juice from the cane and converting it into sugar. The grand improvement in modern sugar manufacture, the vacuum pan,

should especially be considered as an indispensible adjunct to it. Neither should the latter be of too small a size, but of such capacity as will admit of that gradual growth of the crystal by successive additions of fresh sugar liquor to the granulating mass as is requisite for the formation of a strong full-grained sugar: the smallest-sized pan compatible with this advantage, I consider to be one capable of containing and bringing to the state of crystalization at least 8 tons' weight of sugar. Vacuum pans of this capacity have been made on different models as to shape and dimensions, but I would recommend as worthy of confidence that known as the seven foot pan, that being the measure of its internal diameter at the broadest part, where the upper and lower hemispheres are connected. A pan of this size, well supplied with steam, and properly fitted with a steam worm and jacket, a good air pump, and plentiful supply of condensing water, and with the whole apparatus in good order, is sufficient to boil off with ease 360 maunds of uncured sugar per diem, commencing with the cane juice already evaporated by other means to the consistency of 26 degrees of Baume's scale: the proportion of molasses to the crystalizable substance in this uncured sugar will of course vary with the quality of the sugar-cane, and the degree of skill with which it has been manufactured. Allowing however 40 per cent. of the mass for molasses as a fair average, it follows that a pan of the size described will be equal to the production of 206 maunds, or about 7¾ tons of dry sugar per diem.

The average yield of uncured sugar from the weight of ripe cane in Bengal may be taken at 8 to 9 per cent. At the average of 8¾ per cent. it will be found, that to provide the above quantity of sugar for the vacuum pan, a supply of about 4,000 bazar maunds of cane will be required daily. And as the average yield in weight of cane per beegah, one-fourth being plant canes and three-fourths rattoons, may

be taken at 150 maunds,* it follows that about 26⅔ beegahs of such cane will be required to be cut and crushed daily to keep up this supply: applying this rate of daily work to a cultivation of 2,000 beegahs, gives 75 working days in all as the manufacturing season for an estate of that extent: or three months' work on the average of 25 working days per month. And it follows, that such an estate by the above calculations should yield an annual produce of about 15,600 bazar maunds, or 570 tons of sugar; and in addition thereto 10,400 bazar maunds or 380 tons of molasses, besides skimmings, equivalent to the production of 50 to 60,000 gallons proof strength of very superior rum.

In the chapter on Native cultivation it was stated, that 15 maunds of goor might be taken as the average produce of a beegah: of this however, 12½ per cent. at least is dirt and scum, which is lost in the subsequent processes of converting it into clean and pure sugar,† leaving about 13 maunds of uncured sugar only, in lieu of 15 maunds of goor; and this will be found to be the weight of produce as obtained by the above calculation: the equivalent in dry cured sugar being on an average 7⅛ maunds per beegah.

It is very far more profitable to have a small estate, compact and well cultivated, than a large and scattered cultivation difficult to overlook and control: and I consider, one of the above extent, 2,000 beegahs, being sufficient for the employment of one vacuum pan, to be the utmost that should be undertaken for the supply of any one factory. Let this be well overlooked, and it will be found more productive than an estate of double the size, stretching beyond

* This average I have calculated as follows:—

From one-fourth plant-canes,	average	180 maunds per beegah.
Ditto ..... 1st Rattoons,	....	160 ditto.
Ditto ..... 2nd Rattoons,	....	140 ditto.
Ditto ..... 3rd Rattoons,	....	120 ditto.
Average of the whole,		150

† This refers to sugar prepared in a European refinery.

the ready supervision of the owner, and left necessarily to the care of subordinates less interested in its success, and involving extravagant outlay in its gathering in for manufacture. Mr. L. Wray, a West India planter, who had some experience of India cane cultivation in the Goruckpore district, and who published some papers on the subject in 1813, under the title of "the Sugar Planter's Companion," remarks, that 500 acres, equal to about 1,500 Bengal beegahs, is considered in Jamaica a very large estate: and unless the lands be very compact, and none of them in straggling patches, as we usually find cane cultivation in India, it would be better even not to exceed this breadth of cultivation for one set of works: and where this extent of good land cannot be procured, with the advantages of compactness and lying close to the works, it would be preferable to abandon the project altogether; as a less extent than this would not produce sugar sufficient to warrant the outlay for vacuum pan apparatus: unless indeed, the latter were also made available as a refinery of Native raw sugars, procurable with facility for such purpose.

Choice of a site.

This is a matter of very great importance, as on the judgment displayed therein, the future success or failure of the undertaking must greatly depend. There are two considerations of great moment in this selection; the fitness of the soil for cane cultivation, and the facilities for water or land-carriage to and from the works which the situation may afford. A third condition which is hardly of less consequence than those above given is, that the land should be above the reach of all ordinary inundation from the rivers.

The quality of soil preferred by the Native cultivators has already been described in the chapter on their mode of culture, and the soundness of their choice is verified by all who have had experience in the matter: a cold black marl,

and a very sandy soil are equally unfit for the purpose, but most others may be rendered capable of yielding good crops by means of manuring and other preparation: most soils in which the red or yellow clays predominate are well suited for it, and a mixture of ferruginous or calcareous matter, especially the latter, are valuable qualities.

The soils of Lower Bengal are mostly of alluvial origin, and the *character of the country slightly undulating*: the higher levels, though frequently too sandy, are on the whole well adapted for cane, so long as they are within the reach of irrigation: the intermediate low-lands are more generally of the cold black or very sandy description, more adapted from their situation for paddy cultivation, to which they are generally appropriated. The banks of the small rivers which permeate most of the districts, are frequently high and of suitable soil, and I do not know any position that could be chosen more favorable for cane cultivation than a tract stretching along the high margins of one of these streams; not only for the generally desirable nature of the soil, but also for the no less important advantages it would afford of irrigation, and of water-carriage, as well for *conveying the manures to the field, as for bringing the cane* therefrom to the mill. As already hinted, the lands should be so chosen as to have all the cane pieces lying as close together as possible, both for the greater facility of superintending the cultivation, and diminishing the cost of carriage, as well as that of irrigation, as will be explained hereafter; and for the same reasons, the spot fixed upon for the site of the factory and manager's dwelling house, which should adjoin each other, *should be as near as possible to the centre of* the estate.

It is important also, that the site of the works should be chosen in one of the highest spots, as well as close to the navigable stream, if such an advantage has been secured: at all events, it is essential for it to be located on the margin of some river or lake where an unlimited supply of good water

may be depended upon throughout the year. A high level being thus availed of, throughout the months during which the steam engine is not employed in working the cane mill, its power may be very economically applied in pumping water for the irrigation of the cane lands: in this case the distribution of the water from the higher level will be easy, its flow requiring only to be directed along rough channels cut in the ground, and so conducted from field to field, with perhaps the aid of one or two lifts only, which can be effected by the native modes described in a former chapter, for the more distant parts of the cultivation. Besides the aid of the cane-mill engine in pumping water, as suggested, a good supply of refuse water is also constantly procurable from a vacuum pan sugar-house when at work; such as the condense water from the air pump, the overflow from the feed apparatus to the steam boilers, and from the refrigerating of the still; all of which may be economised for the irrigation of the cane fields without any additional expence for pumping if the site of the works be on an elevated level.

Laying out and preparation of the ground.

After the satisfactory selection of a site, the next business is the dividing out the ground into convenient pieces: no certain rule can be given as to the size of these, depending as it must on the different levels of the ground and the interruptions it is subject to in the shape of roads and rivulets; but if possible, they should not be of less extent than 10 beegahs nor larger than 50 to 60 beegahs: the larger the piece the less expence will be incurred per beegah in ditching or fencing it; and the danger of damage from white-ants is diminished in proportion to the less extent of bank or pathway divisions in the field, which always serve to harbour these and other vermin: and there is no doubt, that the frequent *hauels* or small ridges in the lands in Bengal, owing to the numerous petty tenements into which they are divided, by leaving

so many divisions and corners never disturbed by the plough afford no small encouragement to the ants, rats, &c., with which they are infested. On the other hand, a cane-piece exceeding the limits I have advised for a convenient size, is not only difficult to examine thoroughly after the cane is high, and to measure out for task-work in the cultivation, but also becomes difficult of access to all its parts, owing to the distance of a portion of it from the cart road or river by which it communicates with the works; and the inconvenience thereby entailed, in manuring and gathering in crop, will be readily understood without further argument.

The pieces having been divided out, the next consideration is to provide for their efficient drainage, a matter of not a whit the less importance than the provision for their sufficient irrigation when requisite, and which should be considered one of the first principles of cane planting in Bengal. If the heavy rain is allowed to lodge on the field, and gradually evaporate or subside into the ground instead of finding a free egress, the roots of the plant begin to decay, the leaves turn yellow and sickly, and its growth is stunted; added to which, the ground becomes so soft and spongy as to render it impossible to be worked by spade or mattock, and rank grass and weeds soon spring up, exhausting the soil as the cane languishes: these effects are very soon visible after the water has once become stagnant on the field; so that their efficient drainage from rain water, and elevation above the reach of inundation from the rivers, are very essential to the success of the crop. The ditches formed by the earth thrown up for the boundary hedge of the field may be rendered subservient to this purpose, by opening a communication from them to the main drain which carries off the accumulated water to the nearest river: in addition to these, smaller or cross drains should be made at distances of 120 feet apart, running across the cane-pieces, and communicating with the ditches at either side of the field. These ditches or outer drains

should be 3 feet deep, and the same in width at top, with sloping sides, so that the bottom is only 1 foot wide; and the smaller or cross drains should be 2 feet deep by the same in breadth at top, and sloping to a width of 6 inches at the bottom: drains of this form will be found to stand much longer than those having perpendicular sides. The size of the main drain must of course be regulated by the number and length of the drains from the field leading into it. The earth that is dug up in making the cross drains should be thrown to a distance on the field, so as rather to assist the slope, and consequently the flow of water to them, which would be impeded were it left banked on each side of the drain itself; when once well made, they require but little care to keep them in order, nothing more being requisite than to clear them of any silt that may have accumulated, two or three times during the year.

Lands intended for cane in Bengal are generally pretty free from weed or jungle; but should any new land be appropriated for this purpose, it will be necessary to commence its preparation by destroying all large bush that may be upon it, and cutting out of the ground such roots as might impede the progress of the plough, or stroke of the mattock. In all lands newly turned to cane purposes, I would strongly advise the planter to commence with a deep hoeing, which is performed with the *dehroo*, a kind of mattock about 15 or sometimes 18 inches long, and of several seers weight, fixed to the end of a 8 feet long handle:* this instrument enters the ground at an angle with its surface, the laborer with a heavy stroke causing it to penetrate about a foot deep, and turning up a large clod of earth at each blow; it consequently turns up more subsoil than is ever reached by the native plough. Ten good workmen can turn up a beegah of ground in this way, as a day's work; laboring 7 or 8 hours only, as the work is heavy for natives. The *Dhangas* or hill coolies are the

* See plate II.

most expert at it. The best season for mattock hoeing is in October or November, while sufficient moisture remains in the earth to render it easily worked: the succeeding cold weather then cracks the clods, rendering them friable, and more easily reduced by the plough in the ensuing spring.

During the next 3 or 4 months of the cold and dry weather, the time should be occupied in carting or boating out the manure to the fields, where it should stand in convenient heaps until required to be spread; this prevents the necessity of the cattle and laborers being diverted to this work afterwards, when they are more required in attending to the ploughing and planting. The following are the manures which can be best availed of, and which I shall refer to in the order in which they should claim the planter's attention.

1st. *Cattle dung*, which is a manure no less valuable than easily obtainable, owing to the numerous herds of cattle which are kept in almost every village of India, as well as the certain supply which the planter may always depend upon from his own cattle-sheds; these should be constructed with a floor sloping from each side of the house towards the middle, along which a small brick gutter should be sunk in the floor to carry off the urine, and all washings of the house, into the manure pit: the latter should be dug a short distance from one end of the cattle-shed, and of sufficient size to hold the collections of six months of its sweepings: the earth thrown up in digging this pit should be banked round its margin to prevent the rain water from the surface of the ground flowing into it. It is preferable if it can be allowed to decay for five or six months previous to its transport to the field, and for this purpose the contents of the pit may be taken out and well heaped up at one side, or a second pit may be dug, so that one may be filled while the contents of the other decay in succession. The Natives expend a great portion of their cattle dung by drying it in the sun and burning it as fuel; but they are easily induced to

store it up for sale to the planter, and when once a market is found for it, a large quantity may generally be obtained in this way at a trifling cost.

The planter should also economise the sweepings of his stable and sheep house in the same way: on a sugar estate, no such resource of manure, however small, should be suffered to be wasted.

2nd. *Cane Trash,* when well rotted, forms also a very fine manure. When the concentration of the juice is effected in the vacuum pan, and the open coppers are employed only to evaporate the water of the cane juice to bring it to the consistency of a thin syrup, a large proportion of the cane-trash is always available for manure. An economical mode of preparing it for the field is to dig a pit in the vicinity of the still-house, if there be one on the works, and after filling it with the trash to allow the waste drain of the still to communicate with it: this will carry out the spent-wash or refuse dunder of the still, the washings of the fermenting vats, &c. daily to flow over the trash, thereby not only assisting its decomposition, but rendering it more valuable as a manure by enriching it with the decomposed sugar present in the dunder. If the mass is allowed to ferment with this assistance, from the time of the cane crushing until the period for carting it to the fields in the following January or February, it is then well fitted for use. If Dr. Liebig's theory, of the decomposed constituents of any plant forming the finest manure to assist its reproduction, may be confided in, this should form, without exception, the best compost for manuring cane lands.

3rd. *Decayed cane leaves* also form a manure of similar character to the preceding. After the cane has been cut and stripped of its leaves, and the latter are left on the field, they should be collected in heaps on some convenient spots near the field, and at the distance of a beegah or so apart; a light covering of earth should then be spread over them

to press them together and assist their decomposition, which the succeeding rains generally suffice to complete, and the heap is ready for use as manure for the following season. This I consider a more economical method of using them than burning the leaves on the ground, as is sometimes practised.

4th. *Tank earth* is much prized as a manure for cane throughout Bengal, and deservedly so. It is the sediment procured from the bottom of such tanks or shallow rivulets as remain filled with water during the greater part of the year, but which is evaporated under the influence of the hot dry winds of March or April, and at this time 8 or 10 inches of a rich deposit may be dug from their beds, which is valuable as a manure in proportion to the time which has elapsed since the last similar stratum was removed from them.

5th. *Scum* from the evaporating coppers and clarifiers is a rich manure, and should be thrown into a pit near the boiling house, as it is collected daily. When the factory is used as a refinery of native sugars, during the months it is not engaged in taking off the cane crop the cultivation is assisted by the large accumulation of scum daily derived from this source. It should however be *well decomposed* before its application to the fields, otherwise its highly fermentative qualities seem to act as too great a stimulus to the canes, giving them a sickly appearance, and causing a check to their growth, from which they take a long time to recover.

6th. *Seetee* or the decayed leaves and stalks of the indigo plant, after its coloring matter is extracted, is also a good manure, and within the reach of most sugar planters in Bengal. It should however have been allowed to decay at least two years before it is fit for use as a manure: for should any woody fibre of the stalks remain undecomposed, it will inevitably attract the white-ants when spread on the field. Its decay would be much assisted, and its quality as a manure improved, by allowing the refuse water from the indigo vats, after the feculæ have subsided, to flow over it.

This refuse water is also of itself a potent manure, and should there be any cane land so situated with respect to the indigo vats, as to allow this water to flow over it during any stage of its cultivation, its valuable properties are soon visible in the crop.

7th. *Ashes* from the cane-trash, when burnt as fuel under the evaporating coppers, are highly prized as a manure by the West India planter. The quantity compared with the land cultivated being small, I advise their being mixed in the same pit with the scum or decaying cane-trash; whereby their virtues will be more widely distributed, consisting probably in the alkaline salts they contain, than if used separately. I consider coal ashes or cinders to be of little or no value as a cane manure.

8th. *Bone dust* has never, I believe, been applied on a large scale as a manure in Bengal; though judging from the success which has everywhere attended its use in Europe, it deserves every attention here. Bones of cattle are plentiful and cheap in most parts of the country. In the Burdwan district, I procured any quantity at the rate of 4 to 5 maunds per rupee, delivered at the works, equal to about 12 shillings per ton; and the common *dakee*, or pedal mortar, or any other simple contrivance, may be availed of to reduce them to powder at a proportionate low cost: or the more recent and better approved plan of reducing them by solution in dilute sulphuric acid might be availed of any where in the vicinity of Calcutta, where this acid is procurable at a moderate cost.

9th. *Oil-cake* is considered by the Natives the very finest manure for the sugar-cane, its fertilizing qualities being not less valued than its property of keeping off white-ants from the cane. In lands infested with these vermin, I would certainly recommend its use, though its great expence in most localities would forbid its general application: a hand-full thrown into each cane hole in planting, which will consume

at the rate of about two maunds per beegah, and a similar quantity dug into the earth around the roots after the first three or four weeks of growth, will generally suffice to preserve them from the ants until the cane has acquired sufficient strength to be in less danger from them; for it is always remarked, that they attack the plants which are of weakly appearance and in want of moisture, in preference to those of a luxuriant vegetation. The Natives, in addition to their ordinary supplies of manure, apply oil-cake to the extent frequently of seven or eight maunds per beegah; and where it is not too expensive and supplies of other manures are short, it may be safely substituted in the proportion of eight maunds per beegah in lieu of 100 maunds of cattle dung or other equivalent substance.

The above are the manures easily obtainable by any planter, and as they are found to answer all practical purposes, I do not discuss the merits of other kinds, however valuable, the expence of which forbids their general application; such as guano, salt, charcoal, carbonate of lime, &c. The chemical analysis of the different descriptions also, however interesting a subject to those who have leisure for studying their affinities, and the tests and apparatus for analysing both the soils and manures, can seldom be required by the practical planter in India, and is therefore not entered upon here. A knowledge of the principles of chemical agriculture, which seems fast growing up into a perfect science, should not however be undervalued by those engaged or interested in Indian agriculture, and the works of Liebig and Johnson may be recommended to the perusal of all such; with the warning however, not to be led away by the splendid theories of these philosophers into any extensive schemes of experimental planting, however promising they may appear. An experiment may always be made in the first instance on a scale sufficiently large to demonstrate its worth for more extensive adoption, and at the same time so as not to incur

any material loss in the expence involved in it should it fail: and not till its success has been proved beyond all doubt and question, should it be allowed to supersede the certain and beaten track, the leading of which to success has the proof of past experience.

The proportion of manure to be applied to the land should be at least 400 maunds per beegah of cattle dung, decayed trash, tank earth, or scum, or a mixture of these, on ground preparing for cane plants; and half this quantity to be added each succeeding year that a rattoon crop is raised from it. For plant-canes, about three-fourths of the whole quantity should be worked in with the last ploughings previous to the planting, and the remainder should be applied near the roots of the plants with the subsequent diggings: it will be found better to apply a portion of the different descriptions of manure to each piece in preference to manuring with one description only. It is not necessary to *weigh* out to each piece the assigned quantity, but strong bamboo baskets should be procured, which, when filled, will hold half a maund each of the different kinds in a medium state of dryness; and these should afford the means of measuring it either on to the land direct if it lies adjacent, or otherwise into the carts conveying it to its destination near the field, where it should be piled, as convenient, in round heaps of 100 or 200 maunds each. A slight examination of these by the planter or superintendent will enable him to guess pretty correctly if the fair quantity has been carried out; or by re-measuring it this can be readily proved at any moment. The common bamboo cart, or hackery of Bengal, is ill adapted for carrying manure; and it will be found cheaper to substitute an improvement upon these by constructing some rough bullock carts of wood, with sloping sides and a movable plank at the hinder part, so that the whole contents may be readily tilted out on their arrival at the field. By having these carts all of one size, they may be made also

another means of readily measuring the quantity of manure they may collect at the fields.

Assuming the proportions above given for the requisite quantity of manure per beegah to be applied, the planter may readily calculate from the breadth of plant and rattoon cultivation he has undertaken, the total amount he will require. For a cultivation of 2,000 beegahs, allowing one-fourth of this to be plant-cane and the remaining three-fourths to be rattoons, which contemplates a succession of three years' rattoons after the plant crop, he will find 500,000 maunds of manure must be provided: and it behoves him to seek out in time for such extraneous supplies as may be required to complete this quantity in addition to the resources of his own factory and cattle-sheds. The other sources from which they may be looked for I have already referred to in the list of the various manures available in Bengal.

It must be observed in conclusion, that the requisite quantities of manure per beegah above estimated, have reference to the ordinary description of land in Bengal exhausted by many years of continued crops; and a different treatment would of course be called for with rich or newly cultivated lands, such as are being reclaimed from the jungle in Goruckpore and other districts; and in such cases, the planter must be guided by his judgment in the manuring or other preparation of the ground.

Ploughing I recommend being performed by the Native plough; my experience in the use of the English or American plough in Bengal not having been sufficiently satisfactory to warrant my recommending it with confidence to others. Undoubtedly the latter is much more effectual in the work it performs, and it turns up the furrow from a depth never reached by its Native representative: yet it requires so much more *power* than the latter, as to place it quite beyond the strength of the ordinary run of Native cattle. I tried on one occasion a description of American plough, constructed

by a friend, who had paid much attention to the subject; it was of a much lighter make than ordinary, and thereby adapted, as far as possible, to the capabilities of Indian cattle: yet though it was drawn by four or six of the best up-country oxen, their weight and sinew proved unequal to its effectual working. The cattle soon got distressed, and the ploughmen unwilling to urge them further: their dislike from religious prejudice to distress their oxen being superadded in this instance to the Native innate antipathy to any innovation on their traditional habits and customs. With two or three yoke of good buffaloes, I believe, such ploughs are to be worked; but the greater difficulty of managing these animals, and the higher cost of their first purchase and subsequent support, are objections which probably more than counterbalance the gain derived from their use with the English plough; and I must therefore look upon the latter as an experiment, until it has been proved by further trial, more economical than my own conclusions have shown it to be. We must bear in mind, that in India, neither man nor beast are capable of the physical exertion they can undergo with ease in a colder climate; and that any extraordinary effort of animal strength in the climate of Bengal must generally be followed by a corresponding measure of rest; so that in fact, the more economical effect is found to be obtained by the continued and patient exertion of lighter efforts, of which the Native method of ploughing affords an example, than by overtaxing the physical powers to such extent as to interrupt their continued and regular use. Besides which, if the long mattock hoeing, as already recommended, has been effectually performed, the necessity for deep ploughing is in great measure obviated, the subsoil being already loosened to nearly the same extent as could be effected by the latter.

Should good showers fall in December or January, so as partially to reduce the clods turned up by the mattock, one

or two ploughings may be beneficially given at this time. Afterwards, the first showers falling subsequent to the 15th February should be taken advantage of to plough again; and five or six ploughings should then be given *at convenient* intervals up to the time of planting.

It will be found much more economical for the planter to keep up an efficient herd of plough cattle of his own, than to depend in any measure upon hired cattle or ploughs. Not only will the former secure to him a certain supply of valuable manure, but the greater certainty of their services will be found no less important; for it is too much to expect that the ryot will willingly spare his cattle and ploughs for the use of the planter at the very time when he most requires them for his paddy or other Native crops, for all of which the plough is called for at the same season as for the cane; and the planter must therefore either be content with inferior cattle and see his work delayed, or resort to coercive measures with his ryots, which generally end, from the ill feeling or affrays which they provoke, in being more expensive than the keeping his own herd. Ten ploughs, with twenty-two head of cattle, which allows an extra pair to supply the place of any that may be occasionally off work from sickness or other casualty, are sufficient for all the purposes of 100 beegahs of cultivation; and in ploughing, carting the manure to the fields, and the cane from thence to the mill, work will be found for them throughout the year with very little idle interval.

The cattle brought from Tirhoot, Purnea, and other districts north of the Ganges, are of larger breed, with considerably more bone and weight, than those of Lower Bengal, and I would always recommend them to be obtained for cane cultivation.

The cattle-shed should be a long brick-walled building, the walls about 7 feet high, standing in length east and west, with the north wall perforated with air holes, 18

inches diameter, 4 feet from the floor, and 7 or 8 feet apart: the south side should be open, excepting such pillars as are required to support the roof, and these may be 18 inches square and 6 feet apart: the roof should be of thatch and gabled on the common Native plan, which renders the shed much cooler than with a flat masonry roof; a railed enclosure should extend to the south of the shed sufficiently large to allow of all the cattle lying there during the fine nights of the hot season. The shed should measure 14 feet wide inside the walls, and the length should be proportioned to the number of cattle it is intended to shelter: for 100 head of cattle it should be about 80 feet long. So much of the planter's success must depend upon the health and efficiency of his cattle, that he will find a portion of his time well bestowed in a frequent visit to their sheds, and attention to their cleanliness and liberal supply of wholesome food.

After the last ploughing is completed, and a day or so before planting commences, it is advisable to smooth down any remaining clods on the soil by means of the Native harrow, or bamboo ladder, drawn over the surface of the field by a yoke of oxen, aided by the weight of the ploughman standing upon it; this is a very simple and cheap contrivance, and I have not found any better substitute for it.

Planting.

