THE

TEA PLANTER'S MANUAL,

BY

T. C. OWEN.

[*WITH COLOURED LITHOGRAPHED PLANS OF AN IRON, AND A WOOD-AND-STONE, TEA FACTORY, DRAWN TO SCALE.*]

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PREFACE.

THE "TEA PLANTER'S MANUAL" is more a compilation of the opinions of others and the results they have arrived at, than an original work. So much has been written on all subjects connected with tea both in India and Ceylon, that there is little new to be recorded; but it has been my endeavour, whilst quoting from the writings of others, to give the most reliable and recent information on all points. The very valuable notes by Mr. Armstrong have been largely availed of, with the author's permission, and Mr. Rutherford has supplied some valuable data regarding buildings and cost of working tea estates. Messrs. Brown & Co., of Hatton, kindly supplied me with the two factory plans: the first their own design, the second in accordance with dimensions given them.

T. C. OWEN.

MEMO.

For the benefit of readers of this "Manual" in Europe and elsewhere, we must remind them that the Ceylon currency is a silver one in rupees and cents of a rupee, about 15 rupees at present counting to the £1 sterling and cents following in proportion.

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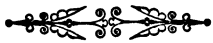


INTRODUCTION.

Early History of Tea Planting in Ceylon.

It has been stated by Tennent that the cultivation of tea in Ceylon was attempted by the Dutch and failed. Mr. Moon, in charge of the Botanic Gardens, Kalutara, is said to have had tea planted there in the first quarter of this century, some trees of which remained up to a recent date. The first tea introduced by planters in the British era was about the year 1841 or 1842, and its history is as follows, as recorded in the Agricultural Review of the "Ceylon Handbook and Directory:"—

It is doubtful whether the trees brought by Mr. Maurice Worms from China and planted on Rothschild estate, Pussellawa, or a selection of Assam plants introduced by Mr. Llewellyn, of Calcutta, to Penylan estate, Dolosbage, were the earlier arrivals here.* Some plants were transferred from Rothschild to Kotmale, the Ramboda Pass, and Pundaluoya, but no systematic attempt was made at cultivation, though for a short time the Messrs. Worms manufactured a little tea in Pussellawa as an experiment, employing a Chinaman for the purpose, but the result was said to be an outlay of about £5 per lb. of the tea prepared! The plants, however, throve exceedingly well, and when the Ceylon Company, Limited, in 1865,† took over the properties of Messrs. Worms, they found a small extent of tea on Kondegala on the Ramboda Pass, to which they soon began to pay attention. A planter of experience in Assam became their tea manager, and an importation of Bengali coolies afterwards took place on their account, but did not turn out well; this Company has now, however, a wide area under tea. Earlier in the field and more successful were the proprietors of Loolcondura plantation, Hewaheta (then Messrs. G D. B. Harrison and W. M. Leake, now Messrs. A. G. Milne & Co.), whose produce, under Mr. Jas. Taylor's careful management, has acquired the highest reputation among Ceylon teas. So early as 1865 Mr. Taylor by Mr. Harrison's orders began

* Since this was written, Mr. E. Gepp (tutor at the time in Sir Anthony Oliphant's family,) has shewn how he put out some 20 tea-plants behind Oliphant House, Nuwara Eliya, in 1843 They were received from China and sent up to Nuwara Eliya by the then Director of Botanic Gardens, probably Dr. Gardner.

† Mr. P. D. Millie says he had tea planted in Pundaluoya in 1861.

Early History of Tea Planting in Ceylon.

collecting tea seed from Peradeniya, and planted it out along the roadsides in 1866. In that year Mr. W. M. Leake being Secretary of the Planters' Association, he moved that body to get Sir Hercules Robinson's Government to send Mr. Arthur Morice, an experienced Ceylon coffee planter, on a mission to inspect and report on the Assam tea districts. The result was a valuable report published by Government and reproduced in the *Tropical Agriculturist* volume for 1885-6. That Report induced Mr. Leake to order for his firm (Keir, Dundas & Co.) a consignment of Assam hybrid tea seed (the first probably ever imported)* in 1866, and this seed was handed over to the care of Mr. Taylor on Loolcondura. Mr. Taylor's first clearing of 20 acres was felled in the end of 1867, a year before the Ceylon Company had felled any forest for tea.† The Company imported Assam seed and began planting the hybrid kind in 1860.‡

* The tea introduced by Mr. Llewellyn was Assam indigenous, some of the trees, for such they are, still existing on Penylan estate, Dolosbage.