Before proceeding to give instructions for planting, I shall say a few words with reference to the preparation of the seed plants. The green tops of the ripe cane are undoubtedly the best seed for the new crop, and as the cane is cut and cleaned for the mill, these should be at once tied in bundles and removed from the field to a moist and sheltered situation; such as under the shade of a large tree, where they should be half buried in the earth, and their moisture preserved by occasional watering until the planting season: oil-cake pounded and mixed with liquid mud should be poured

over them in the manner practised by the Natives and described in a former chapter, as a preservative from white-ants. The Native mode of dividing and resetting the plants however, I consider as unnecessary for planting on a large scale: there is little danger of their vegetating too strongly until the middle of April, when planting should at once commence in all situations where irrigation can be availed of, so as to keep the spring crop alive until the first showers render it no longer necessary: but if desirable to preserve the seed plants until the following month, this may be done by raising them from the earth, cutting off short the leaves that have sprouted from them, and resetting them in another similar situation. When carried to the field for planting out in situations where white-ants are frequent, the old dry leaves adhering to them should be roughly stripped off, as they are apt to attract these enemies.

The above remarks apply to planting in April or May. October and November are however good months for planting, while sufficient moisture remains in the ground from the previous rains, to bring the vegetation so far forward before the succeeding hot and dry weather sets in, that the leaves of the cane may form a shelter to the ground, and so help to preserve its moisture to the roots. For planting at this season, the ground should be prepared previous to the setting in of the rains by hoeing and ploughing: an occasional ploughing is also given whenever the weather permits during the rains, to keep down the weeds, and the final ploughing and manuring is given a few days before planting, which it is not safe to attempt later than the 15th November, unless the ground be within the reach of irrigation. In this October planting, the seed is obtained by cutting down some of the smaller and least forward canes from the nearest cane-piece, and dividing their whole length into cuttings, having two or three eyes in each. Their thus being supplied fresh from the growing plant ensures their fitness for vegetation.

The October planted crop is generally the finest, as might be expected from the longer period, 14 to 15 months, allowed for its growth, arriving at maturity in the December of the year following its planting, or during the succeeding January. It has the advantage of the planting taking place at a cooler and more genial season of the year than with the spring planting, and consequently its out-door superintendence is more easy and agreeable. It obtains the full benefit of all the first showers of the succeeding spring, to which may be attributed, perhaps, more of its after-luxuriance than to the progress in more growth it gains during the cold and dry weather. And in a large cultivation, the spring labors of planting are greatly relieved by having a good portion of the crop already growing.

My own practical experience of October planting being confined to the Burdwan district, I should mention that the China cane is the only description I have found sufficiently hardy to withstand the heat and parching winds of the succeeding months without the aid of constant and expensive irrigation. In many other districts however, where the soil and climate are of a more humid nature, I have no doubt that less hardy varieties of cane would be found to succeed equally well.

In planting, I find the best plan of several I have tried, is to plant in rows running in straight lines from side to side of the field, in the direction of the greatest inclination or fall; so that the spaces left between the rows may serve as channels to conduct the superfluous rain water into the drains. The work commences, at one side of the field, by stretching two lines along its whole length 4½ feet apart, and fastened to pegs fixed in the ground at convenient intervals. Within the space so enclosed, plant three rows of cuttings, one along the middle of the space, and one as close as can well be done to each line or string: this is done by one man throwing up the earth with the *kodaul* or spade, so as to form holes 5 or 6

inches deep, along the line; while his companion follows dropping two or three seed plants into each hole, and taking care that there may be in each at least four sound eyes or buds: these holes are made at a distance of 2¼ feet apart, measuring along the line, from centre to centre of each hole, which is readily done with a light bamboo rod of that length in the hand of the man who carries the basket of seed plants. The first space being filled, a space of 2¼ feet is next measured off for a channel between the rows, the lines are then again laid down 4½ feet apart, and the same routine proceeds regularly throughout the cane-piece. This mode of planting is easily learnt by the natives, and requires but little more trouble or expence than their own plan, which indeed it very much resembles.

The West India planter will no doubt express surprise at the close planting above recommended, accustomed as he has been to see cane-rows set 4 feet apart: as much as 6 feet apart even has been recommended by some experienced planters, to facilitate as far as possible the admission of light and air to the stems and leaves. Such system however, I am convinced, is not adapted to the climate of India, where the object should be kept in view of forming a shade with the foliage of the plants to protect their roots and stems from the parching glare of an Indian sun, and form a partial screen against the desiccating influence of our Indian hot winds.

Digging, weeding and watering.

After three or four weeks from the date of planting, the earth should be loosened with the *kodaul* and heaped up round the roots of the plants; and this should be repeated twice more, at intervals of about a fortnight. With these two last diggings also, the earth should be drawn up from the 2¼ foot spaces between the rows, and thrown towards the middle of the cane rows, so as to give an inclination from them towards the spaces now formed into channels. After

the rains have fairly set in, digging is impracticable from the moisture of the soil, but the roots of the cane should be kept free from weeds until the plant is so far advanced as to prevent further injury from them; and for this end, one or two weedings may be required, which are best performed with the native weeding spade or *neranee*, used by women or children. The use of the channels or spaces between the cane rows is now more apparent, as admitting the laborers or the superintendent throughout the cane-piece without damage to the plants.

Tying up or binding the leaves around the canes, I consider a superfluous labor; the great trouble and expence it occasions not being compensated for by any corresponding advantages. Neither have I found the custom of trashing the canes, as practised in the West Indies, adapted to the climate of Bengal. A part of a field, which I trashed in January on one occasion, with the view of assisting the ripening, was spoiled in a week by the dry wind exhausting the moisture of the canes, and causing them fairly to crack at the joints. But I consider this, nevertheless, a question to be decided by further experiment; or at least with respect to other districts, where the climate may be more favorable to the practise.

The great importance of *irrigation* has already been more than once adverted to. No certain rule can be given as to the extent and frequency with which it may be required. In spring planting, if the weather be propitious, and seasonable showers continue to fall after the plant is in the ground, it may happen that no irrigation will be required until the following October or November. For spring planting however, two to three artificial waterings may be looked on as the average of what is required for the healthy development of the plant, and four or five for October plant. This is for dry and elevated districts. There are some localities where the extreme moisture of the soil renders it nearly superfluous;

such as in parts of the Backergunge, Furreedpore, Jessore, and Pubna districts, where the Natives seldom or never water their cane crops.

It remains only to refer to the most economical methods of obtaining irrigation where it is required. Where steam-power is available, it will always be found cheaper than manual labor,—more especially in the case of sugar works where the mill-engine is already erected, and but little additional expence is required to divert its power to the working of pumps for this purpose. The supply of water it will be capable of affording would be regulated by the power of the engine, and the height it had to be raised from the level of the river or other source of supply; but would in any case, if the elevation of the works be high as compared with the cane lands, be a valuable assistance to the estate. In addition to this, if the vacuum pan house be worked as a refinery during the months it is not occupied with the cane crop, the waste water from this source, as mentioned in a former page, would *afford regular irrigation for four to five beegahs of ground* per 24 hours of factory work. To irrigate the lands more distant from the works, however, other means must be resorted to, and watering with the *cheonee*,* or basket-throw, is very effectual and comparatively cheap. A double barrel lifting-pump, worked by means of handles, and the aid of a fly-wheel, may also be used with advantage. A pump of this description may be worked by eight coolies in two spells of four each, and will throw a pretty constant stream of 2½ inches diameter for heights of not more than 25 feet, and will irrigate five to six beegahs of ground per diem: it may be fixed on a light carriage with small truck-wheels, so as to be moved about from field to field as required, and if kept in order will be found more economical than the Native methods of irrigating:—even including interest on its first cost, which, with leather hose and all appurtenances, would be about 1,500 Rupees.

Cutting.

October plant begins to ripen in the December of the year following; and from the latter month the planter's judgment is daily called into exercise for deciding which pieces should be first reaped for the mill. All experienced West India planters, without exception, lay much stress on the importance of cutting their cane at the exact period of its maturity if good sugar is to be the result; and there is no doubt its quality will be deteriorated, and its rate of yield diminished, if cut unseasonably, or even a few days only before or after the period of its full ripeness. Where too large a surface of cane for the crushing power of the mill threatens to become ripe at the same moment, part of it should be at once irrigated, so as to throw back for a week or two its progress to maturity: and by these means, added to a strict watch on the state of the weather and the progress of his crops, the experienced and attentive planter may so regulate the gathering in of his crop as to supply all to the mill with little or no loss from deficient or over-ripeness. Several tests of the ripeness of the cane have been recommended, but the most certain and satisfactory is, to gather two or three canes of average size from* the field to be tried, taking care not to select all from either side, but rather from the middle, which is usually the most backward part, from enjoying less sun and air than the margins,—and these samples should be passed through the rollers of the mill itself, which may easily be turned by hand for the occasion, and the specific gravity of the juice so obtained, tested by the saccharometer. As soon as the density of the juice is indicated by 10 degrees of Baume's scale, the period has arrived for commencing the manufacture; from 10 to 11 degrees of this scale* being the average

* It should be observed, that in using these saccharometers with juice, when frothy and fresh flowing from the mill, they indicate ½ to 1 degree less than the actual density, as is apparent when the same juice is allowed to rest for a short time: this is owing to the quantity of minute air bubbles floating in it when first forcibly expelled from the sap-vessels of the cane.

proof of ripe cane juice in Bengal; although, towards the end of the season, after warm weather has set in, I have known it *indicate as high as 12 degrees of Beaumè, which is equivalent* to 22 per cent. of saccharine or other matters in solution, *and very fine sugar to be the result.*

The business of cutting and cleaning the canes is best left to the Natives under a *contract for effectually performing it* at a fixed rate per beegah, or per 100 maunds of cane delivered at the mill. They do it very effectually with a light sickle, but the planter's supervision is called for to see that it is not done carelessly and earth left attached to the root end of the canes; otherwise the subsequent labor of clarifying the juice will be much increased. The cane is cleaned on the field, and with its twisted leaves, packed in bundles of about a maund weight each, and is from thence carted direct to the mill: it is generally considered, that the shorter the time which elapses between the cutting and crushing of the canes the better; though, I believe, if they be not already over-ripe, no material injury is sustained if the crushing be not delayed beyond 24 hours after they are reaped.

Rattoons.

Amongst the Native cultivators rattoon crops are nearly unknown; it being their universal *practice*, with very few exceptions, to break up with the plough all their cane lands as soon as *possible after the crop is out, and to employ* them for some different crop during at least one succeeding *season before again planting them with cane.* Their opinion, that their lands are incapable of bearing two succeeding cane crops from the same stoles, is, in most districts, as deep-rooted as it is unfounded. It is true, that my own experience extends only to successful rattoon cultivation for the China cane, the extreme dryness of the Burdwan climate rendering the rattooning of the less hardy Native varieties here unsuccessful, unless aided by plentiful irrigation: though, I feel

fully satisfied, that this objection would not apply to other districts where the soil and climate are of more humid character. From China cane, however, I have obtained very fine *fourth* rattoons with no extraordinary care in cultivation; but will assume three crops only, in addition to the plant crop, as the ordinary run for Bengal.

After the crop is cut, if sufficient moisture remain in the ground to admit of the passing the plough through it, this is carefully done at once, turning up the furrow between the cane rows without disturbing their roots. After the first spring shower the manure is applied, and the earth mixed therewith is thrown up with the spade around the cane roots. One more banking up, and one weeding, are generally sufficient to complete the cultivation, except as regards irrigation, should such be required, at a later period of the season. From the much less labor required on rattoon crops, the expence of their cultivation is reduced to about one-half of that requisite for plant canes.

Superintendence.

I would wish to impress upon all engaged in cane cultivation, the importance of constituting such a scheme of surveillance over the various divisions of the labor as will ensure each being performed efficiently and in its due season. I attach especial weight to the necessity of this, because I believe it has not been sufficiently recognized by the generality of cane planters in India, who have been content to leave too much to the superintendence of their Native *Gomashtas*; the majority of whom cannot withstand the temptation of deriving an illegitimate profit from the many opportunities of peculation so expensive a cultivation affords them, where its control is left in their hands; and great disappointments have as surely followed such a course.

One of the first principles I would recommend for adoption is, having the *whole* of the field-work performed by con-

tract. For all the operations of hoeing, ploughing, planting, watering, &c., a certain rate of remuneration per beegah should be determined on, and the order for its payment should not be signed until the planter is satisfied, from his own inspection, or that of his assistant, that the work is completed in a proper and efficient manner. If such inspection prove satisfactory, the stipulated remuneration should be paid readily and without deduction; and the planter, who has in this way established a credit for fair and regular payment, will soon find he is able to conduct his business without having recourse to the very objectionable practice of advancing part payment for every work he requires. This plan of contract-work saves the planter, as may be easily imagined, a great deal of the labor of superintendence: and indeed, for cultivating a large estate, the only other alternative of employing gangs of laborers paid by the day I look upon as next to impracticable as applied to cane agriculture. For *no* superintendence, Native or European, could suffice to overlook efficiently many gangs of coolies, working simultaneously in distant parts of the estate; whose only object would be, as all who know the Native character will bear me witness, to earn their day's wages at the very minimum expenditure of labor on their parts. To secure to the planter the labor which will prove the cheapest, he must enlist on his side the determination of the laborer's mind as well as the work of his hands; and this he can only do by *giving to every* individual cooley a direct interest in the quick and efficient performance of the task assigned to him.

What is known as ryotty cultivation, or the advancing money to ryots in the villages adjacent to the factory to meet a certain portion of the expences of cultivation, under a contract with them to deliver the cane when ripe at a certain fixed rate per beegah or per 100 maunds,—I look upon as a method as little adapted for cane cultivation as working by daily laborers; however well suited it may be for indigo, where the

cultivation is of so much simpler a nature, and the total outlay per beegah only about one-third of that for sugar-cane. A total failure of an indigo crop is comparatively unknown, and where the ryot, by neglecting his task, in any year incurs a debt to the planter in the shape of a balance, which he may or may not liquidate the following season, the loss in either case cannot be great to either party: whereas, the reverse of this would soon be apparent in a cultivation like that of cane, involving an expence of 15 to 20 Rs. per beegah: for it was estimated, that the actual first cost to the Native cultivation in Burdwan, and other districts in the vicinity of Calcutta, was not less than 15 Rs. per beegah for cane delivered at the field; and it is probable that not less than 20 Rs. per beegah could form an inducement for them, even with the stimulus of advances on their crops, to cultivate for another party. Again, the ryot's inclination would naturally be to give his first and best attention to his rice and other crops, in the result of which he feels a more direct interest than in that of the planter's cane; and the latter would consequently be in danger of comparative neglect at the very period when the greatest attention was most essential to its successful growth. Add to this, the extreme difficulty always incurred in getting advances liquidated by Natives, and of divesting them of the impression all more or less seem to have, that money so paid to them is their own property, and not merely left in trust with them for the benefit of the party advancing as well as for their own, and it will be found that the trouble and vexation entailed by a ryotty account for such a cultivation as cane, leave small chance indeed of its ever proving profitable.

Assuming then that the planter has arranged with the body of laborers he requires to employ, by contracting with them for a certain fixed rate per beegah to be paid them for each of the respective operations of the field work; he will next find it requisite to divide them into convenient

gangs, each having a certain space of land allotted to them to cultivate. These divisions of land may be conveniently limited to about 100 beegahs each. To each of these divisions should be appointed two head Native overseers or *Gomashtas*, one of them to keep the accounts of the division, and enter regularly the daily transactions and all receipts and disbursements of his division in the Native language; the second, or field *Gomashta*, to overlook all details of the field work, to be the medium of communicating the planter's orders to the laborers therein, to direct them in their work, and be in a measure responsible to the planter for its due performance. To facilitate the correct keeping of the cultivation accounts, every cane piece on the estate should have a number appropriated to it; which will always form a means of ready reference for the planter, and enable him to view, at a glance over his journal, the progress that has been made in any particular spot of his estate. It is hardly necessary to add, that during the hours when the laborers are at their field work, one or other of these *Gomashtas* should be in constant attendance with and overlook them.

In addition to the supervision of these headmen, I have already mentioned that the planter or his European assistant should, by a personal attendance at and examination of the crop, assure himself that the labor in each succeeding operation has been efficiently performed before signing the order for paying for it; and effectually to conduct this duty it is requisite for him to take his daily rides over the estate, or the portion of it in his immediate charge. Close and unremitting attention is called for on his part; and should the proprietor or manager of the estate, as is probable, not have sufficient leisure to devote to these details, he should delegate them to assistants. For every 1,000 beegahs of cane in cultivation, I consider that one head and one junior assistant ought to be employed to ensure its efficient supervision. The former should have had some experience in cane or other

description of Indian field business, and be acquainted with Native customs and prejudices; while the duties required from the junior assistant are not more than an apprentice to the business can conduct, who, by the experience he is acquiring in it may eventually qualify himself to succeed to the senior charge. The duties of the senior assistant should comprise the general direction of work in the land under his charge; and he should every morning ride over as large a portion thereof as he can conveniently examine, and personally direct to the *Gomashtas* the operations requisite to be next performed: he should always carry a field-book with him on these occasions, and note therein the orders as he gives them, so that he may, on his next visit to the same spot, ascertain by reference thereto, without trusting to the aid of memory, if his orders have been duly executed;—and if found to be so the same should also be noted on the spot. His note-book should form the materials from which the Journal of the cultivation is constructed, and to the latter the record of all field transactions should be daily transferred. The junior assistant should have charge of the Journal and other account books, and the drawing up therefrom of all vouchers for payment for work done to be signed by the senior assistant; and lastly, each of these assistants should be ready to undertake the work of his fellow for a time, in addition to his own, in case of indisposition happening to either; so that the work might at no time run the risk of falling into arrear.

The remuneration for superintendence, I am of opinion, should not be made merely by monthly stipend: the work required both from European assistants and Native *Gomashtas* is unremitting, and requiring all their energies and attention to conduct it properly. It is, therefore, judicious to render them directly interested in the successful result of their labors, by allowing them a commission on the product thereof as a stimulus to their industry, and encouragement to devote their entire attention to their vocations: they should

therefore receive direct salaries as follows: senior assistant 80 Rs. per month, junior ditto 60 Rs., head *Gomashta* 6 Rs. per month, under ditto 4 Rs.; and in addition to this, they should each receive a commission on the actual produce realized at the gathering in of the crop as follows: to the head assistant 4 annas per maund on the quantity of dry sugar manufactured from the cultivation under his charge,—to the junior assistant two annas per maund on the same; and one anna per maund to each of the two Native *Gomashtas* for all the sugar manufactured from the cane in their respective sub-divisions. At the commencement of this chapter, the average produce in dry sugar per beegah was estimated at $7\frac{4}{5}$ maunds. Allowing this to be realized, the aggregate remunerations for superintendence will be found to result as follows:—

	Salary for 12 months.	Commission for 12 months.	Total remuneration for 12 months.	Gross monthly income.
	Rs.	Rs.	Rs.	Rs.
Senior Assistant, ..	960 0	1,050 0	2,010 0	212 8
Junior Ditto, ...	720 0	975 0	1,695 0	141 4
Head *Gomashta*, ..	72 0	48 12	120 12	10 1
Under Ditto, ...	48 0	48 12	96 12	8 1

The above rates may be liable to modification, according to the custom, or ordinary rates of remuneration, varying in different districts: it is however the *principle* of this mode of recompence I here wish to inculcate, rather than the precise rates to be afforded; the object thereof being, as before explained, to engage all seriously in the *success* of the cultivation. The expence of European superintendence per beegah of cultivation would amount, by the above scale, to Rs. 4-9-8, and of Native ditto to Co's. Rs. 2-2-9: during the three months or more of the manufacturing season however, the services of the European assistants would be principally availed of in the mill, boiling, and curing-houses; and in reckoning the cultivation expences considered sepa-

rately, we should make a deduction on this account, say to the extent of one-fifth of their remuneration.

Having traced the progress of the cultivation until the cane has arrived at the mill, a summary of the expences attending it, by the plan I have recommended, will form an appropriate sequel to this chapter.

Estimate of expence on cultivating and delivering at mill 2,000 beegahs of sugar-cane in Lower Bengal, under European management.

Ground-rent, 2,000 bhs., at 2 Rs. per beegah, ..	Co's. Rs.	4,000	0 0
Hoeing 500 bhs. for plants annually, at 1-4 per ditto, ..		625	0 0
Ploughmen, for ploughing with factory ploughs and cattle,			
500 bhs. plants, average 6 times annually, ... = 3,000			
1,500 bhs. rattoons, once ditto, 1,500			
4,500 men, at 1 anna each,		281	4 0
Manuring 500 bhs. plants, at 400 mds. per beegah, .. = 200,000 mds.			
Ditto 1,500 bhs. rattoons, at 200 ditto, ... 300,000 ,,			
Total, .. 500,000 ,,			
Estimate one-third from factory, cattle-sheds, &c., .. = 166,666⅔			
Leaving to be purchased, .. 333,333⅓ mds., delivered on fields at 12 annas per 100 maunds,		2,500	0 0
Spreading manure on fields 500,000 mds., at 2 annas per 100 maunds,..		625	0 0
Harrowing 500 beegahs plants, at 1 anna per beegah for laborers, ...		31	4 0
Preparation of the seed for 500 beegahs plants, at 12 annas per beegah, ...		375	0 0
Planting 500 beegahs, at 1 Rupee per beegah, ...		500	0 0
Digging 500 beegahs plants, three times, ... = 1,500			
Ditto 1,500 beegahs rattoons, twice, ... 3,000			
4,500 bhs. at 8 annas each,		2,250	0 0
Carried over, ...	Co's. Rs.	11,187	8 0

Brought forward, ... Co's. Rs.		11,187	8 0
Weeding 2,000 beegahs twice, at 8 annas per beegah, ..		1,000	0 0
Repairing hedges and draining 2,000 beegahs, at 8 annas per beegah, ...		1,000	0 0
Watering, say twice per annum, at 1-4 per beegah, ..		2,500	0 0
Cutting and cleaning cane, including cartmen conveying to mill; 2,000 beegahs, average 150 mds. per beegah, is 300,000 mds., at Co's. Rs. 3-8 per 100 maunds, ...		10,500	0 0

Live stock account.

440 bullocks, at 15 Rs. each, . Co's Rs.	6,600		
4 horses, at 80 Rs. each, ...	320		
	6,920		
Annual charge to keep up ditto, say 10 per cent., ..	692		

Current expenses on ditto.

10 Headmen, at 3 Rs. per month, is per annum ..	360		
10 Boys, at 2 Rs. per ditto ditto, ...	240		
Food for bullocks, at 1 Rupee per head per ditto ditto, ...	6,280		
Ditto and keep of four horses, at 10 Rs. per month each, per ditto ditto, ...	480		
		7,052	0 0

Dead stock account.

20 Bullock-sheds, at 150 Rs. each, ..	3,000		
50 Carts, at 16 Rs. each, ...	800		
200 Mattocks, at 1-4 each, ...	250		
200 *Kodaullies*, at 12 annas each, ..	150		
200 *Nerances*, at 2 annas ditto, ...	25		
200 Ploughs, at 1-4 ditto, ...	250		
Harrows, string, &c., say	25		
Saddlery, say	100		
Total, ... Co's. Rs.	4,600		
Annual charge, to repair losses and wear and tear, say 10 per cent., ...		460	0 0
Carried over, .. Co's. Rs.		33,699	8 0

Brought forward, ...	Co's. Rs.	33,699	8 0

Superintendence.

European, 1st assistant (per former account),..	Co's. Rs.	2,910 per 1,000 bhs	
Ditto 2nd ditto (ditto), ...		1,695 ditto.	
		4,605	
or for 2,000 bhs.	Rs.	9,210	
Deduct 1-5th of ditto to manufacturing account, ..		1,842	
Balance, ...		7,368	

Native ditto (per former account).

Head *Gomashta* per monsem, ..		120 12	
Under ditto, ...		96 12	
	Co's. Rs	217 8	
per 100 beegahs, or for 2,000 beegahs, is..	Rs	4,350	
Total superintendence, at 5-13-9 per beegah, ...			11,718 0 0
Total, ...	Co's. Rs.		45,417 8 0

being equal to an outlay of Rs. 22-11-4 per beegah.

In the chapter on cane cultivation by Natives it was shown, that to the ryot the expence of cultivating the cane and cleaning it for the mill was about 15 Rs. per beegah; in a subsequent page it was attempted to be shown, that an advance of one-third, on this estimate of actual prime cost to the ryot, would be called for to constitute it a sufficiently remunerative and encouraging cultivation, as compared with other Native crops, for him to prosecute for the purpose of disposing of the cane to the planter, or selling its product when manufactured into goor. From this it appeared, that

20 Rs. per beegah at least would be the return for labor expended, required by him to induce him to cultivate; and even this, from the general poverty of the ryots, and the long time (as compared with other crops) they would have to wait for their returns, would render it hardly sufficiently remunerative to them, unless assisted by the planter from time to time throughout the year, by advances of money; a system which, if not altogether inapplicable to cane cultivation, as I believe it to be for reasons already stated, would certainly involve a further expence in surveillance over the application of the money so risked by the planter: add to this, the necessarily more scattered cultivation if it is entrusted to ryots, and the consequent increase in cost of carriage to the mill; and in weighing these several considerations it will be found, that in so far as the cultivation is concerned, the application of more systematic labor and effective means by the planter himself, through his paid servants, will prove in fact as economical, and far safer in its results, than any other means he could adopt of raising his canes with Native labor:—and this even with all the charges of efficient European superintendence which I have included, and which will probably be deemed, at first sight, extravagant by those who have not given the subject a full and calculating enquiry.

The preceding calculation, it must not be forgotten, applies to the districts of Lower Bengal; and the rates of cost on the different field operations are in accordance with the rate of wages in the districts around Calcutta: *different,* and probably much lower rates, will be applicable to more distant parts of the country; and in some districts, where the current value of labor may be much lower, it follows that the cost of cultivation, whether by Natives or Europeans, will be reduced in nearly the same proportion, without in any way affecting the general principles of the *system* above recommended, for securing the best crops at the lowest possible outlay.

In conclusion, I shall give the form of Journal for cane cultivation, which I would recommend to be kept regularly written up on every estate; and the small trouble which it will cost to do this, will be found amply compensated for by the satisfaction it will afford, in seeing at one view, and comparing the exact results of the various degrees of care and expence bestowed on different parts of the estate; varying also with the qualities of the soil and different descriptions of plant under cultivation.

The following is in fact a convenient abstract of the field-book, in which the operations of every day are entered in detail by the assistants for each division of the estate, for their own guidance:

N. B.—It is not necessary to weigh the *whole* of the cane as delivered at the mill for the purpose of finding the weight obtained from each piece as set down in the Journal; but 10 or 20 bundles, chosen as fair samples of each field, may be passed through the scales, and the average weight of the whole piece calculated therefrom. The column of the average weight per beegah will be found very useful in enabling the planter to determine how long the piece may be kept in rattoons to greater advantage than by ploughing it up for re-planting.

Cane Cultivation Crop, 1847-48.

Division A, of 1,000 Beegahs, under charge of Mr. ————————, Assistant, and Mr. ————————, Sub-Assistant.
Sub-division No. 1 of 100 Beegahs 10 Cottahs, under charge of ————————, and ———————— Gomashtas.

No. of cane piece.	Name of Village.	Measure of land. Beegahs.	Cottahs.	Chittacks.	Description of Cane.	No. of hoeings.	No. of ploughings.	Manures applied per beegah in bazar mds. Cattle dung.	Cane refuse.	Oil-cake.	Sugar scum.	Tank earth.	Date of planting.		No. of diggings.	No. of weedings.	No. of waterings.	Date of cutting.		Total weight of Cane produced. Bundles.	Bazar mds.	Soors.	Chittacks.	Average weight of Cane produced per beegah. Bz. mds.	Soors.	Chittacks	No. of Cane-tops produced. Kahun.	Pun.	Remarks.
1	Seebpoor,	16	18	0	China plant,	1	7	200	50	5	0	145	1846	Oct. 15.	4	2	0	1848	Jany. 2d	2,800	3,012	0	0	178	13	12	190	0	
2	Ditto, ..	10	12	0	Do. 1st ratoons, ..	0	1	100	0	0	50	50	1845	April 10.	2	1	1	..	Feby. 10	1,650	1,605	0	0	151	16	10	105	10	
3	Ditto, ..	4	0	0	Ditto ditto,	0	1	100	100	0	0	0	..	....	2	1	1	..	....	680	700	20	0	175	5	0	40	5	
4	Ditto, ..	3	5	0	Ditto ditto,	0	1	50	150	0	0	0	..	....	2	1	1	1847	Dec. 20	520	546	0	0	168	0	0	39	0	
5	Rampore,	13	0	0	Pooree plants, ..	1	8	90	100	10	0	100	1847	May 1.	3	2	2	1848	Jany. 10	2,700	2,302	0	0	177	3	1	148	12	
6	Ditto, ..	5	15	0	Ditto ditto,	1	9	150	50	10	140	0	1847	May 1.	5	1	3	..	....	1,070	1,103	10	0	191	36	8	65	0	Canes, average 9 feet high.
7	Ditto, ..	3	10	0	China 2d ratoons, ..	0	1	100	0	0	50	100	1844	April 4.	2	1	3	..	Jany. 4	420	408	0	0	116	22	13	36	4	
8	Ditto, ..	12	5	0	Do. 3d ditto,	0	1	100	0	0	50	100	1844	April 5.	2	1	4	..	....	1,500	1,545	0	0	126	5	8	108	2	
9	Ditto, ..	18	15	0	Do. 3d ditto,	0	1	50	50	5	0	95	1843	June 1.	3	2	2	..	....	2,080	2,055	0	0	109	24	0	205	0	
10	Ditto, ..	14	10	0	Pooree plants, ..	1	7	0	200	0	0	0	1847	May 10.	4	2	4	..	March 13	2,746	2,400	10	0	165	22	1	170	10	White-ants in this piece until 2nd watering.
		100	10	0																16,166	15,677	0	0				1108	11	
																								156	30	0			

Total average weight of cane,..

CHAPTER III.

ON THE MANUFACTURE OF SUGAR FROM CANE BY THE EUROPEAN METHOD: EMBRACING THE EXPRESSION OF THE JUICE, CLARIFICATION, AND EVAPORATION TO THE STATE OF SYRUP.

The cane having been brought to the works and stacked near the mill, so soon as a quantity sufficient for three or four hours' work is collected, the business of manufacturing sugar therefrom should at once commence. This comprehends the following consecutive processes, the details of which may be considered separately. 1st, expression of the juice from the cane. 2nd, its clarification. 3rd, evaporation to the state of syrup. 4th, filtration through cloth. 5th, filtration through animal charcoal. 6th, concentration in vacuo. 7th, curing. Of these several heads the first three are described in this chapter.

Expression of the juice.

Not a few are the modes of extracting its sugar from the cane, which have at different periods been invented, adopted, and abandoned. To trace their progress and the causes of their failure would form a chapter more curious than useful. Almost universal preference is now given to the horizontal three-roller mill, worked by steam or water power, as the most effective and economical apparatus for the purpose yet discovered; though it is always allowed, that even this is very far from being a perfect machine for the ends desired,—the complete expression, namely, of the saccharine juice from the solid fibre of the cane. Chemical analysis has demonstrated, that the fluid contents of fresh cane form 90 per cent. of its entire weight; and that these consist of water holding saccharine and other matters in solution;

whereas, the proportion actually obtained by the operation of these mills is from 50 to 60 per cent. only; so that could the planter obtain a perfect means of extracting the juice, he would realize a clear gain of 50 per cent. on the present weight and value of his crop, minus only the difference in value of the megass or cane-trash, as fuel or manure, when thus entirely deprived of its sugars; a loss certainly not worth consideration in this country, where its place for either purpose can be so readily supplied from other sources. From the ordinary run of Bengal canes, I have found 60 per cent. realized only by carefully feeding the mill, and regulating it with a slower motion than is usually adopted. For rollers of 16 inches diameter, an ordinary size, I have found four revolutions, equal to 16 feet superficial velocity, per minute, to be the most effective speed for the mill to be worked at; and if the feeding board be supplied with regularity, and the engine-man keep on the alert to regulate carefully the supply of steam to the engine, this rate of motion may be kept up with little difficulty. Care is required in bracing the rollers, that is, in setting them up for work by means of the screws which regulate their distance from each other, so that there be no unequal strain through such distance being greater at one end of the rollers than at the other: the space left between the first and second rollers should be about one-eighth of an inch, and between the second and third one-sixteenth of an inch. I need hardly add, that this setting of the mill should never be left to the care of the Native engineer.

Mills with four and five rollers have been adopted in some places, which afford a third pressure, and are said to yield 10 to 15 per cent. more juice from the weight of cane. Not having had any opportunity of testing their effects I cannot speak confidently of their advantages. But taking into consideration the additional friction they would cause to the whole machine, and the additional power which would be

required from the engine to work them, I am inclined to think, as economical effects can be obtained from the three-roller mill with careful regulation of its speed and feeding.

Respecting the construction of the mill and engine,—it should be of a description the most simple and least liable to derangement; a remark which applies to all machinery for Colonial use: a saving of the space it may occupy is generally of much less moment than lessening its liability to derangement, by simplicity in design and adequate strength of the various parts, where the means of repairing or replacing them in case of accident are deficient, as in most of the Colonies. This error, in erecting machinery with the parts too much crowded into a narrow space, appears a very common one in this country, where its avoidance seems so especially called for. The engine room should be open and airy, and room and light should be afforded as much as possible to the pumps and all working parts of the machinery, so as to admit of their being "got round" and examined while at work, and all dark holes and corners should be carefully avoided. And lastly, every engine and mill should be furnished with duplicates of all cast-metal working parts, such as spur-wheels, cranks, &c., which are liable to fracture at all times. A condensing engine should also be preferred to a high pressure one, as well for the reasons above given as for the saving of fuel it will effect. There seems no good reason why the high pressure engine should have hitherto obtained the preference it has done for the use of cane-mills; the plea which is generally urged in its favor, of its greater compactness and facility of transport to the Colonies, being of little moment compared with the consideration of which description of engine is the most efficient for its work when arrived there.

The quantity of cane capable of being crushed in any given space of time varies of course with the power of the mill, as well as with the more or less perfect expression of

the juice, and this last depends in great measure on the speed and regulation of the movement. Working with a 12-horse power engine and mill adapted thereto, I have found an average of 60 bazar maunds of cane crushed per hour to be a fair estimate of its capabilities, with a slow and effective motion. This was with one of Fawcett and Preston's high pressure portable engines, with their mill to correspond; a description of machine however, which is now never made, but replaced by more simple apparatus. The effective power of all cane mills and of the engines adapted to them, as made by different engineers, or worked with different degrees of steam pressure, varies so greatly, though professedly of the same nominal horse power, that a fair *practical* trial with the mills in good working order, and with the ripe cane itself, appears to be the only sure test of their capability, as to the quantity of cane they can crush thoroughly in a given space of time. Judging however from the comparative performances of engines of different powers, it is evident that the effective result per horse power increases with the total power of the engine and mill used; and an engine of 20-horse power may therefore be considered as capable of crushing effectively at least double the quantity of cane per hour, as compared with that subjected to a 12-horse power engine, such as above referred to; besides having sufficient spare power for the ordinary engine work of a vacuum pan, hereafter to be described. It is advisable however in every factory, to have some spare power in the steam-engines adopted; for the wear and tear of the working parts is much diminished, and the general results more to be relied on, when not kept worked up to their full power. Lastly, it is preferable on every sugar-cane estate to have two distinct engines and mills, in preference to combining all the required power in one; as in the latter case, any accident to the machinery happening during crop time, which might occasion a stoppage of the mill for several days, would occasion a loss more or less serious to the planter

in proportion to the quantity of plant he might have ready cut at the time, in addition to that caused by the delay in taking off the already ripe portion of growing cane, and loss of wages to the people employed in the works. Whereas, by having two independent mills and engines, the risk of such losses is very considerably reduced.

Upon weighing the above considerations therefore, it will be found, that two engines of 20-horse power each with mills to correspond, will be the best arrangement for a cane cultivation such as I have recommended; each of the engines being besides adapted to work an air-pump for the vacuum pan, the cold water pump to supply the whole works, or any other work required from the steam-engine; so that either of them should be fitted and available for the whole duties of the factory, in addition to crushing its share of the crop of sugar-cane.

The mill-house should be erected near one end of the works, and so as to be easily accessible both from the cart-road and the river, or other water supply, on which the works depend. It should have a good space of clear ground adjoining it, for the convenience of stacking the canes as they arrive from the field, and where they should be sheltered from the sun by a temporary shed of bamboos and mats, which can be erected every season for 5 or 6 Rupees. The mills themselves should be set on massive masonry pillars, at such elevation that their bed-plates may be about ten feet above the ground level: and to this height the cane can be carried up to a platform next the rollers on an inclined plane by hand-labor, and there fed to the mill in the usual way; or preferably it can be elevated by the simple contrivance of the endless band, which enables the cane to be fed from the level of the ground, and to be passed with regularity to the rollers by their own rotatory motion: this contrivance appears to answer its purpose very well, and to be very generally approved of, and has besides the advantage of keeping the

cane-feeders and other workmen at a distance from the wheels and rollers, and so lessening the liability to accidents through their carelessness. The object of this elevation of the mill itself is the obviating the necessity of pumping the cane juice as soon as it is expressed, which is necessary on the old plan of setting the mill on the ground level, to elevate it so as to command the clarifiers into which it should be conveyed as soon as possible after it leaves the mill. This pumping is very prejudicial to the fresh juice, tending as it does to hasten its fermentation by the churning motion given to it by the action of the pump-bucket and valves; and the impossibility of keeping the pump and cistern entirely clear from an accumulation of juice. This tendency to fermentation is an evil most carefully and watchfully to be guarded against throughout the manufacture, from the first expression of the juice until its conversion into concentrated sugar; but most specially so before the juice is first brought to the boiling point of temperature in the clarifiers. The nature of the juice and the warm climate of India render this accident a very likely one to befal, and as it is an evil which no subsequent treatment can entirely remedy, every precaution is called for to prevent it.

When once the cane crushing business has commenced, it should be continued without intermission throughout the the week; except for about an hour at midday, and the same at midnight, for the purpose of thoroughly oiling and greasing the joints and brasses of the machinery, clearing out the fires, or any other odd jobs which cannot be done while all is in motion. Twenty-two hours' work out of the twenty-four may thus be gained, and should be persevered in so long as ripe canes can be supplied to the mills; arranging however, if possible, to work up all prepared canes by the closing hour of Saturday night, to recommence on fresh cut canes on Monday morning, without carrying over any stale plant from one week to be crushed in the next. To conduct this

routine with effect and certainty, three spells or watches of mill-men, engineers, stokers, and boiling-house men should be provided, dividing the time into eight hours for each watch; the first commencing at midnight and continuing till 8 A. M.; the second from that hour till 4 P. M.; and the third from 4 P. M. till midnight: for these consecutive hours the men will be found to work cheerfully without break or intermission, or to leave their post for refreshment; and it will be found cheaper so to work than with two watches, dividing the 24 hours' work between them. An European Superintendent should be appointed to each watch, and personally superintend the work throughout. Once at least in the 24 hours he should see the rollers, gutters, and all parts over which the juice has flowed, thoroughly washed with lime water, to prevent the encroachment of any incipient acidity from fermentation; and the same should be observed on closing work on Saturday night.

A careful attention and regulation of the field work is at the same time called for, to cut and supply the canes only in such quantities as may be required daily at the mill, and to see that a sufficient quantity is stacked up every evening to keep the mills supplied throughout the night, without leaving a superabundance to reach beyond the time, next morning, when fresh supplies can be brought in from the field; the rule being, that when once the canes are ripened, they should be worked up as quickly as possible; for though no deterioration worth notice takes place in the cut canes through fermentation of their juice, especially if kept shaded from the sun, even for two or three days after being cut; yet loss is incurred by the partial drying up of the juice in the sap-vessels, and the consequent impracticability afterwards of separating so large a percentage by the action of the mill.

Each spell of Native workmen required for a double mill-house, such as above described, will be as follows, and their ordinary rate of wages is also given:—

1	Head Native engine man, per month, ..	Rs.	6	0
2	Under ditto, at 5 Rs. per month, ..	..	10	0
2	Boiler-stokers, at 5 Rs. ditto, ...	..	10	0
1	Fuel man, at 3 Rs. ditto, ...	..	3	0
8	Cane carriers, at 3 Rs. ditto, ...	..	24	0
4	Mill feeders, at 4 Rs. ditto, ...	..	16	0
6	Trash carriers, at 3 Rs. ditto, ...	..	18	0
24	men. Total wages per month, ..		87	0

Clarification.

As the juice is expressed by the rollers it falls on the bed-plate of the mill; which, being of a concave form, and with an aperture at one end, the juice passes through this into a gutter lined with sheet lead, and is thereby conducted to the clarifiers. It has been a very general practice to conduct it in the first instance into a vessel called the "cold receiver," a square cistern, lined with lead or copper, until sufficient juice accumulates to fill one of the clarifiers, and to allow it to flow into the latter only after being tempered with lime and allowed time for some of the feculencies to subside. This intermediate stage however, I consider quite unnecessary, and even prejudicial in India, where the tendency to fermentation in the juice is so great, that any delay in the process from the time the juice leaves the mill until it is brought to a boiling temperature in the clarifiers, must be detrimental to it. The gutter from the mill therefore should conduct the juice at once over the range of clarifiers, into which it should be caused to flow in succession, by means of plugs fixed in the gutter over each, and opened as they are ready to receive it. So soon as the juice has attained the boiling temperature of 212° Fahr. all immediate danger of fermentation is obviated, and indeed need not be apprehended until this temperature is again greatly reduced; and this should by no means be allowed to happen throughout, or

until it is granulated into sugar. So soon therefore as six or eight inches depth of juice is collected in a clarifier, heat should be applied to it and increased as the vessel fills; which it should do in an hour at the utmost, with the juice from one mill only,—so that very little further time will then be required after filling to bring it fully up to boiling point.

Under the old regime of West Indian manufacture, the clarifiers were generally of thick copper, of circular form, about seven feet diameter, two feet deep, with convex bottom, and containing 300 to 350 imperial gallons; with a stoke-hole and flue beneath them in which fire was applied by burning megass or dried cane-trash. Since the introduction of steam, however, this agent has been found a far more economical and manageable means of applying heat, both for clarifying the juice and evaporating its watery portion to reduce it to the condition of syrup; and I would undoubtedly recommend its adoption in all new factories. In some old established sugar works, however, where the proprietor may wish to adopt the use of the vacuum pan, without incurring the expence of an entirely new apparatus throughout, he may find it suit his purpose to make use of the means, in open fire clarifiers and evaporators, which he has all ready to his hand, for bringing the juice to the state of a syrup before final concentration in vacuo.

But in erecting a new factory, steam alone should be relied on in all the operations of applying heat to the liquid sugar. The clarifiers should be of oblong form, and two feet six inches deep; the dimensions otherwise are immaterial, so that the contents measure about 350 imperial gallons as a convenient size; seven feet long by four feet broad would be a convenient shape, and they should be made of wrought iron plates, quarter inch thick, and well rivetted together. Eight clarifiers of this size and shape will be found sufficient for the work corresponding with the mills and other appliances under consideration. The use of copper for these

vessels, when heated by steam, is unnecessary, and the saving of expence by the substitution of iron is considerable. The steam is applied by means of three inch diameter pipes of thin copper, five of which are laid from end to end of each vessel, and connected into one coil laid near its bottom. Into these coils steam is introduced from a main steam pipe, running along the entire length of the range of clarifiers, and it is regulated by steam-valves attached to one end of each coil; whilst the other end is connected with a condense box, which carries off all the water produced by the condensation of steam in the pipes.

When the clarifier is about three-fourths full the temper-lime should be added. Quicklime should be procured for this purpose, and the most effectual plan of obtaining it fresh is to procure the limestone and burn it, as required, in a simple kiln. The proportion of lime given must be regulated entirely by the degree of acidity in the juice: several rules have been given for ascertaining this proportion with precision, but I have found the use of the litmus test-paper the most simple and certain; by applying it to a sample of the juice in the clarifier, and continuing to do so, adding lime by degrees and mixing it thoroughly with a wooden oar, until no remaining acidity is indicated and the clarifier full:—the steam-valve should then be fully opened, and the vessel should not be further disturbed until the contents are drawn off: 10 to 15 lbs. per square inch is sufficient pressure of steam for the clarifiers: with this in about three-quarters of an hour after they are full a smart ebullition will commence:—this should be allowed to continue for a minute or two, as a boiling heat is requisite to thoroughly coagulate the albumen present in the juice; the steam-valve should then be shut, and the clarifier left for half an hour to allow the scum to harden on the surface, and such impurities and feculencies as may be floating in the liquor, and which will not rise with the scum, to subside to the bottom. The juice is then

ready to be run off as soon as required; which is done by turning the cock at the end of the clarifier, and allowing the contents to flow along a gutter into the open evaporators. At this stage it ought to be of a clear bright aspect, and of a dark yellow or orange color: if too little temper has been given, a slight dullness and tendency to lemon color will be perceptible; whereas, if too much, the color will be heightened to a fiery or brownish-red. The variation in the proportion of lime required to any given quantity of juice, sufficiently indicates the great diversity in quality of the latter; sometimes half a pound is sufficient for a clarifier of the size above referred to, and at others as much as 4 or 5 pounds, to neutralize the acidity present.

The clarification, or as it is frequently called defecation, as above described, is the same in principle, and differing but slightly in detail from the practice of the West India planters. Suggestions for its improvement however, have been numerous and varied in their nature. Filtering the cold juice, ere it enters the clarifier, through animal charcoal and other substances, has been advocated; but I have not found any wire-sieve or cloth filter effectual in separating any impurities which are not readily thrown up in the scum of the clarifier; and charcoal filtering at this stage I consider as misapplied, from its not only delaying the process, but the impurities in the juice must quickly render it useless and occasion its frequent renewal, while its virtues are far better applied after the defecation is completed. Various are the agents which have been recommended for use in the clarifiers to effect the chemical transmutation of the mucilage, albumen, chlorophylle and other matters prejudicial to the sugar; and for facilitating their separation from it. The salts of alumina, nut-galls, sulphuric acid, and several of the metallic salts have had their advocates; but great objections have been found to the practical use of most of them, and have caused the old plan of quicklime tempering to maintain its

ground. Most of the metallic salts are virulent poisons, and should not be trusted in any way in the hands of native workmen, whose habitual carelessness would render their use at all times highly dangerous. Sulphuric acid and nut-galls are also objectionable; the former from its caustic properties requires extreme care in its use, and is never necessary for cane sugar; though in the refining of date sugars it is sometimes of service:—and the latter, from the danger of spoiling the whole of the juice to which they are applied, should iron in any shape be left in contact with it. Common alum however, or what is said to be preferable, the sulphate of alumina, which is largely used by the beet-root sugar manufacturers in France, may occasionally be of good service in assisting the clarification of the juice, when, (as is sometimes the case,) it does not readily become bright and transparent with the aid of lime and heat. Four ounces of alum for a clarifier of 350 gallons of juice, I have found a sufficient proportion in such cases: it should be pounded and thrown into the clarifier as soon as heat is applied, and the lime added afterwards as usual.

It has been recommended to filter the cane juice through bag filters and bone charcoal as it passes from the clarifiers; but I prefer both these operations being performed at a subsequent stage of the manufacture; that is, after the watery portion of the juice has been evaporated and the latter is brought to the state of syrup. At this stage I believe they are more effective; the bag filters then separating whatever further portion of coagulable matter may have been solidified by the heat applied in the evaporation, and the charcoal then removing with better effect the coloring matter, which is in fact produced principally by that evaporation.

The cane juice from the clarifiers I therefore allow to run directly to the open evaporators: a man should be in attendance at the clarifier discharge-cock while open; and as soon as the juice begins to flow thick and muddy, from the mix-

ture of the scum or subsided impurities with it, the cock should be closed, and the refuse, which should only be an inch or two in depth at the bottom of the clarifiers, should be run off into the scum tub, to be carried therefrom to the distillery as required: this tub is placed outside the boiling house; it is made of seasoned wood and furnished with a plug, and the scum is either carried to it from the clarifiers in buckets, or preferably by a gutter fixed under the line of clarifiers, and communicating with each discharge-cock by a small moveable shoot to be used after the clear liquor is run off. The clarifier is then washed out with lime water, and is again ready to receive fresh juice from the mill. Cleanliness is as indispensable to successful sugar making in this as in all other parts of the process; and that clean water may always be at hand for washing the pans, gutters, &c., a pipe should be conducted from the water reservoir to one end of the boiling house, and there fitted with a brass cock.

With respect to the labor required for this department, one man should be appointed to the charge of each clarifier, and if he gives due attention to his work, his employment will be found pretty constant. A sirdar or headman also should be in charge of the whole business: he should be a man of trust and experience, whose duties should be to regulate the supply of lime by the use of the test-paper, to see that thorough cleanliness is preserved in the house, and to be generally responsible to the European in charge for the proper progress of the work in his department. As the clarifying proceeds uninterruptedly while the mills continue work, it also requires three spells of workmen allotted to it, and each spell, with its expence, may be therefore reckoned *as follows*:—

8 Clarifier men, each at 3 Rs. per month,	..	24	0
1 Headman, at a monthly wages of ..	..	8	0
Total,	..	32	0

Evaporation.

As already remarked, the specific gravity of the juice, as it flows from the mill, is indicated by 9 to 12 degrees of Baume's saccharometer; and this indication is but little if at all altered up to the time of its passing, when defecated from the clarifiers; for though some small portion of its water has been evaporated by the heat there applied to it, this is about compensated for by the absence of the albuminous and mucilaginous matters separated from it in the scum. The object of the process of evaporation now to be described is to increase the specific gravity of the juice, by the dissipation of a portion of its water, to 25 or 26 degrees of Baume, preparatory to its filtration and final concentration in vacuo.