† In 1871-72 (see an interesting letter in T. A., page 153, Vol. 1885-6) Mr. Leake was able to sell the produce of the Loolcondura tea-garden in Kandy and samples of the Ceylon Company's tea were also tested in 1871, and the result induced them at once to extend cultivation. Accordingly Mr. Jenkins, an Assam tea planter, took charge of the Company's operations. Mr. James Taylor had commenced the Loolcondura plantation some years before, and had made fairly good tea, but Mr. Jenkins gave valuable advice to, and inspired confidence in, Mr. Taylor, who however, after a brief visit to India, began to supply tea equal to Assam in preparation and quality.

‡ In 1867, the Director of the Botanic Gardens reported that a sample of Ceylon tea prepared from China (Bohea) plants had been favourably reported on in London, and for several years Dr. Thwaites continued pressing the advantage of cultivating this hardy plant on the attention of the Government and the public. Dr. Thwaites thought the natives might grow the Bohea kind with advantage, as it succeeds almost anywhere. In 1868 there were 270 plants of Assam two feet high prospering well at the Hakgala Gardens, and two years after, the distribution of seed commenced, the opinion being that the Assam kind would succeed best at an altitude above the limit of coffee. In 1872 Dr. Thwaites saw no reason why the sides of our higher mountain-ranges should not be covered with flourishing tea plantations, while he strongly recommended the cultivation of the China Bohea kind on abandoned coffee land. In 1875, the fact was fully recognized that the cultivation of tea in Ceylon was an established commercial success. The following reference to the prospect of extended Tea cultivation in Ceylon is from one of Dr. Thwaites' Administration Reports:—"Nearly all the forest land available for coffee cultivation in the above-named districts (Dimbula and Dikoya) has now become private property; and although it has not all yet been planted, it is probable that after a very few years, when about ten thousand additional acres of forest will have been felled, the coffee estates will have reached their limit. But there will still remain extensive tracts of land suitable for plantations of tea, and to this purpose they will undoubtedly be sooner or latter devoted, if one may judge by the example of the tea estate at Kondegala. This property has been unskilfully handled, and the trees have been exposed to various drawbacks. They are also planted in soil much inferior in depth and quality to that which is to be found in many parts of the vast expanse of primæval forest, the elevation of which is too high for the growth of coffee; yet the Kondegala tea is pronounced to be equal to the best production of Assam, and the field for European enterprise is thus open for many years to come."

Early History of Tea Planting in Ceylon.

During 1873 and 1874 a good many plants of both the Assam hybrid and the China variety were distributed from the Peradeniya and Hakgala gardens; then and later on, the chief means of supply was through the importation of large quantities of Assam seed from Calcutta, a very considerable business having sprung up in this way; but latterly a great deal of good seed has been made available on the older local plantations, the cost and the risk being less than from imported seed. Indeed one reason why cultivation did not more rapidly extend up to 1883, was the comparative scarcity and dearness of tea seed with the failure to germinate of much of the seed imported, either from its loss of vitality *en route*, or from ignorance of the best mode of treating it. There was then no money to spare with many of our planters to invest in maunds of seed at from R50 to R80 per maund.*

Seeing that the tea plant flourishes in Ceylon on gardens very little above sea-level on the Western Coast, and at all altitudes inland up to plantations under the shadow of Pidurutalagala at about 6,800 feet, it is hard to say what limit can be placed on the area to be planted with tea during the next few years: already over 100,000 acres are covered with the shrub, and although much has been planted on existing estates, there are still expanses of cultivated land which have yielded very poor returns in crops of late years, which offer facilities (and encouragement) for planting with tea. There are also reserves better suited for tea than any other product. Nowhere in our planting districts have we heard of tea bushes failing: everywhere this product seems to be flourishing luxuriantly.† Leafage rather than blossom and fruit distinguishes our natural vegetation; and if the old Indian tea planters in our midst are to be believed, nowhere on the opposite continent is so much encouragement offered to go into "tea" as in the Central and Western Provinces of Ceylon. Capitalists interested in coffee property do not now require to be told of the advantage of adding tea as well as cinchona to the estate products.

* The imports of tea seed into Ceylon from India cannot unfortunately be given from the Customs accounts, as there is no separate account kept, all seeds being classed together. But there is no other seed imported of any planting importance, and it is significant that the imports have risen as follows:—"Seeds and plants" imported in 1850—R24,000; in 1860—R18,000; 1866—R3,696; 1867—R6,413; 1868—R3,482; 1869—R5,880; 1870—R5,716; 1871—R3,960; 1872—R5,014; 1873—R6,374; 1874—R12,811; 1875—R31,467; 1876—R29,423; 1877 R64,672; 1878—R116,805; 1879—R191,122; 1880—R46,672; 1881—R47,712; 1882—R44,617; 1883—R176,327, 1884—R213,000 (of which R203,000 from India, tea seed of course); 1885—R188,814. Tea seed was got in 1866 and 1869-70 but not again till 1873-9. Meantime Cinchona, Cacao and Liberian Coffee seed were freely imported between 1875-81. Tea seed in quantity has come in chiefly since 1882.

† As we have mentioned before, the Kandyan natives who have watched in some districts the beginning and abandonment of coffee declare that tea is quite a different thing, that it is "a jungle plant," meaning that it has found a permanent home in Ceylon. Nevertheless, we do not for a moment shut our eyes to the fact of tea in Ceylon as in India, being accessible to the attacks of many enemies: white ants in one or two cases have done much damage to young plants here; red spider is not unknown, and various other insects, none of much importance, have been found on the trees. The "black bug" of coffee has also been found on tea.

Early History of Tea Planting in Ceylon.

Few plantations are without patches, if not fields, which have never done and never will do much good in coffee, and where it is equally useless to try the bark-tree, but for which tea seems well-adapted. On badly grubbed coffee land, where cinchona cannot be got to grow, the tea-bush seems to luxuriate. We believe one of the most promising fields of tea in the country was, some years ago, the scene of abandoned, because completely grubbed-out, coffee. On the other hand, the danger now (1885) almost is that proprietors may be in too great a hurry to transform their coffee into tea plantations: our advice has been for many months back, *festina lente*: wherever there is coffee in good heart, to be very loath to supersede it while putting tea in alongside or in reserves.

At the Melbourne Exhibition the analyses of Ceylon and Indian teas by official experts proved the superiority of the Ceylon leaf as reported by the Commissioner (Mr. A. M. Ferguson) as follows:—

	Extract.	Soluble Salts.	Theine.
Darjeeling pekoe ...	38·97	3·16	1·96
Ceylon " ...	43·80	3·32	1·82

In total extract the Ceylon leaf is superior by very nearly 4 per cent; it is also superior by ·16 per cent in soluble salts, while only in theine (a constituent in which the Ceylon *orange* pekoe specially excelled) is our pekoe ·14 per cent below the Darjeeling tea. In the case of pekoe souchong, which will be the description of the great bulk of the teas which Ceylon will send into the markets of Australia and other parts of the world, a comparison can be instituted with similar teas from the hot Dooars, from lofty Darjeeling, from the fat alluvials of Assam, and from Cachar, foremost of Indian districts for high quality teas—(if the claims of the high-grown leaf from Darjeeling, Kumaon, the Kangra Valley, and the Nilgiris are reserved). Here are the figures:—

	Extract.	Soluble Salts.	Theine.
Dooars pekoe souchong ...	40·97	3·08	2·86
Darjeeling " ...	41·80	3·20	1·96
Assam " ...	40·12	3·04	1·66
Cachar " ...	40·66	3·24	1·44
Ceylon " ...	42·80	3·12	1·86

In this case, as in both the others, Ceylon takes the lead in the important item of total extract: shews fair figures for soluble salts, and but for the extraordinary figures for theine in the case of the Dooars tea would compare well in respect to the property which, specially present in tea, is also a principle in coffee. There is little doubt that of all the properties of the tea leaf, theine is the most variable in proportion to care or the reverse in preparation. Here is how the Indian and Ceylon souchongs compare:—

	Extract.	Soluble Salts.	Theine.
Darjeeling souchong ...	36.99	3·02	1·66
Assam " ...	39·27	3·00	1·46
Cachar " ...	40·29	3·12	1·76
Ceylon " ...	40·40	3·20	1·84

In the case of this, the lowest class of tea which Ceylon is likely to make and send in quantity into the markets of the world, our produce ranks highest, not only in total extract but in soluble salts and theine: *in all which makes tea valuable in fact.*"

The progress of Ceylon tea is indicated in Fer-

guson's Directory as follows:—

Area of tea planted out:—

Recent Progress.