It has been proposed by some engineers to conduct this part of the process also in a vacuum pan; but besides its being very doubtful if any advantage in the quality of the sugar would be gained thereby, the increase in the expence would be without doubt very great; owing to the large proportion of water to be evaporated, and the power of machinery required to effect the same at a low temperature by maintaining a vacuum for the time it would occupy. It is well known that the greatest detriment to the quality of the sugar, by exposure to high temperatures, is caused *after* the cane juice is brought to the consistency of a thick syrup; and that by the old plan of conducting the whole process in copper boilers over an open fire, as still practised in the West Indian and other Colonies, it is mainly in the teache, or concentrating pan, that the injury to both color and crystalization is inflicted; and that little or no injury is sustained by the juice up to the point of its evaporation to a syrup of the gravity above referred to. It is hardly necessary to describe here the system of open pan evaporation and concentration referred to, as it is detailed at length in all works on West India cultivation. It may however be briefly described thus:

a range of 3, 4, or 5 round-bottomed copper, or sometimes cast iron pans, gradually diminishing in size from a capacity of 300 or 350 gallons to one of 90 gallons, and suspended over a fire common to all; and through these the juice is passed in succession, commencing with the largest; the pans being all set on the same level, the juice is ladled from one to the other as the evaporation progresses, until the contents of the last pan, or teache, become sufficiently concentrated to be passed to the crystalizing vessel, and their place is then supplied from the next pan; and so on in succession until the whole of the juice is concentrated.

On estates or factories furnished with the series of evaporators just described, into which it is desired to introduce the modern improvements of the vacuum pan, it has been proposed to avail of the old plan, to conduct the evaporation therein until the juice is brought to the state of syrup, removing only the last or concentrating copper, and arranging the work of the latter to be performed by the vacuum pan: and a considerable saving of immediate outlay, with little or no detriment to the work, may no doubt be effected by this arrangement.

When however new works are to be erected, it is far preferable to adopt the valuable agency of steam in this, as in all other parts of the manufacture where its use can be availed of. The pans best suited for steam evaporators are 14 feet long by 7 feet broad, and 18 inches deep, with a series of 3 inches diameter copper pipes, laid along the bottom in the same manner as described for the clarifiers. Some of these evaporators, as well as the clarifiers, have been made with a double bottom for the steam to circulate in the chamber thus left, instead of through copper pipes as above recommended; but such it must be obvious is a less economical application of the heat than with the pipes, having their entire surface covered with the liquid to be heated: inasmuch as with the double bottom the radiation of heat from the under surface of the steam chamber is lost, and that from the

upper surface only is available for any influence on the contained liquid. Six of these evaporating pans would be required for the works under consideration: they may be most economically made of quarter inch thick wrought iron plates, rivetted together, as described for the clarifiers; and should be furnished with brass discharge-cocks in the same manner. The juice, as it leaves the clarifiers, flows into them to the depth of about a foot, leaving the remaining height to be filled by the ebullition of the juice; any further scum that may rise to the surface during the evaporation should be removed with skimmers, and sent away in buckets to the scum tub.

The space lost in the evaporators, by the gradual dissipation of the watery portion of the juice, is supplied from time to time with fresh juice from the clarifiers; and this is repeated until the whole contents have attained the required density. As the work progresses, the liquor should be occasionally examined by filling a small quantity of it into a wine glass or phial, as well as by the test paper; and should any acidity or dullness still be apparent, it should be corrected by small quantities of milk of lime thrown into the evaporators until the acidity disappears. In case of the ebullition being too violent, and consequent danger of the juice boiling over, this evil is quickly checked by throwing into the rising liquid a small quantity of milk. Practice enables the man in charge of the boiling to decide from the appearance of the juice, as to its color and the size of the bubbles it throws up, when it approaches the required density: he should not however depend on this alone, but should have a simple brass saccharometer, marked with the degrees of proof for the range of density the juice will pass through until brought to syrup consistency, and corresponding with the scale of Baume: this should be always at hand for testing every skip before it is allowed to be run off to the vacuum pan house. When the juice attains the required

proof of 26 degrees of Baume, the steam should be shut off from the evaporator, and its contents at once run off to the syrup cistern, placed in the adjoining room of the vacuum pan house.

In addition to a thorough washing which the evaporators should have at least once every day, the whole, at the close of every week's work, should be scoured with sand to remove any thin film of carbonate of lime, which precipitates from the lime in solution with the sugar, and encrusts the copper steam pipes; and from its property as a non-conductor of heat, retards the boiling process if allowed so to accumulate.

To conduct the work of the evaporators, one man in attendance to each pan is required, and one headman to keep account of the general progress, and be responsible for the regular attendance of the rest and the cleanliness of the pans and work: the full complement, for the six evaporators at work, will therefore be as follows:—

1 Head boiler, at a monthly wages of	..	Rs.	8 0
6 Under ditto, at 3 Rs. each,	.. .. ..		18 0
			26 0

In cases where the old plan of evaporation in open fire coppers is adhered to, the additional expence of a stoker to each pan, and two boys to supply dry trash for fuel, must be reckoned in calculating the cost of labor.

The clarifiers and evaporators, as will be observed in the plan given, are all set in the same building; which should be very open and well ventilated, to allow of the free escape of the vapour as it rises from the boiling liquid. It should be in fact constructed simply of a high roof, supported on pillars, or walls with wide archways through them; sufficient to protect the work and workmen from rain and sun, but otherwise left open to the atmosphere.

CHAPTER IV.

ON THE MANUFACTURE OF SUGAR FROM CANE BY THE EUROPEAN METHOD, CONCLUDED—EMBRACING FILTRATION THROUGH CLOTH AND THROUGH ANIMAL CHARCOAL; CONCENTRATION; CURING; CUTTING UP AND PACKING; AND SYRUP SUGARS.

The cane juice, prepared and evaporated as described in the last chapter, is now in the state of a clarified and thick syrup, its strength being denoted by 26 degrees of Baume; and were the evaporation continued in the coppers or steam evaporators, the effect would be at once to concentrate it to the consistency of a granular mass, requiring only to be cooled and left at rest, and its molasses separated, to bring it to the state of raw or Muscovado sugar. And this is in truth analogous to the process, adopted with slight variations in all sugar growing countries, until the improvements of the last ten years brought to bear more perfect and economical methods. It has now been proved by successful practice in both French and English Colonies, that sugar of the finest quality can be produced by *one* process direct from the cane juice; by conducting it previous to concentration through the processes of filtration and decoloration by animal charcoal, and then concentrating it in the vacuum pan and curing it by improved methods. And I may add, that I have proved by my own experience that this can be effected with as great success and advantage in Bengal as elsewhere.

The proprietors of the sugar estates hitherto established in Tirhoot and other districts in this country appear, with scarcely an exception, to have confined their objects to the production of a Muscovado sugar, and the consequence is they have been left to compete for a sale in the Indian mar-

kots with the khaurs or other native sugars, of similar quality, and equally well or perhaps better adapted for the purposes of the refiner; or if they shipped to the home markets they have had to compete there with the Muscovadoes, which form the bulk of the sugars brought from our own West Indies and Mauritius, as well as from foreign Colonies. In this they have undoubtedly erred greatly; inasmuch as with ordinary skill and means of refining, and with very little additional outlay, the cheap labor of this country would have enabled them to produce a white and well crystalized sugar, fitted to stand the voyage home without deterioration, and to compete with the better class of grocery and refined sugars of the English markets; which are prepared from the same Muscovadoes by a separate and expensive process.

The description of the several operations reserved for this chapter has hitherto been considered as pertaining exclusively to the subject of "sugar refining," from the details of which they differ but very slightly; to superintend them efficiently the planter or proprietor of a sugar estate, who may not have had experience in the art of refining, would do well to engage the services of a person possessing such experience. This precaution, especially where new works are being established and the Native workmen unaccustomed to the various manipulations, will probably save the estate the loss of many thousand Rupees; there being much in the management and regulation of the work throughout, which experience alone can teach sufficiently, and which could hardly be gathered from any written account. Nevertheless, a short description of the several processes may prove useful, as showing the principles on which they should be conducted; and I shall therefore refer to them in order. The building best adapted for the following operations should be about 35 feet in height, divided into three stories or floors, and 60 feet in length by 40 feet broad, will be found dimensions sufficiently convenient for all purposes, and will admit of the

whole business being performed without the labor of pumping, or otherwise mechanically raising the syrup after it has in the first instance been brought to the uppermost story; as will be more clearly comprehended by a reference to the plan of sugar works appended to this volume. This arrangement is also the most favorable one for adapting the sugar house to the refining of native raw sugars, should it be desired to convert it to such use during the months it is not occupied in taking off the cane crop.

Filtration through cloth.

The filter here referred to is a mere mechanical contrivance for effectually separating from the syrup any remaining impurities that may be floating in it, its effect being similar to that of a fine sieve: the filter most commonly used for this purpose is that known as the Schroëder's or bag filter, and is too well known to need more than a brief description here. The liquor to be filtered is run into a square head-cistern, a convenient size for which is 4 feet long by 2½ feet broad and 15 inches high, into the bottom of which are screwed thirty-two brass bells, about 6 inches in length, having each a hole of one inch diameter opening through it from the head-cistern: over the outside of these bells are tied the open ends of the filter bags: each of these consists of a bag of strong cotton cloth, that known as American drill is well suited for the purpose: it should be in the form of a sack 24 inches wide, 6 feet long, and strongly sewn, and it should be confined in a tube of coarse canvas of the same length and 6 inches wide. The bags, thus suspended from the bells, are enclosed in a wooden or metal case, sufficiently large to contain them without coming in contact, and to allow a few inches clear at the bottom, where a cock is attached to conduct the filtered syrup as it runs from the bags to the charcoal filters. The evident advantages afforded by this apparatus are the large filtering surface comprised in a small compass, and the quick-

ness and facility of conducting it without cooling the syrup; the filter case being made to close tolerably tight, and so prevent the escape of the hot vapour rising from the descending syrup, the passage of which through the cloth would be materially retarded were it allowed to cool, by the greater specific gravity it would thereby acquire,—being as much as 2 to 3 degrees of the saccharometer.

If the previous operations of defecation and skimming have been properly conducted, each filter of the above dimensions will strain 500 to 600 gallons of syrup without requiring the bags to be cleansed; and four such filters will be found amply sufficient for the extent of work proportioned to the apparatus already described. Care is required to see that no fracture is left in the cloth bags. The water in which they are washed may be returned to the clarifiers.

The bag filters are placed in the second story of the vacuum pan house, their head-cisterns being on a level with the upper story floor. As we left the syrup at the close of the last chapter in the syrup cistern placed on the ground level, it is therefore necessary it should be raised to the height required to command a cistern placed above the filters from which the supply to the latter is regulated; this is effected either by a simple force-pump, worked by hand or by a bell-crank attached to the engine: or by a monte-jus, which is a simple and ingenious contrivance for raising syrups without subjecting them to the motion of pumping, and seems deserving of being more generally adopted than it has hitherto been. It is a cylindrical close vessel, furnished with two horizontal pipes from its base, one of which communicates by a cock with the syrup cistern on a level with which it is placed, and the other with a perpendicular pipe reaching to the vessel into which the syrup is to be delivered. After filling the cylinder with syrup from the cistern the cock between them is shut, and that attached to the upright pipe is opened; a small jet of high-pressure steam is now in-

troduced into the upper end of the cylinder, which by its pressure on the surface of the contained syrup forces it up the pipe into the vessel prepared to receive it, and this operation is repeated until the required quantity is raised.

The cistern, in the third story of the building, into which the syrup is thus delivered, should be of capacity to hold 500 to 600 gallons, and should communicate by a common pipe or gutter to all the filters by means of a cock or plug over each. Should the house be adapted for use as a refinery of native sugars, one of the blow-up pans, which should be situated in this story, would answer all the purposes of the cistern required. In any case it should be furnished with a coil of steam pipe, to afford means of bringing the syrup once more to boiling heat before filtering: this not only facilitates the filtration but generally separates another slight scum, which it now throws to the surface, notwithstanding all the care bestowed on it in the previous stages of clarification and evaporation.

The syrup as it passes from the bag filters should be perfectly bright and clear; and the color that of pale to dark sherry wine, according to the quality of the juice, and the proportion of lime that has been required for its defecation. Should it not have the character of brightness, the filter in use is in some way defective, and the syrup should be directed to one of the others until the leak or other fault is remedied.

Filtration through animal charcoal.

The word filter probably owes its derivation to the φιλτρον of the Greeks, originally used by them to express a love-charm, though it has been brought, like many other words engrafted on the modern English, to bear a widely different signification. Looking however at the virtues of animal charcoal in the refining of sugar, the application of the word does not seem inappropriate; appearing, as they do, little less occult and wonderful than those attributed by the

ancients to their magic gifts. For in *what way* the charcoal acts, the penetration of our chemists has hitherto failed to discover; its beneficial *effects* only are satisfactorily known, and these are concisely summed up by Dr. Evans in his valuable work on sugar, which I have already referred to, as follows:—1st—Decoloration of the syrup, which extends both to the sugar and molasses. 2nd—Abstraction of any excess of lime which it may contain. 3rd—The neutralization of any free acid. 4th—The removal of nitrogenized matters. 5th—The amelioration of that viscid condition which inspissated cane juice frequently presents. 6th—The promotion of granulation. And the sugar refiner is content to avail himself of these wonderful effects, without studying to discover by what hidden process the "charm" works.

Since the commencement of sugar refining as an art, assuredly no discovery has been made of equal importance to it with this agent; a truth which must be acquiesced in by any one practically acquainted with its virtues, for these are by no means over-estimated by Dr. Evans in the above passage from his work: and after this decisive opinion in its favor, his readers are hardly prepared for his somewhat lukewarm recommendation of its "trial" in the boiling houses of our West India Colonies, influenced, it would appear, by some doubt as to whether the improvement it would effect would be compensated for by the expence it would entail. But whatever weight this objection might have in the present state of those Colonies,—though I believe that even there it is one that would disappear before a fair practical trial,—no such doubt can arise regarding its use in all sugar works in India; where indeed its benefits have for several years been well known and availed of, and where the low cost at which the charcoal can be prepared forms one strong inducement for its general adoption. This may be more readily understood by contrasting its cost price in England, where raw bones are usually sold for 5*s.* to 6*s.* per cwt.,

and the prepared charcoal for 12*s.* to 18*s.* per cwt., with their cost in Bengal, where, valuing the Rupee at 2*s.*, I have constantly purchased the raw bone at the corresponding price of 7*d.* to 9*d.* per cwt., and made good charcoal therefrom at a cost of 2*s.* 6*d.* to 2*s.* 9*d.* per cwt.; and the expence of re-calcination of the charcoal is proportionably low.

A history of the progressive steps of improvement in the use of bone charcoal, and of the various methods in which its virtues are still availed of, would be more fitted for a chapter in a work devoted to sugar refining than for introduction here; I shall therefore rest contented with describing the plan I would recommend for its adoption on a sugar-cane estate.

The form of filter most generally approved of is that of the long cylinder. The best are made of wrought iron plates rivetted together, and they have been used of heights varying from 6 to 22 feet, and of 4 to 6 or more feet in diameter. For cane juice syrup I would recommend a medium size of *12 feet in height and 6 feet diameter, as sufficient for all the* ends they are required to fulfil; as well as to afford good and substantial service in the event of their being required also to assist in the refining of native sugars. The filters are close vessels, furnished with a man-hole door at top and bottom for filling in and emptying out the charcoal, but closed when the filter is in use; and with an induction syrup-cock at the top, and one for eduction of the filtered syrup at the bottom; also with a small steam-cock introduced near the top to throw a jet of steam, when required, into the body of the charcoal. A perforated wooden tray supports the charcoal 2 or 3 inches from the bottom of the filter; the latter is lined throughout with a coarse blanket, and the charcoal properly prepared is then filled into it to within a few inches of the upper end of the cylinder: the man-hole is then closed and the whole is ready for use.

The steam-cock is first opened to allow the mass to be thoroughly penetrated with the heat and moisture it affords,

and the syrup from the bag filters is then allowed to flow through it: the syrup which comes away during the first few minutes is usually of a dull cloudy appearance, and should be run off to the foul syrup cistern, to be pumped up again to the third story with the fresh syrup from the evaporators: as soon as it begins to flow clear it is conducted into the clear liquor cistern which supplies the vacuum pan.

A slow but constant stream through it should be kept up during the first three days the filter is used: it is then "steamed out," that is, the steam-cock is opened, and the steam allowed to act on it for several hours until the condensed water which flows from it has little or no sweetness perceptible in it; the filter may then either be used again with diminished effect for another three days; or is emptied and re-filled with fresh burnt charcoal, according to the quality of sugar it is desired to produce.

Four 12 feet filters, such as above described, will be found sufficient for a sugar-house of the size and capabilities I have recommended, to produce a very powerful effect in improving the sugar made in it. The number of filters however, and the frequency with which they should be re-filled with re-burnt charcoal, must depend entirely on the description of sugar it is the planter's aim to manufacture,—the quality of the cane juice he is working upon,—and the degree of care bestowed on the previous parts of the process; the whiteness and strength of the sugar produced following in great measure the proportion of fresh charcoal afforded to it. I have seen a perfectly white and bold-grained sugar produced, by the process described, direct from the cane; and with a sufficiency of charcoal and due care in the manufacture, it does not admit of a doubt but that the whole crystalizable produce of the plant may be obtained in this form. At the same time some judgment is required on the part of the planter, to guide him as to the extent to which he should avail of this valuable agent; influenced, as he should be, by the wants of

the market he is manufacturing for, and the corresponding expence he is incurring in preparing the different qualities for that market.

The preparation and re-calcination of the charcoal are important parts of the business, and require care and attention; for if imperfectly performed the effect becomes the opposite of beneficial to the sugar: as there is no great difficulty in the preparation however, and bones are procurable in abundance in every part of the country, every sugar factory ought to possess the means of making it to supply its own wants. To enter into a detail of its mode of preparation is beyond the design of this work; but I may mention, that the expensive patent apparatus in use in England is by no means requisite, and the more simple and cheap retorts or other vessels generally adopted here, are by far the best adapted for this country and for Native management.

Concentration.

This is the final boiling of the cane juice, to effect the crystalization of the sugar and the evaporation of the remaining superfluous water which kept it in solution in the form of syrup. It was formerly always performed in the "teache," a round-bottomed copper or iron pan, forming the last of the series of cane juice evaporators over the open megass fire, as described under the head of evaporation: the decomposition of a portion of the sugar, by the charring, and long exposure to a high temperature, which it suffered in this process, was most detrimental to its quality; and the "teache" has now begun to disappear from all well regulated sugar estates, and its place to be occupied by the vacuum pan. This valuable invention is now too well known to need description here. The great objection hitherto to its adoption has been its expence; but the improvements of late years, in simplifying and reducing the cost of machinery, and the substitution of cast iron for many parts formerly made of

copper only, have gone far to remedy this objection. I have already stated my opinion, that a pan to contain at least 3 tons of sugar, is the smallest size deserving of confidence, for producing the most beneficial effect in perfecting the crystalization.

Economy in the first outlay, so far as it is consistent with the efficiency of the apparatus, should also extend to other parts of the apparatus. The vacuum in the pan is formed by an air-pump assisted by the action of cold water, which condenses the vapour as it rises from the boiling sugar; and the least expensive application of this is effected by what is known as the plan of "internal injection," that is, the injection of a jet of cold water through the vapour itself in its passage from the pan to the air-pump; and with water of the average temperature procurable in this country, a pipe of 2 inches internal diameter will furnish the stream of water required for this purpose for a pan of the size recommended; this water mixing with that formed by the condensed vapour from the sugar is drawn off by the air-pump, which indeed in this way performs the work of a water-pump also.

The management of the boiling process should be confided to a vacuum pan boiler of some experience; as it is difficult to acquire, except by practice, the skill to regulate the gradual supply of syrup and formation of the crystal according to the quality of the material under treatment. The boiling of a pan of cane syrup of 26 degrees of Baume, to give 3 tons of uncured sugar, will usually occupy about four hours; and allowing half an hour interval between each boiling to empty the pan and readjust it for work, will give about eighteen working hours per diem to complete the four boilings required, as estimated at the beginning of Chapter II. of this part of the work.

From the vacuum pan the sugar is precipitated, when fully concentrated, into the heater,—an open vessel placed directly under it, and furnished with a steam casing: in this the

temperature of the sugar is sometimes raised several degrees to liquefy the molasses and allow of a more perfect formation of the crystal. This is however an expensive piece of apparatus, and may generally be dispensed with, and its place supplied by a round-bottomed iron pan or other vessel, merely adapted to receive the sugar from the vacuum pan; as, if it be desired to raise its temperature previous to setting it to cool, this can be equally well done in the vacuum pan itself, by destroying the vacuum and allowing the steam alone to act upon it for a short time.

From the heater the concentrated sugar is transferred to the cones or moulds ranged on end around the fill-house, or room in which the heater is placed: this work is always performed by manual labor, the hot sugar being carried in copper basins, and is a slovenly and rude part of the work; appearing to require some cleaner and more efficient contrivance to be substituted, to place it on a par with the improvements lately introduced into all other parts of the art of sugar refining.

The best cones are now made of sheet iron, and have, with few exceptions, quite superseded their old predecessors, *which were always made of red earthen-ware.* The best size hold 125 lbs. of uncured sugar as it falls from the pan; and as this will leave, if well crystalized, about 82 lbs. or one Indian bazar maund of sugar after the separation of its molasses, this size also affords a ready means of estimating the daily produce of the crop. A gradual cooling of the sugar in the cones is favorable to its perfect crystalization, and all cold draughts of air should therefore be guarded against in the fill-house, and the cones should not be removed to the curing house for at least twelve hours after being filled.

In Bourbon, Mauritius, and other Colonies, vessels of a larger size have been adopted for curing, and wooden cases holding a ton or more weight of sugar each are used, and have been introduced on some estates in this country; the theory

in their favor being, that a freer and more perfect crystalization takes place in them than in vessels of smaller capacity. My belief however is, that the improvement in the crystalization which they have been found to induce, may be attributed more to the gradual cooling which would take place through so large a mass of sugar, than to any other advantage referrible to the size of the vessel: and when the superior advantages of the cones are considered,—whether as to the facility with which they may be conveyed to any part of the works, or their contents examined at any stage of the curing, by merely inverting one or two from each boiling and turning out the loaf,—no doubt can remain as to the preference which they deserve.

Curing.

This is a part of the process of sugar making which has become much less tedious and uncertain in its operation since the introduction of animal charcoal in the boiling house. Before this agent came into use the curing occupied generally from two to three weeks, and required the application of as many magmæ, or strata of pipe-clay, to effect the complete descent of the molasses from the crystalized portion of the sugar. Now, however, after its condition has been ameliorated by the influence of the charcoal, one magma generally suffices entirely to dispel the molasses, and a second is called for only when an extra degree of whiteness is required.

The magma here referred to is a clarified syrup of 25 to 30 degrees' density, and it should be made by melting sugar rather whiter in color than that it is intended to cure. It is used by cutting up the face of the sugar in the cone to the depth of about two inches, and then smoothing it with a trowel so as to present an even surface; the magma, when cold, is then poured on it to the depth of an inch, and this, by its weight, penetrates the mass of sugar carry-

ing the molasses down before it; the latter being further assisted in its descent by the crystalization of the sugar in the magma itself, and the water thus set free helping to attenuate it.

The cones being brought to the curing house, the plugs at their apices are withdrawn, and each is set on its separate jar to receive the molasses or syrup which flows from it. That which drops for the first two or three days is generally considered as molasses; the jars are then changed and the magma being applied, all which drops subsequently, which is of a lighter color and less glutinous, is considered as syrup, and is set apart for re-boiling separately. After the first magma has been allowed to penetrate from two to three days, and the face of the cone has again become firm and crisp, the whole loaf should be turned out and examined, and if the crystalization appears good, and the color uniform to within five or six inches of the apex, it may be allowed to complete the curing without further treatment; which will probably be effected in three to four days more: but if the magma has penetrated but little and the sugar remains clogged and dark colored, another magma will be required, and the curing be several days delayed. Such at least will be the probable course of the work; but practice alone can teach the refiner the plan in all cases best adapted for securing to him the description of sugar he wishes to produce. If the boiling and previous treatment have been successful, from eight to twelve days, according to the quality of the produce, should suffice to complete the curing.

Cutting up and packing.

The "cutting up," or reduction of the loaf to the state known as "crushed sugar," is performed by the sugar knife: this is composed of a number of steel blades, about 18 inches long, affixed to the circumference of two wheels, and turned by a handle, or a belt connected with the engine: against

these revolving blades each sugar-loaf is slowly pressed, and the sugar is thus shaved off by them with but little fracture of the crystal. One of these knives will reduce with ease 7 to 800 loaves per diem.

From the knife-house the sugar is frequently conveyed at once to the packing-house, and there packed for sale or shipment. A great portion of water however is still contained in it, and this renders it liable to loss of weight and deterioration of color on the voyage home, or if stored for any time in this country. Both evils are however avoided by giving it a partial drying in the sun, or by merely exposing it to the influence of a dry wind for a few hours before packing it.

Syrups.