	1867.	1868.	1869.	1872.	1873	1874.	1875.	1876.	1877.
Acres	10	200	50	10	250	350	1,080	1.750	2.720

	1878.	1879.	1880.	1881.	1882	1883.	1884.	1885.
Acres	4.700	6.500	9,274	13,500	22,000	32,000	67.000	102,000

The latter acreage becomes 116,000 when coffee and cinchona interplanted with tea are added, and it is to be presumed that in all cases the tea has been planted to supersede the former products when sufficiently developed. This extent shows an increase of 80,000 acres in the period of less than three years since December 1883.

Export.

The Chamber of Commerce exports are as follows:—

1875-6=282 lb. 1876-7=1,775 lb. 1877-8=3,515 lb. 1878-9=81,595 lb. 1879-80=103,624 lb. 1880-1=277,590 lb. 1881-2=623,292 lb. 1882-3=1,522,882 lb. 1883-4=2,262,539 lb. 1884-5=3,796,584 lb.

The following have been estimated as the yields for the next four seasons:—

Probable Export of Tea from Ceylon:—

Season	...	..	1885-6	=	6,750,000 lb.*
"	...	...	1886-7	=	12,000,000 lb.
"	...	...	1887-8	=	20,000,000 lb.
"	...	...	1888-9	=	30,000,000 lb.

The estimate here given for the current year will undoubtedly be exceeded,* and it is quite possible that the succeeding estimates are proportionately moderate. An elaborate estimate has been compiled by Mr. Rutherford, which agrees closely with that given above, but there are many who think that both the area estimated to be planted, and the yield from the young fields, are under the mark.

Land available.

The amount of land suitable for tea cultivation is very large, and there are extensive tracts in the low country, apart from Government reserves, which may be expected to be taken up before long. In the coffee districts there is still room for considerable extension, and there can be no doubt that 200,000

* Up to 16th September, 1886, the total export is 6,904,761 lb.

to 250,000 acres of tea will be planted in Ceylon before many years pass, an area which will rival in yield that of India itself. As to the possible distribution of this large amount of tea we have had some very interesting statistics and remarks from Messrs. Gow, Wilson & Staunton as follows:—

World's Consumption.

The figures in the subjoined list, which are chiefly based upon an *average of five preceding years*, give the amount of tea taken for home consumption in various countries, together with the average quantity annually consumed per head of the population:—

		Annual consumption in English pounds.	Annual average consumption per head of population in English pounds.
Australian Colonies		18,018,000	7·66
New Zealand		3,902,000	7·23
Great Britain ...	1885 ...	178,655,000	4·90
Newfoundland		824,000	4·38
Canada		16,600,000	3·69
Tasmania		389,250	3·04
Various British Possessions	1884 about	3,930,000	1·66
United States	about	65,000,000	1·30
Holland		4,382,500	1·05
Cape Colony		1,128,500	0·90
Natal		327,300	0·76
Russia		62,408,500	0·61
Denmark		746,000	0·37
Argentine Republic	1883-84	900,000	0·30
Persia ...	1884 about	1,043,000	0·13
Portugal		561,000	0·12
Switzerland ...	1880-82	292,000	0·10
Norway		170,400	0·09
Germany		3,113,500	0·07
Morocco	about	354,000	0·06
Belgium ...	1883 ...	203,000	0·03
Sweden ...	1880-83	139,250	0·03
Austria Hungary...	1883-84	739,500	0·02
Spain ...	1884 ...	136,000	0·01

We would now first enquire whether the above statistics warrant us in the belief that any of these markets are capable of expansion.

It is often supposed, or taken for granted, that Great Britain consumes more tea per head of her population than any other country, and that her trade has reached a point which is capable of little or no further development. Now the foregoing table shows that our Australian kinsmen annually consume 7·66 lb. of tea per head; this they have done for several years past. In 1885 Great Britain used only 4·90 lb. per head, and in no previous year had her constantly increasing consumption reached this figure. In New Zealand also the proportionate consumption is far larger than in the United Kingdom. May we not therefore assume that there is still room for expansion in the home consumption in the mother country, although perhaps it will never attain to the proportions reached in these two colonies.

In Canada we notice that the quantity used is proportionately more than double that of the United States.

World's Consumption of Tea.

On the continent of Europe there is no country, with the exception of Holland, whose annual consumption exceeds one pound per head; the nearest to her—Russia—takes only a little over half a pound, and in almost every other European country the proportion is infinitesimal; indeed, there are places where tea can only be obtained from the shop of the apothecary.