While describing the routine of sugar making in the first instance, I have forborne to speak of the disposal of the syrups; not wishing to confuse thereby the simple detail of manufacturing sugar direct from the cane juice. In the old routine of West India sugar manufacture, all the drainings from the sugar were considered as molasses, and appropriated to the distillation of rum. Of late years however, some attempts have been made to extract a further portion of sugar from them in the West Indies, by re-boiling and crystalizing them, transferring the refuse of this second boiling only to the distillery. In Mauritius also, an inferior sugar is always made from the molasses. By adopting the use of bone charcoal however, the qualities of the molasses become no less improved than those of the original sugar, and they may accordingly be re-boiled, and sugar extracted without any doubt as to the advantages thereby resulting. At the same time it must be expected, that the quality of the molasses or syrup, with reference to the saccharine matter it is capable of yielding, depends greatly upon the character of the sugar from which it is derived: should the latter be of strong, well-formed crystal and light color, the whole of its drainings may be

re-boiled to advantage: on the other hand, should the original grain be small and ill-formed, and the color still high, notwithstanding the action of the charcoal, it is generally better to send the first runnings from such direct to the still-house, reserving only what is collected after the first magma is applied to be returned through the vacuum pan. But here again it is difficult to convey by written instructions what is best to be followed in practice; and the experience and judgment of the planter, after considering the quality of his molasses and the percentage of sugar he may expect to derive from it, can alone rightly determine him as to the advantage of re-boiling it. In lieu of simply re-boiling the molasses in the vacuum pan, it is frequently found more profitable to carry it to the cistern over the filters, and after diluting it to the consistency of 27 degrees of Baume with lime water, and heating it to boiling temperature, to pass it through the bag and charcoal filters before concentrating it again in the vacuum pan.

All syrup sugars require being concentrated to a higher consistency than original sugars, to induce the perfect formation of their crystal, and consequently occupy a longer time in the subsequent curing process: in very weak syrup-sugars the crystalization is sometimes not complete until two or three days after the cones are removed to the curing house, and the plugs should therefore be left in for that time and then removed. One to three applications of magma are then required to separate the molasses, and the whole curing will probably occupy 15 to 20 days. A stratum of pipe-clay is also frequently found useful in assisting the separation of molasses from weak syrup-sugars, and is the only part of sugar refining in which its use is now-a-days admitted: it is prepared by melting pipe-clay in water to the consistency of a smooth semi-liquid mud, and applying this to the depth of one inch on the surface of the sugar to be cured, previously smoothing the surface in the cone with a trowel.

An invariable rule to be observed in the treatment of molasses or syrups is, to re-boil them as quickly as possible after their separation from the sugar in the cone; their deterioration and consequent loss of strength in saccharine matter being very rapid if left to stand as syrups in this climate. A boiling should therefore be made as frequently as sufficient can be collected for the purpose, and should be passed through the vacuum pan after the ordinary sugar boiling of the day is completed.

I have heard it alleged by experienced sugar planters that by boiling the sugar, and subsequently its syrups, *free*, that is, by concentrating it less highly than is usually practised, the syrups retain such strength that their crystalization may be repeated until as small a proportion as ten per cent. only of the whole weight is left, incapable of further granulation, in the shape of molasses. I must confess, I have not obtained any thing like this result in practice in Bengal; though with very fine cane and adequate means of working I conceive it quite *possible* to be realized.

CHAPTER V.

ON THE EXPENCES OF MANUFACTURE, AND COST OF CANE SUGARS PREPARED BY THE EUROPEAN METHOD.

This, though last in order, will be considered by no means the least important chapter on the subject of cane sugar manufacture.

In Chapter II. it was shown, that the ripe cane could be delivered at the mill at a cost of Rs. 22-11-4 per beegah, or Rs. 15-2-8 per 100 maunds by weight: assuming this as the basis of our calculation, there remain to be added the

expence of labor and materials employed in the manufacture itself; and a proportion of the capital invested in the block, or machinery and buildings of the works, to represent the annual loss by their "wear and tear."

I shall commence by an estimate of the

Cost of the works.

The machinery I will assume to be all ordered from a good maker in England or Scotland, as the course generally preferred; though many parts, such as the malleable iron cisterns, evaporators, clarifiers, &c., may be as efficiently made in Bengal and at the same expence—or probably at less when all the charges of transit are included. Several vacuum pans have also been manufactured by Messrs. Jessop and Co., Engineers, of Calcutta, which are said to perform their work well, though I have not had an opportunity of proving this by my own experience. In sending home an order for machinery, some respectable makers should be selected, whose name would be a guarantee for its efficiency: great disappointment may thereby be prevented in the subsequent trial of its capabilities at the works.

The market value of machinery at home varies not a little in proportion to that of iron; and this is more especially the case with sugar machinery of the present day, in which this metal is principally availed of, in place of the more expensive copper and bell metal, which tended so much to swell the bills for such an investment a few years ago. In the following estimate a liberal valuation has been placed upon all parts of the apparatus as ordered from the best makers, and circumstances may frequently render the total sum here given susceptible of a very considerable reduction.

The size and arrangement of the requisite buildings I have already partly described, while detailing the successive steps of the manufacturing process; and the same will be found more clearly explained by a reference to the ground-plan of the factory, given at the end of this work. Native masonry is com-

paratively cheap in most parts of Bengal, and I need not enter into tedious details to demonstrate that the sum I have estimated under this head, 30,000 Rupees, will be found sufficient for all purposes, if due regard to economy be observed, and judgment be exercised, in adapting, to the purposes required, the peculiar building materials and means afforded by the district itself in which the works are situated, as far as may be possible, rather than import them at unnecessary and greater expence from distant parts of the country.

Estimate of cost of block.

2	Condensing engines, each 20 horse-power, connected with a 16 horse-power cane-mill, with duplicate pinions, spur-wheels, segments, &c., £ 1,700 each, ...	£ 3,400	0
8	Clarifiers, with steam-pipes and valves, £ 25 each, .	200	0
6	Evaporators, with ditto ditto, £ 30 each, ...	180	0
2	Evaporated juice-cisterns and 2 clear-liquor ditto, with pipes and brass cocks, £ 20 each; monte-jus or pumps, £ 20, ...	100	0
2	Juice-heaters over filters, £ 20 each; four 30 bags 6 feet bag filters, £ 20 each; four 12 feet charcoal-filters with pipes and brass cocks, £ 25 each, ...	220	0
	Charcoal-burning tubes, charcoal-mill, sieves, &c., ..	110	0
	A 7 feet vacuum pan, with 2 air-pumps, condense water pump and connexions, ...	750	0
	Four 30 horse-power steam-boilers complete, at £ 180 each,	720	0
	3,000 iron cones, at 4*s* 4*d*. each, ...	650	0
	Freight, insurance, packing and shipping charges, ..	200	0
	Total cost of machinery, ...	£ 6,530	0
	say at exchange of 2*s*. per Rupee, Co's Rs.	65,300	0
	Outlay on buildings, ...	30,000	0
	Ditto on erection of machinery	3,000	0
	Contingencies, say	1,700	0
	Total, ... Co's. Rs.	1,00,000	0
	Add interest on outlay during time of erection, say for 12 months at 10 per cent. per annum, ...	10,000	0
	Total cost of block, .. Co's. Rs.	1,10,000	0

The works after being erected should be kept constantly in good repair, and the current expence of doing this should be charged to the yearly account of manufacturing expences. In addition to this, I would charge to the annual crop of sugar, ten per cent. on the value of the block; the same to be set aside to compensate for wear and tear of machinery, or to replace any portion of it with any more improved means which the progress of invention may bring into use, so as to maintain permanently the efficiency and value of the works. This percentage gives therefore 11,000 Rupees to be added annually to the cost of the out-turn.

We can now bring together the various elements composing the cost of the cane sugar itself, and the result will appear as follows :—

Cost of cultivating and bringing to the mill the cane from 2,000 beegahs of land (see page 148), ...			45,417 8
Manufacturing expences, viz. wages for Native labor,			
Mill house, ...	87 Rs. per month.		
Clarifiers,..	32 ditto ditto.		
Evaporators, ...	26 ditto ditto.		
Total for each spell, ..	145 Rs. per month.		
which for 3 spells, gives ..	435 Rs. per month.		
and for the three months, a total of .. Rs.		1,305	
Proportion ($\frac{1}{6}$th) of cost of European superintendence to manufacture (see page 148), ...		1,842	
Ditto of general superintendence, engineer, and office charges, ...		1,500	
Carried over, Co's. Rs. ..		4,647	45,417 8

Brought forward, ..		1,617	15,117 8
Coals for 3 boilers of 30 horse-power, each of which will consume of country coal at the rate of 6 lbs. per horse-power per hour, or about 150 mds. per 24 hours. This for 75 working days, gives 10,250 mds., which at 3 mds. per Rupee, is			3,750
Quicklime, oil for lamps, oil and grease for engines, &c. &c., say 100 Rs. per month, for 3 months, ...			300
Total expence producing clarified syrup from cane, ...			8,667
Add expences of refining; including factory repairs, use of bone charcoal, drying and packing, at 1 Rupee per maund of sugar produced, which on 15,600 bazar maunds, as calculated at page 117, is		15,600	
Total expences of manufacture, ...			24,267 0
Interest on block 10 per cent. (see page 187), ..			11,000 0
Total expenditure, ...			80,714 8
Less value of molasses left 10,100 mds., at 8 annas per maund, ...			5,200 0
Net cost of 15,600 mds. sugar, at 4-13-6 per maund, ...	Co's. Rs.		75,514 8

Of this sugar, three-fourths the weight may be estimated as original, or once boiled sugar, at 5 Rs. 2 annas per maund, and one-fourth syrup sugar at 4 Rs. per maund, which will be found to give the same result as above in cost value. The former should be a strong-grained, free, bright-colored, and dry sugar, the color varying from light yellow to white, in

proportion to the success with which the manufacture has been conducted; and the latter of a bright gold or straw color, dry but of somewhat inferior grain to the former.

To the above estimated cost will have to be added the charges for conveyance to the selling market, and the commission or other charges to which it may be liable when arrived there. As its destination would probably be the Calcutta market, either for sale or shipment, the first mentioned expence will vary in proportion to the distance of the works therefrom, and the facilities of river communication: let us however assume 10 annas per maund as sufficient to cover all these charges, and we may then calculate on a total cost of Rs. 5-12 per maund for the first quality, and Rs. 4-10 for the second, delivered in Calcutta. The selling rate when arrived there it is impossible to estimate with any confidence, in times when the values of all sugars are subject to such violent fluctuations as we have recently witnessed; but taking the comparative selling rates of different qualities in the Calcutta market of late years as a criterion, the qualities above described would command about one Rupee per maund beyond the current value of first and second qualities of Benares sugars. Equal difficulty presents itself in the attempt to estimate any rate of profit on the investment; but it will, I think, be conceded, that I have shown good grounds for anticipating a handsome return on the capital employed.

I shall only say in conclusion, that I have been as careful not to *under*-estimate the expences on the cost, whether of the works, the cultivation, or the subsequent manufacture of the cane, as I have been not to *over*-estimate the weight and quality of the produce which may be expected from it. All who are acquainted with the ordinary rates of remuneration for native labor will be able to point out many districts in which most of the agricultural operations, and other expences attending them, may be performed for two-thirds to one-half the rates at which I have allowed them: and it will

be readily granted, that, in estimating the total weight, in sugar and molasses per beegah, the land is capable of yielding, at no higher than what is realized by good native cultivation, I have not been too sanguine in assuming what can be, and in fact frequently has been, obtained by the European planter. I firmly believe, that time and further experience will prove, that a considerable reduction is practicable on most of the items of expence set down in this and the preceding chapters, and that a proportionate reduction in the cost of the sugar may be expected.

I have not directly alluded to the saving which would be effected by working the factory for the nine months of the year it is not occupied on the cane-crop, as a refinery. It is hardly necessary to point out that three-fourths of the sum charged as "interest on block" would in this case be transferred to the refining account; and the consequent reduction of cost on the sugar-cane crop would thus be fully eight annas per maund.

CHAPTER VI.

ON THE CULTIVATION OF THE DATE TREE, AND MANUFACTURE OF SUGAR THEREFROM BY EUROPEANS.

This will be but a short chapter. The history of the subject is indeed an almost uninterrupted blank, and as a field for the future application of European skill and improvement, it may be considered as entirely unbroken.

The very existence indeed of such an article as date tree sugar appears to have been almost forgotten during the later periods of the East India Company's trade monopoly: though in former times occasional reference was made to it in the

correspondence between the Court of Directors and their Board of Trade in Calcutta. In 1793, we find that a shipment of "54 factory maunds" was consigned home by the latter; but the smallness of the parcel probably caused it to be overlooked, and the result of its sale is not recorded. In a Minute of the same Board's Consultations, dated 4th September 1792, we find the whole annual produce of date sugar in Bengal was estimated at 15,000 maunds. The cultivation was probably therefore in its infancy at this period; and its further cultivation was checked for the next quarter of a century, as well by the restrictions of the Company's monopoly, as by the high discriminative rates of import duty imposed on East India sugars by the home government. Previous to 1830 it certainly appears to have been unknown as an article of commerce in the home markets; though long previously used in Calcutta by the Native refiners, and as an article of Native consumption.

No means exist of tracing, with anything approaching to correctness, the yearly rate of increase in the production of date sugar since that period, nor of ascertaining its present extent. From an estimate I have made however of the quantities purchased for the European refineries, added to the amount of native refined sorts sold for export in the Calcutta market, under the names of *guryatta* and *dobarrah*, I have obtained the conclusion, that from 9,500 to 10,000 tons, or at least one-fifth of the whole annual quantity exported to England, is now comprised of date sugars.

The attention bestowed by Europeans of late years on the production of these sugars for the Calcutta or home markets, has been confined to the remanufacture or refining of the native raw material, such as khaur, *dulloah*, &c.; and for this purpose it has been deservedly held in very great esteem, producing a good colored and well crystalized sugar, and yielding a greater percentage in weight of refined goods than can be obtained of equal quality from the same weight and

class of cane sugars. On the other hand, the raw date sugars are more liable to deteriorate by being kept in store, losing both color and strength more rapidly than the former: this applies however to the raw products only; the refined or re-boiled sugars undergoing the voyage home, or being kept in store in India, equally well with those from cane.

The cause of the above-mentioned peculiarities appears to lie in the larger proportion of gluten present in date sugars; and the tendency of this substance to decomposition, when in contact with saccharine matter, seems sufficient to account for most of the characteristics distinguishing it from cane sugar.* These are no less remarkable in the molasses than in the sugar itself; that from date sugar possessing far less saccharine matter and being of much darker color than that from cane, which is probably caused by the gluten being partly decomposed by the lime and heat of the boiling process. Another distinguishing feature however, worthy of remark, is the absence in the date sugar of the empyreumatic oil, so observable in all cane produce, and which affords to the rum made from cane molasses its well known flavor.

On considering the low cost of date sugars as compared with cane, and the little trouble and risk incurred in rearing the trees, it seems, at first glance, remarkable that the European planter has not hitherto been induced to avail himself of this cultivation for producing sugar on a large scale. But great discouragements to the investment of English capital in this way no doubt exist in the uncertain and ill-defined nature of land-tenure in Bengal; the length of time the trees occupy in coming to their full bearing; as well as in the difficulty of collecting the juice for boiling into sugar by the

* Dr. Evans, at page 22 of his work on Sugar, remarks "If a little gluten obtained from wheat be placed in contact with a solution of cane sugar, and the mixture be exposed to a moderately high temperature, it becomes viscid and mucilaginous; its sweetness disappears, and on examination gum will be found to have occupied the place of sugar."

European method after they may have been reared. Yet these are drawbacks which will probably be overcome; and in one locality at least, in the Jessore district, a "date tree estate" has been commenced on a scale which must, in a few years, render it a valuable property to its owners.

In the chapter on Native date sugar cultivation, in the first section of this work, it was shown that the annual produce of a full grown date plantation was equal to 78¾ maunds of goor per Bengal beegah, which converted into khaur may be taken as equivalent to a yield of about 5½ tons of Muscovado sugar per English acre. The calculations given in the subsequent chapter on Native sugar manufacture proved;—1st, That date sugars could be produced at about two-thirds the cost of cane sugar, of equal quality;—2d, That the date crop involved little or no risk, and a comparatively small outlay in the cultivation; and lastly, that good white sugar could be produced therefrom, by Native methods, at a cost of Rs. 4-10-7 per maund, and fine crystalized ditto at Rs. 6-13-9 per maund, equal to 12*s.* 6*d.* and 18*s.* 3*d.* per cwt. respectively of English money, delivered in Calcutta. It does not form a part of my design in this work to treat on the art of sugar-refining in Bengal; otherwise it would be equally easy to prove, that by the application thereof to the Native raw date sugars, good white vacuum pan sugar can be, and is, produced at or within a cost of 5 Rupees per maund, or 13*s.* 6*d.* per cwt. delivered in Calcutta; and this with a fair profit to all employed in its production. Whether any reduction can be made on this cost, by the application of European means and machinery to the juice direct from the tree, and so converting it by one process into marketable sugar, is a problem which it remains for the future to solve.

Again let us look at the map, and trace out the tract of country within the bounds of which the date tree cultivation has hitherto been, with trifling exceptions, confined: at page 44 this tract was roughly measured at 130 miles long by 80

broad, giving a superficial area of 10,100 square miles. Let us suppose only one-twentieth part of this surface to become, in the course of years, set apart for date tree cultivation; and that the average produce be *one-half* of what has been calculated as the yield of trees in full bearing, which would allow 2¾ tons per acre per annum. The total annual produce of such a tract of cultivation, we shall find, will amount to 915,200 tons of sugar, or more than sufficient for the wants of all Europe.

Truly it needs not the gift of prophecy to foresee the continued, progressive, and rapid increase of this valuable cultivation; and that *should* the force of competition with sugars grown by the aid of slavery, cause the Bengal cane sugars to be undersold, and ultimately driven from our home markets, the date tree produce will slowly but surely increase, until it gradually supplies the void; for that the goodness of its quality and low cost of its first production must enable it to undersell the cane sugars of the whole world.

Part III.

ON MOLASSUS, AND DISTILLATION OF RUM.

CHAPTER I.

ON MOLASSES, CANE AND DATE.

Molasses is the residuum of the cane or date juice after the separation therefrom of all the crystalizable portion which can be economically obtained from it in the sugar works; where the great object is to separate the largest practicable proportion in the shape of the more valuable product: it contains in solution a greater or less amount of saccharine matter in proportion to the success which has attended the sugar manufacture; besides the gluten more or less decomposed, *and coloring matter, separated by the curing process.*

The word molasses is also applied to the syrups resulting from the re-boiling of Native raw sugars, by both Native and European refiners; though this, as well as that from the original cultivation, is known amongst the Natives by various distinguishing names, applied to the different qualities of both cane and date origin.

Molasses is very largely and universally consumed by the Native population of India,—principally in the manufacture of their sweetmeats, of which all castes and grades of Native society are extremely fond. It is probable indeed, that since the rise in value of Indian sugars, caused by the legislative

changes of the last ten years, molasses, as the cheaper material, and consequently more within the means of the poorer classes of Natives, of which the great mass of their population consists, has come into very general use in Native confectionary; and that its consumption has, in this way, greatly increased, as a substitute for the sugar, placed by the circumstances alluded to beyond their means to afford. The coarser kinds are largely consumed in the preparation of Native *hookah* tobacco,—and to mix with the mortar of their buildings; as well as to some extent in the Native distillation of spirits.

It follows from these causes, that in most parts of Bengal there exists a certain market for all the molasses that can be produced; the demand being extensive or limited in proportion to the distance from or contiguity to the great marts and bazars for interchange of this and other descriptions of Native produce. Between most of the large Native markets in the sugar districts to the eastward of Calcutta, where water-carriage is always available, and between these and Calcutta itself, a large and important trade is constantly carried on in this material. In these districts it is generally boiled to a very stiff consistency, to reduce its weight and bulk for transport, and filled into earthen jars holding from a maund to a maund and a half weight each; and these are neatly stowed in tiers, supported by bamboo shelves one over the other, in the boats in which they are conveyed. A stranger passing through any of the great river highways of Native traffic, in the districts above referred to, is surprised at the number of these cargoes he meets in his progress. The value in the up-country marts varies very much, though it very seldom falls below eight annas per maund, or rises above 2 Rs. per maund; on the average of the last ten years, it has probably realized about twelve annas per maund.

The trade with Calcutta, and the consumption there alone, must be very large, though no satisfactory means exist of

ascertaining its extent there or elsewhere. In addition to the native consumption, there are in its vicinity 7 or 8 distilleries on the European plan, unconnected with sugar works, which alone create a steady demand for the article to a certain extent.

Many of the Bengal districts are not, however, so favorably situated, with respect to water-carriage, as those above alluded to; and enjoy that advantage for two or three months of the year only, during the rainy season; and as the conveyance of such an article as molasses by land-carriage is both troublesome and expensive, even where good roads are maintained,—a blessing very rare indeed throughout Bengal,—the traffic in this article is in such cases extremely limited, and its current price in consequence falls very low during a great part of the year. In such localities good cane molasses is very frequently procurable at 4 to 6 annas per maund, and 8 annas may be considered a fair average price.

From the circumstances above stated it will be seen, that the position of the Bengal planter may frequently differ considerably, with respect to the disposal of his molasses from that of his contemporary in the West Indies; and that especially if his works be favorably situated for water-carriage, a distillery does not form an *indispensible* adjunct to his sugar estate. On the contrary, it will probably in such cases be more to his advantage to confine his attention to his proper calling as a sugar planter, and to rely on his opportunities of disposing of his molasses in the best and nearest market. The skimmings from the clarifiers and evaporators may also be disposed of in the same manner, previously reducing them by evaporation of their water to the consistency of molasses, and removing their grosser impurities at the same time with the skimmer.

Of late years considerable shipments of East India molasses have been made to the home markets, and have been attended with more or less success: the means of effecting

this, as regards casks and good cooperage, are always available in Calcutta; and at times when the rates of homeward freight are moderate, it may frequently form an advantageous outlet for disposal of this commodity.

In many parts of the country however, it may happen that the sugar estate is so situated, that water or other communication with places of general traffic is difficult or impracticable during the greater part of the year. In such case, storing the molasses until the river communication becomes open is both wasteful and inconvenient; and even when of a considerable density it is liable to absorb moisture from the atmosphere, and its saccharine qualities to become very soon affected by a fermentative action. Add to this the difficulty of storing it at all without considerable loss by leakage, except in metal vessels or tanks, and the loss of interest on its value while in store; and it will be evident that its being so held to await a market could hardly in any case be recommended. The proper remedy in such cases is to have a distillery attached to the works, in which the whole residue from the sugar, whether skimmings or molasses, may be converted into spirit, as quickly as possible after its separation from the sugar.

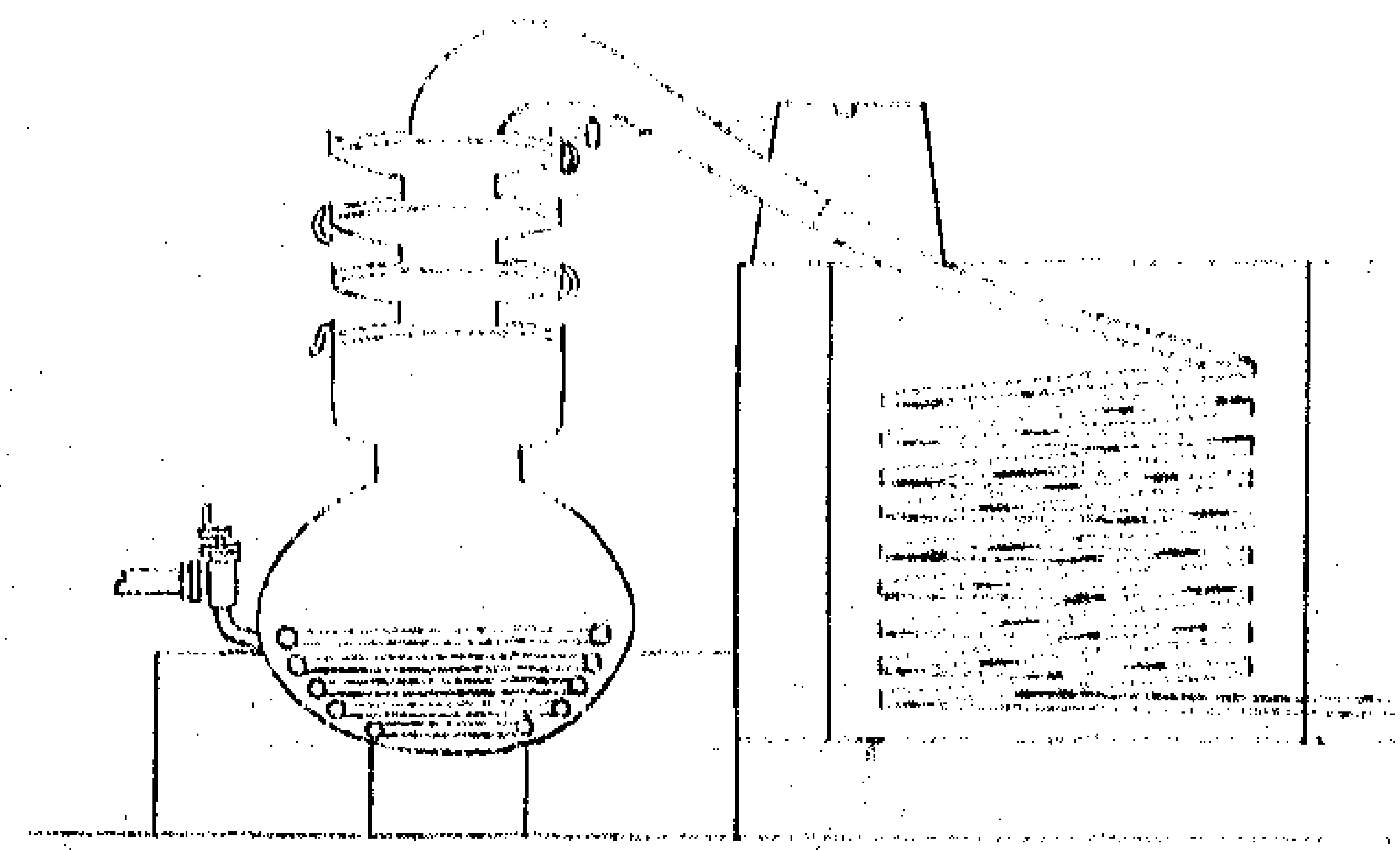
CHAPTER II.

ON STILLS AND THE DISTILLATION OF RUM.

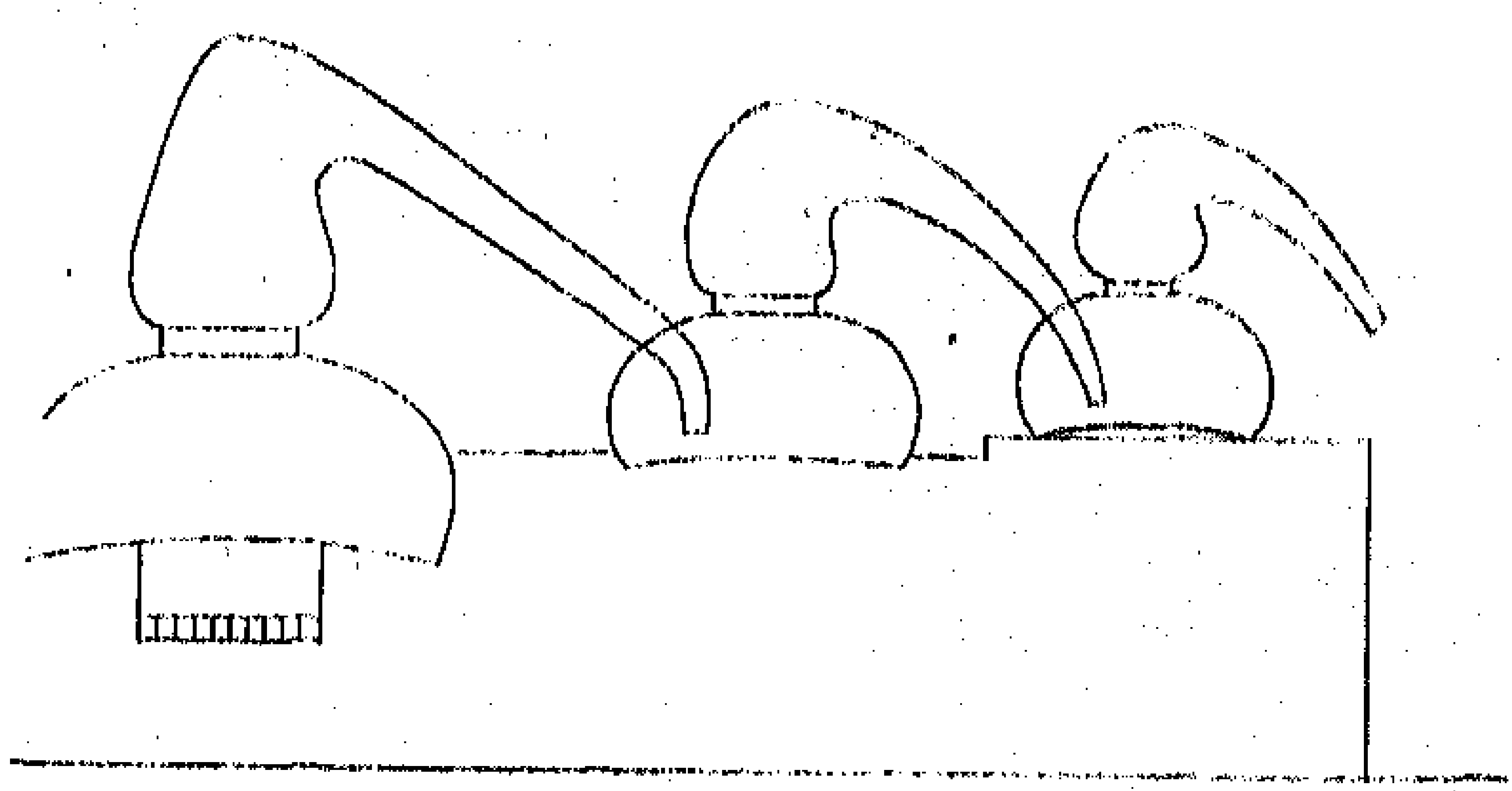
HAVING decided on erecting a distillery in connection with his sugar works, the planter will next have to determine what description of still is best suited to his wants; and the capacity it will require to be of to work off the molasses he is likely to make. The stills most in favor in India

Scale 8 Feet to an Inch

PLATE III.



SHEARS'S STILL WITH STEAM WORM MODIFICATION.



COMMON STILL WITH DOUBLE RETORT.

Stapleton lith. 4 South Road Entally

and our other Colonies, are—1st, Shoares' patent disc still —2nd, the common still with double retort—and 3rd, the Coffey's patent still. I have given a sketch of the two first,* which are however too well known to need particular description here. The Coffey's still has many admirers; but I consider it too complicated and likely to get out of repair to suit the wants of an Indian distillery, where every thing should be chosen for its simplicity, and the facility with which it admits of being cleaned and repaired. Either of the two first named possesses these recommendations; though I am inclined to accord the preference to the Shoares' patent, constructed with four discs, as by the latest improvement, and heated with a steam worm in lieu of a common fire applied underneath it. The advantages afforded by the latter improvement, consist in the facility with which the still can be emptied and re-charged, without the necessity of drawing the fire and the consequent loss of heat and fuel; the great nicety with which the temperature, and strength of the spirit coming over can be regulated at pleasure; and the greater cleanliness and durability of the still from having the fire at a distance instead of acting directly upon it. In the ground-plan of a sugar factory, as given with this work, it will be observed that the still is so placed that steam can be readily and conveniently availed of for heating it, from the general steam main over the boilers which supply the sugar-house; thus saving the necessity for any separate fire or boiler. There being a partial vacuum in the still during the progress of the distillation, no great pressure of steam is ever called for, and 5 to 7 lbs. per square inch is the utmost required.

One defect however exists in the Shoares' apparatus, which seems to require a remedy ere it can be placed on a level, in the economy of its work, with some others of the patent stills. I allude to the great loss of heat in the water which is carried away to waste after passing over the discs

* Plate III.

of the still head. The temperature of this water varies from 180 to 200 degrees Fahr., and an obviously economical application of it might be contrived by conducting it through a copper worm placed at the bottom of a "wash-heater," or separate close vessel fixed so as to command the body of the still, and of the same capacity as the latter. It should be furnished with a small goose-neck, connecting it with that of the still itself, to carry over any small quantity of spirit which might rise in vapor by the partial heating applied to its contents; and with a large stop-cock for the purpose of discharging the whole of them into the main still, as soon as the latter had run off the preceding charge. Thus the heat of the dise water would be imparted to the fresh charge of wash, the temperature of which would be raised to near its boiling point before its introduction to the still; and three or four charges might probably be distilled in the same space of time now occupied by two: or an equal saving might be gained by an 800 gallon still, performing the same work which now requires one of nearly double that capacity. The additional expence of the "wash-heater" would be comparatively small, as a well coopered wooden vessel would no doubt answer the purpose well. As I intend this for a *practical* work, I will not offer further theory in favor of this modification, though I regret I have not had an opportunity of proving its advantages by a trial. I must not however omit to mention, that in Messrs. Shearer' specification of patent, this very plan of a wash-heater and coil of pipe is set forth; but with the addition of the goose-neck also passing through the same vessel ere it passes on to the pewter condense worm: but I have never been able to learn why this part of the original scheme is never carried out in practice.

One Shearer' still of 1,500 gallons' capacity, working only two charges per diem, would be found amply sufficient for the purposes of a sugar estate of 2,000 beegahs. It should be

set high enough to allow of a good sized cask being placed under the discharge-pipe at the lower end of the condense worm, to receive the spirit as it flows over; and should be placed in a high and well ventilated building. In the plan I have given, the cold water for condensation is meant to be supplied, both to the worm and dises, by the steam-engines; the cold water pumps attached to which might be made of sufficient capacity for this supply in addition to the requirements of the sugar-house. It would be convenient however to have a hand-pump in addition, of sufficient power to supply the wants of the still, when required to work the latter out of crop time.

Preparation of the Wash.

The vessels in which the fermentation is conducted are round wooden vats, for which the most convenient size is that corresponding with the capacity of the still itself, the contents of each vat being equal to a full charge of the still. The staves and covers may be economically made of the red *jarool*, a cheap and common wood in most parts of Bengal, and sufficiently durable for the purpose: for the bottoms, which require more strength and toughness, *saul* plank, two inches thick, answers well; though there are doubtless other woods procurable in different parts of the country which would equally suit the purpose. Good native coopers will make up these materials very efficiently and at a comparatively trifling expence.

The vats should be raised on timbers, supported at intervals by masonry, 1½ to 2 feet from the floor, and having the same in clear space around each, so as to leave room for the wash and foul-water gutters below their base level; as well as for repairs to every part when such may be required. The plan of sinking the fermenting vats in the ground, which has been recommended, though I have never known it tried, I consider quite unsuitable to India, where all timber in

contact with the ground is so liable to destruction by white-ants and other vermin; and the difficulty in repairing any leakage, or even of detecting it, in vessels so placed, would probably occasion considerable loss before a remedy could be applied.

The fermenting house should be dry, and as much as possible open to the air and light, so that its cleanliness and the progress of the fermentation may be easily ascertained at all times. The very common apprehension of exposure to the atmosphere checking or injuring the fermentation is, I believe, quite unfounded, or at least as regards Bengal. The vats therefore merely require protection from the sun and rain, for which ends a light sloping roof, supported on walls 18 inches thick, and built with large open arches at frequent intervals, will answer all the purposes required.

As the rules to be observed in the preparation of wash from cane and from date molasses differ considerably, I shall describe each separately.

Cane Molasses is far more productive in its yield of spirit from any given weight than date, owing no doubt to the less gluten and larger proportion of saccharine matter contained in it. The economy of the distilling process depends greatly on the degree of density at which the wash is set for fermentation. The quality and density of the molasses itself varies so greatly, that the only sure guide in mixing wash is the saccharometer; and that made by Bates of London is the one in most frequent use, as well as deserving of every confidence. It is furnished with a thermometer and tables, showing by a scale graduated to each degree of temperature, the percentage of sweets present in any mixture of molasses and water: so that with its aid the wash can be set to contain any required proportion of sweets.

In the West Indies this useful instrument appears to be unknown; the universal practice being to allow a certain proportion of molasses and skimmings by *measurement* in each

100 gallons of water or lees. Porter, in his work on Sugar, gives as the Jamaica receipt, 6 gallons of molasses and 36 gallons of skimmings in 100 gallons of wash; and as 6 gallons of skimmings are held to be equal to 1 gallon of molasses, this gives 12 per cent., by measurement, of sweets. He also informs us that a common proportion in the West Indies is 10 gallons molasses, and 30 gallons skimmings in the 100 gallons wash, giving by the same rule 15 per cent. of sweets. But as before observed, the specific gravity of molasses, as well as no doubt of the skimmings, varies so greatly, that the above rules can afford no sure guide as to the actual density of the mixture. Assuming however the density of their molasses to be 40 degrees of Baume's scale, as a fair average, the percentage of sweets by the two rules above given will be found to stand at 16½ and 20⅔ per cent. respectively. In this computation however, I have not included the lees or "dunder;" that is, the spent-wash or refuse of former distillations, which it is usual to mix in place of the water to the extent of 20 to 50 per cent., by measurement, of the entire wash. Some planters hold that this dunder contains some portion of undecomposed sugar, and that this being brought into action by the new fermentation thus increases the product in spirit. This however can only happen in some cases where the previous fermentation has not been properly completed; and I am of opinion that it possesses virtues independent of this, in its power of destroying the viscidity of the new mixture, and supplying the fermenting principle to it, and thereby aiding the rapidity and completeness of the new action.

I have given the above instances of West India practice,—which though quoted from an authority of nearly 20 years' standing, are still applicable to the present day,—as confirming the results of my own experience, which have proved that a density of 18½ per cent., which is about the mean of the two West India examples, of good molasses, corres-

ponding to a specific gravity of 1075 at the temperature of 82 degrees Faht., affords the best rule for preparing the wash, if the object be solely *the obtaining the largest possible produce in spirit* from the molasses or skimmings to be distilled. The fermentation of such wash would be complete in 8 to 12 days, the time varying with the season of the year, and the ordinary yield should be 5½ to 6 proof gallons old wine measure from each maund of molasses of 40 degrees of Baume.

What I would next point out to the Indian distiller, however, is, that the more extracting of the largest possible yield of spirit from his molasses may not in all cases be the most profitable course for him to pursue; but that the expence in fuel and labor at which this is effected should also enter into his calculations when seeking the best means of producing good rum *at the lowest possible cost per gallon*; which, it will be readily conceded, is the main object he should have in view. It will be found that by setting the wash *richer*, that is, at a considerably greater density than usually practised, and as described above,—the result will be, that though a somewhat smaller yield in spirit from the maund of molasses may be realized, this will be more than compensated for by the larger quantity of spirit obtained in a given time from the same still, and at about the same expenditure of fuel and labor, as was required for producing the smaller quantity from the weak wash.

As this is a part of distillery economy which I have not seen adverted to in my works on distillation, and is, I believe, little understood by the Colonial planter, I shall enter somewhat further into the calculation to explain its peculiarities more clearly.

It will be found then, that by setting the wash at a density of 24 per cent. by weight of sweets, corresponding with a specific gravity of about 1100, thermometer 82 Faht., the fermentation will occupy from 18 to 22 days, according to

the state of the weather, and the produce in spirit will probably average 5 to 5½ gallons from the maund of molasses; or at the rate of half a gallon less yield than from the same molasses with the wash set at 18½ per cent. density. The small loss in yield probably arising from the whole saccharine matter in solution not being perfectly converted into spirit, owing to the large proportion of alcohol checking the fermentation during its later stages. Any distiller may prove the truth of this by his own experiment, as I have frequently done. It may be useful here to mention, that the fermentation, in wash at high densities, is much aided by thoroughly stirring up with an oar the contents of each vat once every morning. Let us now compare the results of a month's work with wash of each of the degrees of density alluded to.

Experiment with wash at 18½ per cent. density, working for one month, with a 1,500 gallon still, taking 2 charges daily, will be found to consume 2,142 maunds of molasses at the density of 40 degrees of Baume, for a working month of 25 days; thus:—

2,142 maunds molasses, at 8 annas, is				1,071	0 0
Coals for a 20 h. p. steam-boiler, at 6lbs. per h. p. per hour, for 14 hours gives 20⅔ maunds per day; or for 25 days 512½ maunds, which at 3 maunds per Rupee, is				170	13 6
Labor—1 mistry per month, ...	7	0	0		
1 mate ditto ditto, ...	5	0	0		
12 coolies for wash-house, at 3 Rupees, ...	36	0	0		
8 pump ditto ditto, ...	24	0	0		
General superintendence, say	50	0	0		
Repairs, ...	10	0	0		
				132	0 0
Interest on block for wear and tear, 10 per cent. on 25,000 per annum,—per month, ...				208	5 4
				511	2 10
Total cost, ...				1,582	2 10

which sum divided over 11,781 gallons, the total yield for the month, at the rate of 5½ gallons per maund of molasses used, gives a cost price of about 2 annas 2 pie per gallon.

Experiment with wash at 24 per cent. density, sp. gr. 1100, working with two charges per diem with a 1,500 gallon still, and for a working month of 25 days, will be found to require 2,924 maunds of molasses of 40 degrees of Baume; thus:—

Molasses 2,924 maunds, at 8 annas per maund,						1,462	0 0
Coals as in the last calculation,				170	13 6		
Laborer—1 mistry per month,	7	0	0				
1 mate ditto,	5	0	0				
14 coolies for wash, at 3,	42	0	0				
8 pump ditto ditto,	24	0	0				
Repairs and general superintendence,	60	0	0				
				138	0 0		
Interest on block for wear and tear as before,				208	6 4		
					517	2 10	
Total cost,			Co's. Rs.			1,979	2 10

which divided over 14,620 gallons, the produce of 2,924 maunds of molasses, at 5 gallons from the maund, gives a cost price of 2 annas 2 pie per gallon, the same as in the first experiment.

It will be found from this, that without any diminution in the actual cost of the rum, one-third more molasses has been converted into spirit in the second experiment than in the first, and in the same period of time; and if the rum is being made to a profit, a proportionate increase in the monthly returns of the distillery will be the result.

It is scarcely necessary to point out, that in cases where the cost or value of the molasses is *lower* than that given in the above examples, the greater proportionate profit will result from the practice of setting rich, as in the second ex-

periment: though on the contrary, when it becomes considerably higher than 8 annas per maund, the weak wash process will be found more economical.

Date Molasses, as already remarked, is far less rich in saccharine matter than cane; its place being supplied by a larger proportion of glutinous and other matters which do not afford spirit in distillation. This poverty of saccharine matter is greater the more frequently the sugar from which it is derived has been re-boiled; as well as in proportion to the length of time it has been kept in store, depreciating from this latter cause more rapidly than that from cane: 4 gallons of proof spirit from the maund is a good average yield from date molasses, and inferior qualities will frequently not yield more than 2½ to 3 gallons.

In preparing the wash with date material the use of the lees is dispensed with, it appearing rather to obstruct than hasten the fermentation: this is no doubt attributable to the excess of gluten already referred to; which seems also to originate the acidity so generally found in the wash, and which is frequently detected in the rum distilled from date material. It is often so excessive in old date molasses as to impede the fermentation unless neutralized; and for this end chalk will be found an invaluable remedy, and I would recommend its always being used with date wash. As soon as the fermentation appears to get sluggish, which may be after the first week, about 2 lbs. of chalk should be pounded, dissolved in a little water, and mixed into each vat by stirring freely, when the fermentation will immediately re-commence; and this should be repeated after another interval of 4 or 5 days. It seems to act by the lime in the chalk having a greater affinity for the acetic acid of the wash than for the carbonic acid with which it is combined, and neutralizes the former at the same time that it sets the latter free.

As no skimmings are available for date-wash, the molasses alone is used; and this should be mixed rich, that is, at least

of 23 to 24 per cent. density; for little or no increase of yield from the weight of molasses will be gained by mixing it in a poorer wash.

Cost of Distillery.

The following is an estimate of the probable cost of a Shearer' 1,500 gallon still, worked by steam, with buildings and fermenting vats complete, in Bengal.

Cost in England of still and discs, pewter worm, steam-worms, and all fittings complete,..	£ 1,100	
20 h. p. steam-boiler and fittings, ...	150	
Cold water pump, wash-pumps, pipes, &c &c, . ..	150	
Freight, insurance and charges, ...	120	
	£ 1,520	
Exchange at 2s. per Rupee, is .. Co's. Rs.		15,200
Building still-house, worm vat, and rum store, Co's. Rs.	1,000	
Vat house, ...	800	
Thirty-six 1,500 gallon fermenting vat, at 80 Rs. each, and 1 mixing ditto 100, ...	2,980	
Three *saul* wood rum vats, 2,000 gallons each,	900	
Erecting still, boiler, pumps, &c., . ..	700	
Contingencies, ...	548	
		7,528
Total, ... Co's. Rs.		22,728
Add interest on money invested during time of erection, say 22,500 Rs, at 10 per cent, ...		2,272
Total cost, . .. Co's. Rs.		25,000

General Remarks.

Great cleanliness is essential to successful distillation: the inner surface of the body of the still should be well scoured at least once a week, every fermenting vat should be thoroughly washed and cleansed from all sediment after each charge is run from it, and all the wash-gutters should be frequently cleaned; and covering them with a coat of

white-wash at the end of every week, tends greatly to preserve them and prevent acidity.

The color for the rum is made very simply, by evaporating a thick solution of coarse sugar in an iron cauldron holding 2 or 3 maunds, until a charring action commences, the sugar becoming of a very dark brown hue, and throwing up large bubbles; it should be continually stirred during the boiling to prevent its actual carbonization by adhesion to the iron vessel; as soon as the process is sufficiently advanced, the cauldron is removed from the fire and its contents poured into a large bucket of rum, with which it is as once well mixed by stirring before any part can become solid by cooling. A portion is then stirred into the rum to be colored, gradually, until the required depth of shade is attained.

Not the least important part of the business connected with a distillery is the procuring good casks in which to convey the rum to its destination for sale; and the more especially if it is destined for consignment to the home markets. The hogsheads in which beer is imported in large quantities from England are very generally availed of for this purpose, but are not nearly so efficient as perfectly new casks are found to be: the average loss by leakage from them being seldom less than 6 per cent. on the voyage home, and it is frequently double that rate; whereas, with good new casks the loss in this way being very trifling, and in many instances inappreciable,—and as it must be remembered, that the freight and other charges fall equally upon the full and upon the partially empty casks,—it will in the end be found the more economical plan to depend entirely upon new ones of the best make alone. By ordering red oak staves from America, they can be made up in this country at a comparatively moderate cost; that of a puncheon of 125 gallons being not more than 6 to 7 Rupees, every charge included.

Part IV.

ON THE SUGAR STATISTICS OF THE BENGAL DISTRICTS.

In this last section of my work, I purpose throwing together such information as I have been able to gather relative to the sugar producing capabilities of the districts of Bengal. The materials availed of for this task have been gleaned—1st, from information scattered through various publications, which will be found occasionally referred to in the marginal notes—2ndly, from local information contributed by friends in various parts of the country, and—3rdly, from notes founded on local enquiry, collected at various periods over the last 16 years in the principal sugar districts.

It is hoped, that however imperfect and undigested a mass of facts collected from such casual resources must prove, the perusal will not be without interest to the merchant; as well as to the friend of Indian progress in civilization, who sees that the latter must go hand in hand with the advance of her commerce; and that it may prove useful in directing to the choice of a favorable locality the future capitalist who may enter the grand and still promising field of Indian sugar production.

The districts subject to the regular government of the Bengal presidency, and comprehended under the title of its "Intra-regulation provinces," are 36 in number, and these are distributed into seven "Revenue Divisions," each having its revenue and finance management under the superintend-

ence of a distinct officer styled the "Commissioner of Revenue;" and as the districts in each of these "Divisions" are not inconveniently grouped together with reference to their general character and productions, I shall avail myself of the arrangement thus afforded, to refer to them in successive order.

The following are the names of the Divisions, with the districts included under each:

Patna Division, ...	Shahabad, Patna, Behar, Sarun.
Bhaugulpore Ditto, ..	Bhaugulpore, Dinagepore, Monghyr, Purneah, Tirhoot, Maldah.
Moorshedabad Ditto, ..	Moorshedabad, Buggoorah, Rungpore, Rajshahye, Pubna, Beerbhoom.
Dacca Ditto, ...	Dacca, Furreedpoor, Mymunsing, Sylhet, Backergunge, Cachar.
Chittagong Ditto, ...	Chittagong, Tipperah, Bullooah.
Jessore Ditto, ...	Jessore, 24-Pergunnahs, Burdwan, Hooghly, Nuddeah, Bancoorah, Baraset.
Cuttack Ditto, ...	Cuttack, Balasore, Midnapore, Khoorda.

In September 1846, the Bengal Chamber of Commerce petitioned the Government of India to procure for them, through their Revenue officers, "a statistical return of the "quantities of lands cultivated both in Bengal and the North-"Western Provinces, for the growth of cane and date goor "and sugars, and the probable consumption in each dis-"trict;" and the Chamber state their object in this application to be "to ascertain the capabilities of the Indian soil for ex-"tending the cultivation of sugar at a cost which could com-"pete in the home markets with the foreign slave and free "labor sugar, the prohibitory duties on which were removed "by 9 and 10 Vic. Cap. 63." This application elicited in due course a return from the Indian Government, prepared

from the reports of the Revenue officers throughout India, of the sugar production of the four presidencies, and embracing a mass of valuable information, though evidently mixed up with numerous errors in its details: these documents have recently been published by order of Government, and as I shall have occasion to refer to that comprising the Bengal return in the course of my observations on the produce of the several districts, I have given it in the Appendix to this work.

Patna Division.

SHAHABAD.

This is the first named district in the Patna division, and extends 117 miles along the left or western bank of the river Soane, which forms the boundary dividing it from Patna and Behar districts. On the north and west it is also bounded by the Ganges and Kurumnassa or Dumra rivers, which leave a rich alluvial deposit on their banks during the annual inundation, and render them more valuable for agriculture than those of the Soane, which are remarkable for the predominance of sand. It contains 4,087 square miles, of which 2,207 are occupied by fields, plantations, gardens, and houses.* There is also a great deal of very fertile land under the steep sandstone hills which occupy the southern portion of the district, and in the picturesque valleys which penetrate between them. The sugar-cane is indigenous, but the cultivation on the highlands labors under disadvantage in consequence of the dry nature of the soil, and the hot winds which are severe for some months, and render laborious irrigation necessary for most crops: its cultivation would appear to have increased considerably of late years, inasmuch as both goor and refined sugar were formerly articles of import for the consumption of the district:† whereas in the recent Govern-

* Rushton's Guide, 2nd series, Vol. II., p. 209.
† Ditto Ditto, p. 250.

ment report* the annual crop is now estimated at 643,902 maunds of goor, of which nearly one-half is calculated as available for export.

The descriptions of cane cultivated are the common yellow country, and the Baar-*ook*, or alluvial cane; there seems little doubt that the latter is identical with the China cane, which it resembles not less in its appearance than in its hardy nature, withstanding the attacks of white-ants, jackals, draught, and excessive wet. It is grown on the *churs* or low lands of the Jumna and Ganges Rivers, where it has been known to continue for two months, more than half submerged by the inundation without sustaining injury; nevertheless it is not esteemed by the natives, who consider its produce in sugar inferior. The Otaheite cane has also been grown near Buxar.

Sugar refining seems still unknown here, and all the goor is of an inferior quality, arising from the rude way in which it is prepared. Buchanan states, that in his time *cheenee* and *shuckur* were imported from Mirzapore, and this is probably still the case to some extent.

As there seems a great part of the land suitable for cane, and the district has the advantage of an open river communication throughout the year, the cultivation will no doubt continue to increase. The mineral resources of the southern portion are very rich, and amongst them limestone and chalk are abundant.†

Patna.

This district, which contains 1,898 square miles, is bordered on the north and west by the Ganges and Soane Rivers. The alluvial lands near the banks of the former are very rich, and command high rents; and the soil throughout the district is more or less fertile, producing some of the finest

* See Appendix.

† Asiatic Society's Journal, No clxxvi., p. 270.

grown crops in Bengal; especially rice, which is largely cultivated. The inland tracts are the best adapted for cane cultivation, which has been steadily increasing of late years. Formerly very little was exported, and the quantity now available for external wants estimated in the Government report at more than two lacks of maunds, and the rate of yield in goor per beegah estimated at bazar maunds 18-0-1, are indications of rapid improvement in the culture. The internal consumption is no doubt very large, the population being numerous, and comprising many wealthy inhabitants.

Native sugar refining is not practised in this district.

Behar.

The general appearance of this district is flat, though interrupted by several clusters of hills; and these and sandy plains occupy, on the whole, no small portion of its surface. The remainder however, is fertile and well cultivated: cane sugar forming one of its staple products.

The cane seems always to have formed an article of cultivation to a certain extent. Buchanan in his statistical survey, 1808-10, estimated the cultivation of Behar and Patna at 20,000 beegahs annually, and says that six different varieties were cultivated. He gives the rate of produce at 10 to 12 maunds of goor per beegah, compared with which the estimate in the recent Government report, would augur a great improvement in the cultivation having since taken place; it being therein estimated at bazar maunds 18-2-7 per beegah, being in fact the highest rate of produce given for any district in Bengal with the exception of Pubna.

The *Pooree* appears the variety of cane principally cultivated; well water is in use for irrigation, and the sediment from tanks and water-courses is in favor for manure. In some parts the canes yield a rattoon crop, and although the latter is said to be very inferior, the general fitness of the soil for the cultivation may be argued therefrom.

The Ganges is the only navigable stream available for exporting the produce of this district; with the exception of the Soane during two or three months of the year: but the Bonares or Great Trunk road, and the branch road connecting the latter with Patna, pass through the heart of the district, and have no doubt contributed greatly to the improvement of its resources. Were these roads kept in good repair, so as to allow of an easy communication with Calcutta by carts throughout the year, much further encouragement for the extension of cane cultivation would be thus afforded.

Sarun.

This is the most northern part of the ancient province of Behar, and reaches from the Nepaul frontier to the Ganges, which forms its southern boundary. The country is very flat, and the soil naturally moist and fertile, being free from the excessive hot winds which parch the more western and southern districts: it is intersected by numerous hill streams which afford irrigation: of this however, little is ever required. The inhabitants are tall and robust, and the country populous; the southern portion is healthy, and the northern parts seem only to require more clearing and general cultivation to obtain the same character. This would be one of the finest and most favorable districts for cane cultivation were the means of communication with the interior improved. The southern portion is in a high state of cultivation, and in the northern part the same seems only checked by the greater difficulty of transporting produce to the Ganges, which is the only navigable river, except in the height of the rains; and even then the danger of navigating the hill streams which become open, discourages their use for valuable cargoes: good roads communicating with the interior would tend greatly to the increase of cultivation and trade.

So far back as 1792, the land under cane cultivation was ascertained to be 16,818 beegahs, from which both sugar

and goor were exported after supplying the wants of the district.* A considerable export trade in white sugar is now carried on at Chupra and Revolgunge, part being derived from this and part from Gorukpore district, where the cultivation is also much increased of late years:—these sugars are made by a similar process to that of the Ghazeepore *pucka cheenee*, which they very much resemble.

It may be remarked, that the date tree seems almost unknown throughout the districts of the Patna division.

Moorshedabad Division.

Moorshedabad.

The Bhagarutee River divides this district into two parts; of these the eastern half is almost entirely alluvial land; the western division is also low, and nearly the whole district is subject to an annual inundation from the river, or to being flooded by heavy rains; the exceptions being the elevated spots where the sites for the villages are chosen, and some parts near the range of low hills near the western boundary of the district: these hills are covered with low jungle, and abound with game. In such a country the sugar-cane could not be expected to thrive, and the principal cultivation is paddy. What little cane is grown is small and stunted, and goor only is made from it. The sugar consumption of the district is supplied from Beerbhoom and the Upper provinces.

Buggoonah.

Like the last-named district, a river, the Kuratton, divides this into the eastern and western parts; and these differ widely from each other in soil and productions, and to some extent in climate. The country east of the river is almost entirely alluvial, and appropriated to the cultivation of rice,

* 1st Appendix to Report on Sugar Trade, p. 169.

jute, and indigo, and the greater portion of it lies subject to annual inundation. In the Western Division the land is higher, and supports the cultivation of mulberry, cotton, *aumun* rice and sugar-cane. The latter is principally confined to two thannahs, called Loll Bazar and Gobindgunge, which lie north-west from Buggoorah station; in these it thrives well, the soil being a rich clay, and retentive of moisture, and the goor made from it has a strong bold grain. This cultivation might no doubt be very much increased, as a great portion of this quarter of the district is still covered with jungle, and subject to the depredations of wild hogs, deer, and buffaloes which harbour therein; and these parts need only to be cleared to increase the space for and remove many impediments to the cultivation.

At Nodapara, formerly the site of one of the East India Company's silk filatures, an extensive European sugar factory has been established for refining the native raw sugars of this and the adjacent districts; and the demand which this will create will no doubt induce a considerable increase in the breadth of cane cultivation within its influence.

Rungpore.

This has been for many years a district noted for its sugar-cane produce, and was one of those selected by the Bengal Government in 1792 for their practical experiments in sugar manufacture. At that period the quantity of land in sugar-cane was reported to be only 6,511 beeghas; but it was also stated, that large quantities of goor were imported from the neighbouring district, Dinagepore, to be manufactured here into sugar. The *Kajoolee* was the only variety of cane cultivated, and on this much attention was bestowed in the ploughing and manuring of the land, and the tying up of the canes. No irrigation was ever required, but a remarkable peculiarity, which has not been noticed in the cultivation of any other district, was, where the ground was relatively low,

the cultivators were accustomed to raise artificially the portion intended for planting cane 4 or 5 feet above the level of the adjacent lands;—a sufficient proof that they rightly understood the importance of thoroughly draining their cane fields. The mill always used was the pestle and mortar kind.*

The *Kajoolee* cane is still the kind principally cultivated, but the *Pooree* is also met with, and the Bourbon variety has been introduced of late years and is said to thrive well. The goor and khaur are of good color and fine strong crystal,—not surpassed indeed by any in Bengal. They appear to be spoiled however by the unskilful manufacture of the natives in converting them into *pucka cheenee*, what they produce being of a weak, small grain, very deliquescent, and seldom of so good a color as the Ghazeepore sugars, which they seem intended to resemble. This manufacture has been practised in the district for many years, and it was formerly brought to Calcutta under the general name of Goraghaut sugar, in common with that of Dinagepore. A very valuable improvement might be adopted by the native manufacturers transferring to this district the system of *pucka cheenee* making practised by their brethren in Beerbhoom: they have the material for making the finest sugar, and want only the skill to conduct the final process.

The northern and western parts of the district abound in rich clay, the soil is retentive of moisture, and as the population is dense and the rate of wages low, there seems every prospect of the cane cultivation continuing to increase, so long as a remunerative return can be obtained from it. It will be remarked, that in the Government return the population is stated at 25,59,000, being greater than that of any other district in Bengal. In the estimate of the total cane cultivation in the same report, there is manifestly some error,

* 1st Appendix to Report on Bengal Sugar Trade.

the quantity of land being given at 19,408 beegahs, and the return in goor at 86,764 maunds, making a yield of only bazar maunds 4-20-15 per beegah. The erroneousness of these figures is corroborated by a Report of the Commissioner of the Moorshedabad Division, dated 1844, on the subject of the Government Cotton Cultivation Experiments then in progress, in the course of which he makes the following remarks:

"In the course of my journey to Rungpore, I was much "struck with the apparent increase of the sugar-cane culti- "vation, and the establishment of *golahs* in various villages, "from which it is purchased by the *baparrees* and sent to "the marts on the river Jenae, and thence to Calcutta and "other large towns. I find that the sugar cultivation in "Rungpore has more than doubled in extent within the last "five years, in consequence of the increased demand for the "article; it was stated to me that 350,000 beegahs of cane "cultivation are now to be found in Rungpore, chiefly in "Pergunnahs Boda, Kajeerhat, Surooppore, Koondy, Batta- "sona, Pyrobund, and Boroobheela: I have now by me a "list of the various *golahs*, or places where the best grained "sugar *(cheenee)* is first collected from the ryots, with the "capacity of each; there are no less than 94 *golahs*, capable of "receiving 20,520 maunds: the whole quantity of sugar pro- "duced is stated at 50,000 maunds, but if the extent of bee- "gahs under sugar cultivation above-mentioned is correct, "the produce must be very much greater; however, there is "no doubt that 50,000* maunds of sugar are produced, this "being calculated on good data, whereas the extent of bee- "gahs is, I suspect, a mere guess; the sugar being manufac- "tured in various ways and of various qualities, the value of "this cannot be taken at less than 4,50,000 Rupees; the pro- "fits are chiefly in the hands of the native venders, the

* "This 50,000 maunds includes only what is sent to the *golahs*."

"ryots being almost all in debt, and forced to sell at a low "price, while they have to pay a ruinous interest for their "debts. I am informed, that a native manufacturer can pro- "duce his sugar at Rs. 5 or 5-8 annas a maund, while the "Europeans who have tried it, find it stands them in Rs. 7-8 "a maund of 80 Sicca to the seer."

As there seems little reason to doubt the cultivation has continued to increase since the date of the above letter, the present annual production is probably more than double that stated in the Government return.

A European sugar factory, with a cane-mill and a small vacuum pan, has been erected near the Civil station; but it has unfortunately been attended with the almost proverbial ill success of such attempts in India, and is now lying inactive.

RAJSHAHYE.

Three-fourths of this district is low alluvial land, inundated by the annual rise of the rivers, and cultivated principally with rice and indigo, the former occupying one-half of the entire surface of the district. To the west of the Civil station of Baulcah, the country is higher and undulating, and the soil of a red gravelly nature: here, and along the banks of the rivers and *jheels*, which are usually the highest spots, the mulberry was in former years largely cultivated; and is still to some extent, though the silk manufacture has very greatly fallen off.

In a district bearing this character, little sugar cultivation could be expected; and the quantity of cane land given in the Government return at 8,000 beegahs, is no doubt fully, if not over-estimated. The goor from this is inferior, and all consumed in the district; and no sugar is manufactured from it.

PUBNA.

This district adjoins that last described, but differs greatly from it in its general character: the country being higher and less subject to inundation and the soil rich, more espe-

cially the portion south of the Ganges River, where the revenue jurisdiction extends southward beyond Commercolly. The last named place was one of the localities chosen by the Bengal Government for their experiments in sugar manufacture in 1792-93; it is recorded, that they obtained workmen from Santipore, in the Kishnaghur district, to manufacture sugar here from the goor,* and we may conclude the *pucka cheenee*, manufacture of this place, owed its rise to this circumstance.

The cane cultivation appears however, never to have reached any very great extent. In 1793 it was estimated at 4 to 5,000 beegahs per annum, and in the recent Government report, the quantity given is 5,000 beegahs only; though it is worthy of remark, that the rate of produce for this district therein given is the highest of any in Bengal. The varieties of cane grown are the *Kajoolee* and *Kulloah*, the former growing on the high, and the latter on the low swampy lands: the latter would appear to resemble in its properties and appearance the Baar-*ook*, described as common in the Shahabad district, and is said to thrive, when the ground is inundated to the depth of 2 or 3 feet during the rains.

The nature of the soil and climate seem to fit this for one of the finest cane-growing districts; and the cultivation is capable of very great extension, there being many fine tracts of fertile land suited for it; the only present drawbacks appear to exist in the somewhat scanty population, and the country being much infested by wild hogs, which harbour in the cover of the long grass on the *chur* lands and commit great havoc on most cultivation in their vicinity. The best sites are the banks of the rivers, which are in most cases higher than the plains lying inland, and remain above the reach of the highest inundation. The margins of the Pubnah river, which joins the Ganges near the station of that name, seem exceedingly well adapted for this purpose.

* 1st Appendix to Report on Sugar Trade, p. 220.

This river is navigable for the largest boats at all seasons, and is said never to break its banks or change its bed like most of the streams in these districts; the reason of this being that from its connecting the Ganges with the Jumna, another large river, the current is constantly changing its direction, following the varying levels of those two streams, which take their rise from different ranges of country.

The soil of this district is so moist that irrigation for cane is never practised nor requisite: planting begins in February, and the young canes soon attain sufficient height and foliage to shelter the ground, and enable them to withstand the dry heats of the succeeding months without injury: gathering in the crop is carried on from January till March of the following year, so that the cane is frequently fourteen months on the ground.

Beerbhoom.

This lies to the westward of Moorshedabad, and in much of its south-eastern quarter very much resembles that district in soil, elevation, and appearance. In the central parts it is mostly comprised of undulating, sandy ground, approaching to hilly as we proceed westward: and in the more southern and western parts the prevailing features are ranges of low hills covered more or less with dwarf *saul* and other jungle. It is traversed by numerous mountain streams, nearly all falling into the two principal ones, called the Adji and the Mayurk rivers: these are unnavigable, and indeed nearly dried up, except for three or four months of the rainy season, during which boats proceed with some difficulty up the two principal streams above named, to about half the length of the district westward. In detached patches near the banks of the rivers, and in the valleys between the hills and undulations, fertile spots are found; and a great deal of cultivation is there carried on with much industry, the sugar-cane having always been one of the chief objects of agriculture.

The Beerbhoom sugars having always been some of the best produced in Bengal, the attention of the Government was early attracted to them; and in their endeavours to increase the sugar production of the country in 1791-92, their Commercial Resident at Soorool, Mr. Cheap, was one of the first applied to, to aid them in this object: this gentleman supplied them with much valuable information on the subject, which was afterwards published,* and, by the interest he took in supplying the Company's sugar investments, no doubt greatly encouraged the extension of its cultivation. One of his earlier reports gives 100,000 bazar maunds as his estimate of the quantity of goor annually produced in the district, and this quantity must have been increased during the several years succeeding.

The estimate given in the late Government report of 91,500 maunds of goor as the present produce of the district, is probably under-rated. In 1847 the exports of sugar of all qualities to the Dhobah sugar-works and Calcutta could not have been less than an equivalent in goor of 70,000 maunds; in addition to which the exports to Moorshedabad were no doubt considerable, besides the large quantity required for consumption in the district.

The *Poorea* and *Kajoolee* are the two descriptions of cane in common cultivation, and attain a fair height and size:—the sediment from tanks, and cow dung, are the favorite manures; and the ryots have a method of increasing the fertility of their fields, by banking them round with earth, so as to retain a foot or more depth of water upon them, which is allowed to evaporate from, or penetrate into, the soil: much of the latter is a red, stiff, ferruginous clay, which is not readily dissolved, and renders this operation easy. A third variety of cane is cultivated amongst the hills in the west and north-west of the district, and which divide it from Bhaugulpore.

* See letters from the Resident of Sonamooky. 1st Appendix to Report on Sugar Trade.

It is generally called the *Banspatta*, or bamboo-leaved, and sometimes the *Sursonna*; and is a thin yellow cane, with very hard rind, which latter property has discouraged its cultivation in the low lands, owing to the difficulty in grinding it; but becomes its principal recommendation amongst the hill jungles, forming its best safeguard against the attacks of bears and monkeys which there abound. Native tradition asserts, that it was first introduced into the district by a former Commercial Resident, which leaves little or no doubt that it is in fact the China cane, which it resembles, and which was introduced into the Company's Botanical Garden, near Calcutta, in 1796, and thence distributed to different parts of Bengal. No sugar is made from it by the hill cultivators; but the goor is brought down for sale on bullocks to Doobrajpore and other places of sugar manufacture in the district, where it is much esteemed by the Native refiners.

Pucka sugar making from the goor is very general in the southern and eastern parts of the district, but mostly so in the villages around Soorool, Soory, and Doobrajpore. It is all of the same character; clean, and well crystalized for native sugars, and bruising the grain is never practised. The finest is made at Doobrajpore, where some is equal in whiteness to the best *dobarrah*. The manufacturers use a wood-ash lye freely in the boiling, which cleanses the sugar while it aids much in forming its hard crystal.

With the exception of one short road, connecting the native town of Elambazar with the Great Trunk road, no others are kept in repair throughout the district; though the means of doing so could be easily and cheaply found in the gravelly nature of the soil in most parts. Were this want supplied, the native production would probably increase considerably; but further difficulties in the way of cultivation by Europeans would be found in the very detached nature of the productive soil, which, as before remarked, is to be found only in comparatively small and scattered patches.

Dacca Division.

Dacca.

This is one of the eastern districts of Bengal, and comprises a surface of 4,800 square miles; having its capital of the same name, situated near its centre on the Boorygunga river: this city was formerly a place of great wealth and importance, but its site was apparently ill chosen for a centre of trade or government: its situation being low, and its climate unhealthy, and indeed its ancient glories seem gradually to have fallen to decay.

The whole district is conveniently distinguished as comprised of the northern and southern divisions; which differ greatly from each other in character, appearance, and soil. The northern portion is high, composed principally of hilly ridges and dense jungles in the west, and of low brushwood jungle in its eastern part. The streams with which it is watered being few, and of small size, this division is relieved with but few cultivated spots; except towards its southern part, where it approaches the city, and where irrigation from the creeks and rivers is more available—and here the sugar-cane, pulses, and other crops requiring to be above the reach of inundation, are raised. The hills and jungles are inhabited by peculiar races of roving hill tribes, who clear occasional patches of the forest land to obtain a rice crop, and then, after reaping it, remove to some other spot.

The southern division extends from the city of Dacca southward, and is nearly surrounded by the rivers Delus-serry,—on a branch of which the city stands,—the Megna, and the Ganges. This is the most important division for agriculture, consisting almost entirely of alluvial land, adapted for rice, hemp, indigo, &c. Its most remarkable feature is its low elevation, causing its *entire* submersion by the annual inundations; and this continues throughout the rains to a

depth varying from 2 to 14 feet, the banks of the rivers being more elevated than the inland parts, and seldom exceeding 3 feet in depth from the surface of the waters. At this season the city itself has been aptly compared to an eastern Venice, isolated by the vast inundation; which Nile-like, serves to enrich the soil but does not improve the salubrity of the climate: the air is characterized by its excess of humidity, and from September to February, the most genial season throughout the greater part of Bengal, the atmosphere here is loaded with constant dews and fogs, mixed with the miasmata of the evaporating marshes. It is estimated that four-fifths of the whole district are subject to annual inundation.

Such a country as that above described could not be expected to prove favorable for sugar cultivation, either cane or date; and accordingly we find it never was known to be so. It seems doubtful if any cane cultivation worthy of notice existed in former years; for though in the Company's correspondence with the Collector of Dacca in 1702, the land under cane cultivation was estimated at 15,625 beegahs, it is probable that a very small portion of this was referrible to Dacca Proper; the district comprehending in those days the whole of Furreedpore also, where cane has always been raised to a considerable extent. For the use of the city and district generally, sugar has always been imported from Jessore, Furreedpore, and other western districts; and the Government return recently furnished goes to prove this is still the case to the extent of nearly 48,000 maunds of goor per annum. *In 1840 the whole cane cultivation of Dacca was* estimated at less than 2,000 beegahs.

/ Notwithstanding the many and manifest disadvantages under which a European sugar factory must labor, situated in such a district as Dacca, yet that city itself has been selected for the establishment of an extensive English refinery; and to this the native raw material is imported from

other districts to be refined, and then re-exported to Calcutta for shipment to the home markets. It is believed that this concern has entailed great losses upon its original projectors, and the property has now fallen into other hands.

Dacca is unapproachable for six months of the year except by the river routes,—all the land approaches to it being more or less inundated during the remaining months; roads there are none, except in the city itself and its immediate vicinity, and beyond these limits, wheeled carriages or carts are never seen throughout the district.*

Furreedpore.

Under the name of Dacca-Jelalpore, this formerly formed an integral portion of the Dacca district, and the Rivers Ganges and Delussery help to form the present boundary between the two. Some of the southern and north-eastern parts are low, and like Dacca, liable to inundation; but the general characteristics of the district are its fertility and high state of cultivation throughout the year. This is especially remarked of all the northern portion, where sugar-cane is cultivated extensively and successfully, as well as the date tree: the latter is very extensively planted over the tract lying between the Coomar and Chundna Rivers, though found also on the elevated ground throughout the district.

The sugar-canes cultivated are the *Kajoolee* and the *Dhal-soondry*: the former requires most care, will not flourish on very wet or poor lands, and is always manured, and carefully tied up: it yields a clean, well crystalized goor, which commands 25 to 30 per cent. higher value than the current rate for that from the *Dhal-soondry*. The latter is grown on poor and low ground, but is not allowed to be inundated; it is never tied up, and indeed little or no care is bestowed on it

* For most of the information in this sketch, I am indebted to Dr. James Taylor's interesting work on the Topography and Statistics of Dacca, published in 1840.

after it is planted until ready to be cut; it yields goor of a fair, light, yellow color, but possessing no grain, and is therefore in much less estcem than the *Kajoolee* by the refiners. It can be produced at a very low cost; and before the competition of the last few years raised the prices of sugar generally in these districts, the price of the *Dhal-soondry* goor usually ranged from 1 Rupee 4 annas to 1 Rupee 8 annas per bazar maund. The cane lands in Furreedpore never require irrigation, and white-ants seldom appear. The *Kajoolee* cane is however subject to a kind of blight, or worm, called by the natives *Bonga*, which appears in the cane-tops, and must be removed by opening them with a knife, and destroying the worm.

The date tree however is the most important cultivation of the district, its produce far exceeding in amount and value that of the cane. The quantity of date goor produced annually, estimated in the recent Government return at 866,098 maunds, is probably not over-rated; upwards of 100,000 bazar maunds of date khaur, which may be considered equivalent to 160,000 maunds of goor, is sometimes sold during the year in one market,—that of Sodepore, on the Burrashee River; and a large quantity is also exported in the shape of *pucka cheenee* to the neighbouring districts.

Mymoonsing.

This comprehends the country to the north of Dacca; its main features are the large rivers which intersect or border it. These are the Megna, the Berhampooter, and the Jenae, all of which overflow their banks in the rains; the inundation usually reaching several miles inland from the main streams, and causing frequent changes in their beds. All the lands within the influence of these annual floods are of course suited only for rice and similar low land crops; but beyond these may be found large tracts of elevated and rich land, with deep, dark-colored soil, and well watered, but in most parts

over-run with dense jungle. Cultivation is said to have increased very much of late years, though there is still abundant room for further clearance and improvement, and the district would seem to offer every inducement for the investment of European capital: the rates of land rent and labor being low, and the population large and increasing.*

Little is known of the cane cultivation in former years, except that the goor produced was inferior, attributed to the low and damp situations of the soil it was confined to, and that the quantity made was not more than sufficient for the wants of the district. But little more is known of the present state of the cultivation except that it is gradually increasing.

Sylhet and Cachar.

These two districts, which adjoin each other, include a tract of hilly country north of the plains of Bengal, and divided by the Cossyah range of mountains from Assam. They are more valuable for their mineral resources than for their agriculture, being mainly occupied by hill and dense jungle, with but few cultivated intervals. The inundations are frequent from the hill streams, and from the excessive falls of rain to which the country is subject during the rainy season; and the inhabitants are a slothful and half-civilized race, and their numbers scanty. The climate is good, and both districts will probably improve much under English government: Cachar became a British possession in 1830 only. Many detached tracts in this district are described as extremely fertile, and yielding three crops annually of rice and oil seeds.

From the general character of these countries, one is hardly prepared to find the sugar cultivation so much increased as to afford 20,000 maunds of goor for export per annum from Sylhet, as appears to be the case from the Government report. In 1792, the land under cane cultivation was esti-

* Rushton's Guide, Vol. ii., 1st series, p. 285.

mated at 1,809 beegahs, from part of which an inferior goor was made, and the rest of the cane was consumed in the raw state.

Backergunge.

This lies to the south of Dacca, and extends from that district to the Bay of Bengal, having its capital Burrisaul, situated near its centre. The great focus of the trade of the district is however at Nollchitty, eight miles north of Burrisaul.

The Sunderbund jungle still occupies a great deal of the southern portion, though much has been cleared of late years. The greater part of the country south of Burrisaul, as well as westward along the line of the Ballisore River, is subject to inundation during several months of the year, and fit only for rice and similar crops: the houses being built on artificial mounds of earth. Throughout the district the soil is a rich alluvium, composed of decayed vegetation, mixed with sand, and yields most luxuriant crops. North and east of Burrisaul the country is sufficiently high to place it beyond the reach of inundation, and here large tracts of land are found admirably adapted for cane cultivation, —which is carried on to a considerable extent, and would admit of a great increase. The date tree cultivation is also large, and increasing in this quarter.

The district has no roads, being so thoroughly intersected with rivers and khalls of all sizes, that every part is easily approached by the boats, with which all the trade and communications are carried on;—these channels also serve to thoroughly drain the lands above their level, to which circumstance the salubrity of the climate is attributed. The population is dense, and the rate of wages low, and the district being so favorably situated for trade will probably cause a great increase in its cultivation of sugar and other valuable crops, in proportion as its advantages become known.

Both cane and date sugars are brought to market either in the shape of goor or of khaur. The goor is always boiled to a very stiff consistency, and then whipped or stirred with a bamboo rod, until it becomes cool; the effect of this is entirely to bruise the crystal and incorporate it with the molasses into an uniform, hard, soapy-looking mass, of a light yellow color: before it becomes solid by cooling, it is poured into round earthen pots, holding about 10 seers each, in which it is taken to market; and the advantage of the above process appears to consist in the saving of any loss by breakage of the pots, should such occur during the transport or stowage in the boats which convey them. The khaur is made by scraping the goor to reduce it to a soft consistency, moistening it with water, and pressing it in the usual way; and by repeating the process several times, a very light colored and dry khaur, but without the least grain, is produced.

The principal markets for cane goor are Nollehitty, Hummidpoor, Phootolla near Muddygunge, and Churanuddee, 6 *coss* north of Nollehitty. And for date produce—Nollehitty, Gurnuddee, Soorkul, Oojeerpoor, and Soojanagur. In 1840, the estimated annual production was 11,000 maunds date khaur, 19,500 maunds date goor, and 15,000 maunds cane goor. In the Government return the date produce is evidently very much under-rated.

All the sugar exported was formerly taken by the native merchants, principally Mughs, to the Arracan coast, Chittagong and Dacca. Of late years, a good portion has been consumed by the European sugar refineries in Jessore and Dacca.

Chittagong Division.

Chittagong.

This district is comprised in a strip, 180 miles long, of the east coast of the Bay of Bengal, and is separated from the Burmese territories on the east by mountainous ranges, which

are covered with jungle, and inhabited by wild and little known hill tribes. Ridges of hills also run parallel with the coast throughout the district; and in the large valleys between them, the soil is sandy but productive, yielding two or three crops annually. There are several navigable rivers, and the innumerable hill streams throughout the country are easily diverted to serve the purposes of irrigation.

The climate is variable, but on the whole humidity is its prevailing character. It is considered healthy for Europeans.

Agriculture in general is at a low ebb, the cultivation of the sugar-cane very limited, and the rate of wages for field labor above the standard. In the correspondence of 1702, so often referred to, we find a similar report to the above of the cane then grown; with the addition that the goor produced was of so inferior a quality, that sugar could not not be made from it;—this was attributed to the great humidity of the climate, causing the cane juice to be weak and watery. The district is no doubt much more favorable for date tree cultivation, owing to its sea-board character and the low range of the thermometer in the cold season.

Tipperah or Comillah, and Bullooah.

These comprehend a large tract of country lying to the east of the Megna river, which divides it from Dacca and Backergunge, extending down the sea-coast to Chittagong, and bordered on the east by a continuation of the chain of hills which separate that district from Burmah.

Their statistics and productions are very little known, but the cane, like that of Chittagong, is reported to be of a very inferior quality, and fit only for making goor. Judging from the Government report however, the cane cultivation in Tipperah would appear to have increased wonderfully of late years: the estimated quantity of goor produced in 1702 being only 9,107 maunds, and now standing according to the

Government report at 146,841 maunds, though still far from sufficient for the consumption of the district. The Otaheite cane was introduced at Comillah in 1810, and with the aid of careful cultivation, produced canes of exceeding size and luxuriance; from which it would appear, that there is nothing in the climate at least inimical to the cane plant.

In Bullooah the date tree is extensively cultivated and goor made therefrom, and the character of the country appears to be very favorable for its increase.

At Luckypoor and Hadjygunge, in Tipperah, the native trade has increased very much of late years, and these places have become large marts for interchange of the productions of the surrounding districts and places on the coast of the Bay of Bengal;—a great part of the trade being carried on by the Mughs.

Jessore Division.

Jessore.

The division which takes its name from this district must be considered as by far the most important one in Bengal for the production of sugar; whether we look at the situation of its districts surrounding the commercial capital of the country, Calcutta; their richness of soil and high state of cultivation when compared with the rest of the country; or the quantity and quality of the sugars which they export.

In Jessore district itself, cane is but little cultivated; though in many parts, especially in the north and west quarters, it thrives well, and yields some of the best goor in Bengal, well crystalized and light colored. We may attribute the comparative neglect of cane cultivation here, first, to the fact of the inhabitants having long practised the far cheaper mode of producing sugar from the date tree, and secondly, to the indigo planters monopolizing most of the finest lands for their cultivation. The description of cane most in favor is

the *Koosoee*, though the *Kajoolee* and *Pooree* are also cultivated.

The date tree cultivation far surpasses in extent that of any other district; as do also the quantity and perfection of the sugars yielded thereby. Though the cultivation has been known here for as long as we have any records of the country, its progressive increase of late years has been enormous; and it is very certain, that the estimate of present annual production given in the late Government report at 865,853 maunds of goor, is far below the truth.

The following is a near estimate of the annual average quantities of sugar in different states of refinement brought into the principal markets of the district, and sold thereat, for the years 1845, 1846, and 1847, and reduced to their equivalents in goor:—the *pucka cheenee* being reckoned as requiring 3 maunds of goor, the *dulloah* 2 maunds 15 seers, and the khaur at 1 maund 30 seers, to produce 1 maund of each of those descriptions:

Markets.	*Pucka cheenee.*	*Dulloah.*	*Khaur.*	*Equivalent in goor.*
Kassulpore and Tromolny,	65,000	55,000	.....	326,625,
Chandpore, Kalleegunge, Chowgacha and Dowlutgunge, ...	.....	90,000	.....	213,750
Singhy, Narcoolbarree and Kudjoora, ...	35,000	12,000	.....	133,500
Rarykolly, Lohagurrah, Bonnatpore, Rajapore, Jennidah and Mugroo,	35,000	.....	.....	105,000
Chandoree and Koloroa,..	.....	9,000	.....	21,375
Jessore, Roobdea, Rajahaut, Jingergacha, &c.,	2,000	12,000	6,000	45,000
Total, ..	137,000	178,000	6,000	844,250

The above includes only what was brought to the markets for sale, and the greater part of which must have been ex-

ported from the district, to which we shall have to add all that was reserved for consumption by the numerous population before we can arrive at the total quantity produced.

The line of the River Bhoirub or Cobbuduck, it being known by the former appellation in the northern part and by the latter in the southern,—marks the tract of country along which the date cultivation has been increased to the largest extent, and the produce brought to the greatest perfection. On this stream stand the Chandpore, Chowgacha and Tremohny sugar factories, erected for refining the native raw material; and possessing vacuum pans and other modern improvements in sugar refining apparatus. These factories have all been erected during the last ten years, and have, by the steady demand for the raw material they have created, contributed in no small degree to the rapid increase of the date cultivation.* This increase is still going on, and plantations in all stages of growth are to be seen in every part of the district, and seem capable of almost indefinite extension; the only check being experienced from the indigo planters, who discourage the appropriation of lands suited for indigo to this purpose.

The soil in most parts of the district is a dark, rich, alluvial mould, and its numerous rivers and their tributary streams afford means of inter-communication and water-carriage for the greater part of the year. During the dry months also large quantities of sugar of all kinds, and other valuable produce, are transported by bullock carts, at a trifling expence, to the bazars on the larger rivers; and the trade with Santipore, Chogda, Sookchur, and the markets on the Hoogly river, in this way is large. From 25 to 30,000 maunds of *dulloah* are frequently carted during the season to Santipore from Chandpore and its vicinity, this being a favorite material with the native refiners for making the well known Santipore *dobarrah* sugar.

* See Appendix D. for the progressive rate of increase in the selling prices of date sugars since 1832.

The climate is considered unhealthy for Europeans, especially in the vicinity of the Sunderbunds; but appears to have much improved of late years, as sickness is not now so general as formerly; and many of the higher localities and the vicinity of the larger rivers appear to be exempt from this drawback.

24-Pergunnahs, including Baraset and Sundcrbunds.

These may be conveniently described as forming one district, though comprising separate sub-divisions in their Judicial and Revenue administration. They include the country extending, north and south, from the Kishnaghur district to the Bay of Bengal, and lying to the eastward of the Hoogly River: on the left bank of which, and centrically placed, stands the metropolis of Bengal, Calcutta.

The whole of this tract is low and flat, bearing the aspect of having been gradually recovered from the state of Sunderbund jungle with which its southern portion is still covered. The soil is almost everywhere a black alluvium, and all the southern portion liable to be inundated by the high tides from the Bay, except where kept out by embankments.

The district being everywhere difficult to be drained, in consequence of its low situation, it is much better adapted for rice and similar wet crops than for sugar cultivation; nevertheless the contiguity of the Calcutta market has induced a considerable cultivation of cane, principally of the Bombay or *Kajoolee* variety, for native consumption in the raw state: the greater part of this is raised in the Baraset division, and is very profitable to the proprietors. A beegah of ground, well cultivated, will yield 15 to 20,000 full grown canes, and is frequently valued as high as 150 Rupees on the spot where grown. Khaura and an inferior description of *dulloah* are also made from the goor, and sold in the Calcutta market.

In the north-east part of the district, a good deal of data tree cultivation is met with, and it is evidently fast increasing.

A most important subject connected with the Bengal sugar trade is the number of European refineries which have sprung up of late years in the environs and vicinity of Calcutta; and though some of them, erected on the opposite bank of the river, are locally in the Hoogly district, yet as they all draw their raw material from the same markets they may be conveniently described together. The importance of these establishments arises from their extensive means of refining, the large amounts of British capital which have been invested in them, and the powerful influence which they have no doubt exercised in increasing the sugar production of the country by their steady demand for the native raw material. They were nearly all erected with the object of refining native sugars, and thereby better fitting them for exportation to the home markets; and so long as an active demand for East India sugars, consequent on the falling off of supplies from the West Indies, continued to prevail, were mostly worked to a profit on this system. The later legislative changes however, commencing with the Act of 1846, for the admission of foreign free and slave-grown sugars, having brought about very sudden fluctuations in the home markets, for which the Indian refineries were quite unprepared, heavy losses have overtaken most of them.

The increased demand, however, for good and refined qualities of sugar in the home markets, consequent on the general reduction of prices, will probably encourage a continuance of the refining business in Bengal for many years to come; and we may therefore expect these factories will continue to be worked, though their number may not be soon added to. The following are the names of those now existing, given in the order of their dates of establishment,—1st, Seebpore, 2nd, Bally Khal,—3rd, Cossipore,—4th, Goosree,—5th,

Albion works, Seebpore,—6th, Strand Mills,— 7th, Baranagore. Those taken together, if fully worked throughout the year, would be capable of working off at least 33,000 tons, or about 900,000 maunds, of raw material per annum; and of producing from 16,000 to 25,000 tons of refined sugar, according to the quality of raw material they might work from. Two of these refineries are provided with rum distilleries of their own; and there are besides, 5 or 6 distinct distilleries on the European plan, in the immediate neighbourhood of Calcutta.

Burdwan.

This, though not one of the largest districts, is one of the richest, most fertile, and best cultivated in Bengal, and yields a larger Revenue to the Government than any other in the Presidency. The soil is variable, but a large portion consists of a stiff ferruginous clay, more or less tempered with sand, and containing nodules of carbonate of lime. The country is high, and above the reach of inundation, except in the vicinity of the rivers, the principal of which are the Damoodu and the Adji: these take their rise from the hill country to the westward, and are fed during their course by the numerous hill streams of Bancoorah and Beerbhoom; and during the rainy season their waters are subject to very sudden and violent fluctuations. Though the cultivated lands in their vicinity are secured from any ordinary rise in these rivers by many miles of expensive embankments, scarcely a year elapses without some of these being overtopped by the inundation, which then carries destruction far and wide for many miles;—and the evil has become more frequent of late, owing, it is said, to the gradual elevation of the beds of the rivers,—especially of the Damoodu. The lands subject to these dangers are principally occupied with paddy cultivation, and the sugar-cane is mostly confined to the higher ground.

For the cane this is, without exception, the richest district in Bengal, the soil and climate being well adapted to it; and the cultivation as well as the manufacture of sugar have been carried on here from time immemorial. Throughout the district the cane crops require irrigation, for which the small rivers and *jheels* afford plentiful supply; and on this, the manuring, ploughing, &c. much care and labor are bestowed. The *Pooree* is the variety of cane principally cultivated, though the *Kajoolee* is occasionally seen in the lower grounds, but is found to require more moisture in the soil, or more frequent irrigation, than the *Pooree*. The latter, if well watered, produces a very fine crop, and probably yields on the average as large a produce in sugar as the cane in any Bengal district. The China cane has been introduced and seems peculiarly well adapted to the district, producing with ease three or four good rattoon crops; but requires the iron-rollers of the European mill to crush it, the native mills not having sufficient power to overcome its tough rind.

In 1792, the whole cane cultivation of the district, which at that time included the greater part of Hoogly within its limits, was estimated at 25,000 beeghs, producing at the average rate of 12 maunds of goor per beegah, or in all 300,000 maunds: and of this it was computed that one-half was exported; principally to Calcutta, in the shape of sugar of different degrees of refinement. The estimate given in the recent Government report, of 400,161 maunds of goor per annum for the present Burdwan district, is probably very near the truth; as also the estimate of more than half of this being consumed within the district itself; there being a large proportion of the population wealthy, and the general body in better circumstances than the average of Bengal ryots, as well as more healthy, and living in well raised mud houses. The cane cultivation would no doubt increase very rapidly were the district blessed with better means of exporting its produce; but like the most part of Bengal it lies

under great disadvantage in this respect. With the exception of the Adji and Damooda rivers, which are only open during the rains,—and even then their impetuous and uncertain character renders their navigation little to be depended on,—the only river communication is that of the Hoogly, with its continuation the Bhagarutty, which forms the eastern boundary; and on this the large bazars of Culnah and Cutwa are situated, and form what may be considered the two Ports of the district. Of the roads communicating with these from the capital, Burdwan, that to Cutwa is impassable during the rains; but that to Culnah is kept in good repair by the Burdwan Rajah, the distance being about 32 miles: this and a third road leading to Hoogly, on the route to Calcutta, are the only two which are passable for bullock-carts throughout the year.

The European sugar factory of Dhobah, near Culnah, already referred to in Part II., is the only one that has been established; but for its native sugar manufacture the district has always been famous. *Pucka cheenee* of a fair quality is made, though not to any great extent,—but large quantities of *khaur* and *dulloah* are sold throughout the year, their principal markets being Kunchenngore, Kishnagur and Dignagur: they are also sold at several smaller towns on the Damooda river, and from these the exports are principally to Calcutta. Kunchenngore is also celebrated for its *dobarrah* and *allah* sugar-balls, the latter made of fine white *dobarrah*, and as hard as loaf-sugar.

The date tree will not flourish in Burdwan.

Hoogly.

Like the two last described districts, this is also exceedingly fertile and well cultivated. The river of the same name forms its eastern boundary, and the Damooda and Roopnarain also flow through it, and fall into the Hoogly a little below Fultah. In the northern half of the district the soil re-

semblies that of Burdwan; and the lower parts along the banks of the rivers are subject to similar sudden inundations with those of that district: but large rich tracts of higher ground are found beyond the reach of these dangers, and here the cane is very successfully cultivated. The southern half is mostly within the influence of the tides; and the soil, a rich black alluvium, mixed with sand, where very fine rice crops are raised. In this division also, whenever the ground rises sufficiently to place it above inundation from the spring-tides, most luxuriant cane crops are cultivated. A large purple variety, known as the Bombay cane in this district and in Calcutta, is the kind principally cultivated. Whence it acquired this name it is not easy to surmise; it appears to be the *Kajoolee*, well developed by the moist rich soil it here enjoys; very large quantities of it are carried to the Calcutta bazars for consumption in the raw state, and form a very cheap and wholesome native luxury. Very fine goor is also made from it, and in this shape, or that of khaur, the greater part of it finds its way to the Calcutta market; or to the bazar of Sulkea, opposite on the west bank of the river, where it is principally bought by the European refiners. The cultivation has very much increased of late years, and the annual produce in khaur is now estimated at 70,000 bazar maunds. On the higher grounds to the northward and westward the *Pooree* is more cultivated, and is very fine about Purrooh and near the banks of the Nyassrai Khall. About Kotulpore and Johanabad, on the Dalkissora River, also, good *dulloahs* are made. The wooden roller-mill is used for crushing the cane throughout the district.

In the recent Government report, the average rate of yield in goor from the beegah, for Hoogly, is stated at only bazar maunds 8-13-4. This apparently low yield in a district so suitable for the cultivation, is no doubt explained by the circumstance before referred to, of so large a proportion of the cane being consumed in the raw state, the

ground for which is of course included in the number of beegahs cultivated;—a similar cause will also probably explain the apparent low rate of yield for several other districts as given in the same report.

There are a good many date trees in the southern parts of the district, and about Gottaul some date goor is made, which is said to be of good quality.

The European refineries in this district have been noticed under the head of district 24-Pergunnahs.

Nuddea or Kishnaghur.

In *productiveness and fertility of soil this district resembles* the others of the same division, but labors under the disadvantages of a want of water communication during the greater part of the year, except in its most southern portion; a line drawn east and west across the district, and intersecting the civil station, will pretty well describe the extent to which loaded boats can penetrate northward except during the rains. The portion south of this line would comprise about one-third of the whole district, and this very much resembles the adjoining one of Jessore in its soil, climate, and productions: the date tree cultivation, which is very large and productive, is principally confined to this portion, and is increasing in as rapid a ratio as that of Jessore.

A great portion of the date produce is sold and exported in the shape of goor, for which the chief marts are Chandorea on the Issamutty River, and Chogda on the Hoogly. Much date *dulloah* is also made along the line of the Issamutty River, and at Dowlutgunge on the Bhoirub. Little or no *pucka cheenee* is made, but large quantities of both cane and date produce find their way to Santipore on the Hoogly River, which has always been a noted place for its native sugar manufacture, and more *dobarrah* sugar is made here than in any other locality in Bengal. The quantity thereof made annually is frequently 25 to 30,000 bazar maunds, the chief

part of which is conveyed to the Calcutta market, and it is frequently shipped for England. The goor and *dulloahs* from which it is prepared are brought from all parts of this division of the district, as well as from Jessore; and during the date sugar season, a large traffic is carried on with the Chandpore market in that district, from whence the sugars are transported here by land-carriage.

North of the line above referred to, the country becomes more elevated, but nevertheless well watered by *jheels*, and the rivers which intersect it; the latter always retaining enough water for agricultural purposes even when unnavigable: here the soil is mostly a brick earth, or sand and clay mixture, exceedingly well adapted for cane cultivation, and yielding most luxuriant crops with less labor than in Burdwan, irrigation being here required much less than in that district. The China cane has been introduced in some parts, and both grows and rattoons well. The Otaheite cane has also been grown, but obliged to be abandoned owing to its liability to destruction by the white-ants,—except in quite the northern part of the district on the alluvial lands, near the Ganges, where this enemy of the sugar planter is very seldom found.

Altogether this district must be looked upon as one of the best adapted for sugar cultivation in Bengal, and affording room for very great extension, in both cane and date varieties. European sugar factories, with extensive cane cultivation, have already been established in two of the large indigo concerns in the northern division; but it is reported they have not yet been attended with the success which their projectors had every right to expect from their advantages in favorable position and efficient means of working.

Bancoorah.

This is one of the most westward of the Bengal intra-regulation districts, bordering on the jungles of Manbhoom, and

having only one-eighth of its surface appropriated to cultivation, the remainder being covered with large forests and hills. Throughout the district the land is undulating.

In the valleys, where the only cultivation is carried on, the sugar-cane forms one of the ordinary crops of the country, though not planted extensively. The *Poovee* is the kind most in favor, and the cultivation resembles that of Burdwan.

The goor is of good quality, and being well cleaned in the boiling process, yields khaur of a bright yellow tinge and good grain: a considerable quantity of this, and of *dulloah* of secondary quality, is made and exported to the Burdwan or Calcutta markets. The principal sugar markets are Bissunpore, Cotulpore, Kishnagur, Bancoorah and Mudjeah.

The only water-carriage available to the district is that on the Damooda river in the height of the rains; and the trade of the district, which is not large, is carried on almost entirely by bullock carts.

Cuttack Division.

Cuttack, Balasore, and Khoorda or Pooree.

These districts stretch along the west coast of the Bay of Bengal, from Midnapore on the north, to the confines of the Madras territory, and together formed in former times the kingdom of Oorissa. The ancient Brahminical writings are all vehement in praising its rivers, its temples, and its fruits, but its agriculture never appears to have been celebrated; and indeed modern experience has proved, that the soil is generally poor and unfruitful, and all its natural productions of inferior quality.*

The whole country may be divided into three regions, the marshy woodland tract along the sea-shore, having much the character of the Sunderbunds, and almost the only produce of which is its sea-salt;—the level plains between this tract

* See account of Cuttack by A. Stirling.

GROUND PLAN
of
Sugar Works and Distillery
For a Cultivation of 2000 Beeghas of Cane

Scale 32 Feet to an inch

— Stapleton lith. 4 Bouverie Road Islington

Charcoal Furnace

Curing House

Packing House

Office

Store Room

Cooperage

Fermenting House

Charcoal House

Vacuum Pan House

Mill House

Boiling House

Steam Boilers

Still House

I I Cane Wells
B B Engines
C C C Clarifiers
D D D Evaporators
E E L Bag Fillers
F I T Charcoal Filters
G Vacuum Pan
H H H Steam Boilers
I Chimney

K Still
L Worm Pot
M Mixing Vat and Pump
N Rum Vats

Appendix B.

Average prices of Native Sugar for the first Six months of the following years at Kessubpore, in the Jessore District.

Years.	Best Pucka Cheenee.			Dulloah average quality.			Khaur.			Goor.			Remarks.
	M.	S.	C.	M.	S.	C.	M.	S.	C.	M.	S.	C.	
1832,....	5	4	0	3	10	3	None.			1	2	0	*Average of 5 years.*
1833,....	5	3	8	3	10	0	None.			1	2	6	Pucka Cheenee, 6 0 4
1834,....	5	15	0	4	2	4	2	7	6	1	5	4	Dulloah, ... 4 0 6
1835,....	7	0	0	4	7	6	3	0	0	1	11	8	Khaur, ... 2 10 11
1836,....	6	11	0	4	4	9	2	9	3	1	7	0	Goor, ... 1 5 8
1837,....	6	12	0	4	6	9	2	15	3	1	10	6	*Average of 5 years.*
1838,....	6	9	3	4	6	3	2	13	9	1	10	0	Pucka Cheenee, 7 12 0
1839,....	7	1	1	5	10	6	3	1	2	1	12	0	Dulloah, ... 5 13 6
1840,....	8	1	9	6	5	5	3	3	7	1	14	11	Khaur, ... 3 5 6
1841,....	10	4	0	8	6	10	4	10	3	3	1	9	Goor, ... 2 0 3
1842,....	7	0	4	4	14	3	3	0	9	1	12	0	*Average of 5 years.*
1843,....	8	6	6	6	12	5	3	11	5	1	15	0	Pucka Cheenee, 7 15 7
1844,....	8	3	10	6	12	5	3	12	7	2	0	0	Dulloah, ... 6 9 4
1845,....	8	0	4	6	10	9	3	5	5	1	13	0	Khaur, ... 3 10 7
1846,....	8	2	11	7	13	0	4	6	9	1	14	0	Goor, ... 1 14 5
1847,....	7	4	3	5	14	6	4	7	6	1	14	0	

During the goor season, that is, the first three months of the year, the prices generally range 25 to 30 per cent. below the average rate for the next three months.

FINIS.

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