Perhaps this is not surprising when it is remembered that large quantities of the lower, if not the lowest grades of China tea are continually exported to the continent, and in some instances, teas of so inferior a character, that they would not be allowed to pass into consumption in this country;—while *good* teas of any description are but little known in many of the European markets. There is strong probability that the judicious introduction of Indian and Ceylon Tea will gradually promote a demand for these more palatable kinds, and we may then hope to find that a growing consumption will speedily result, and that even new fields may be opened up where others than the apothecary shall supply the commodity.

Turning to South America it is curious that although tea, as known to Europeans, does not seem to be largely consumed, an article of a somewhat similar nature, and known as "Maté" or Paraguay tea, is a very popular beverage. The Argentine Republic alone is said to consume annually about 27,000,000 lb. of this article, or something like nine pounds per head. In addition to this, the same country uses a larger proportion of tea than many European countries. It is also encouraging to note that the imports rose from 766,500 lb. in 1883, to 1,030,800 lb. in 1884. It will be interesting to watch the imports during the next few years.

Looking now to the nationalities by whom tea is chiefly consumed, we find that the British decidedly predominates, and that her share of the consumption given in the above table amounts to 223,774,050 lb., or if we reckon the total amount of tea annually exported from all tea producing countries, at as high a figure as 350,000,000 lb., we find that our compatriots actually drink about two-thirds of the whole. In Great Britain, which takes the principal part of this amount, Indian and Ceylon tea have been steadily gaining ground ever since their introduction; and whereas the proportion borne by Indian tea to the whole consumption twenty years ago was only *three* per cent, it has now risen with Ceylon to *thirty-nine* per cent, and these two articles are every year increasing in favour; we may add that Ceylon tea is now being eagerly enquired for by the British public.

If the proportion of Indian and Ceylon tea consumed in the United Kingdom has risen so enormously, have we not the strongest grounds for anticipating a similar expansion in their use amongst our fellow countrymen in other quarters of the globe, who now for the most part drink principally China tea. We believe that these varieties only require to be placed before them in adequate quantities and constant supplies to ensure the development of the same improved taste which now distinguishes the home market, and that every pound of Indian and Ceylon tea which they consume will, provided the present high standard of quality be maintained, have the effect of ultimately displacing a proportionate quantity of China tea;—and these remarks, we think, also apply to European and American markets.

We might touch upon the subject of Indian and Ceylon tea in relation to the United States, but we think we have already said enough to convince Ceylon tea planters, that there is room, not only for the further development and expansion of nearly every existing market, but also for the gradual opening up of fresh ones; and that the world is large enough to deal with any amount of tea with which Ceylon planters are ever likely to supply it.

Extension of Planting.

The extension of tea in India as in Ceylon is being rapidly pushed forward, though the acreage being opened in the former cannot be compared in extent with what is being done in Ceylon. For many years past the Indian Companies have published the results of their working, and these are interesting and instructive. It must be borne in mind, however, that many private concerns show very much more favourable results. The cost of working companies with their Directors, Agents, and others, who in one way or another draw salaries from them, is necessarily very high, and the capital sunk is as a rule out of proportion to the value of the estates held. Under these circumstances we must not conclude that the results of the working of public companies are a true picture of the Indian tea industry as a whole: there is no question that in many cases more favourable results are being obtained by private concerns, worked on an economical basis.

The table (on next page) shows some interesting statistics of fifteen well-known Companies for 1884:—

WORKING OF INDIAN TEA COMPANIES FOR 1884.

Tea Companies.*	District.	Capital.	Shares.	Acreage.	Tea made & Tea sold.	Yield per acre.	Expenditure.	Cost per lb.	Gross Proceeds.	At per lb.	Profit.	Loss.	Profit per lb.	Loss per lb.	Dividend.
		£	£		lb.	lb.	£		£		£	£	d.	d.	
Eastern Assam	Assam	122,240	10	855	252,000	295	...	1/	...	0/11	...	981-19 8	...	..	...
Luckimpore ...	do	78,852	10	911	257,740	283	...	? 1/1½	...	1/4⅛	2,803	...	2·62	...	3½ p. c.
Jokai (Assam)...	do	80,000	...	1,433	600,064	418	19,620	0/7·45	31,436	1/0¾	5,576	...	5·30	...	10 ,, *a*
					D. & T.* 8,889										
					591,175										
Dejoo	do	45,000	10	556	169,648	305	...	...	...	...	531	...	...	...	2 ,,
					,, 1,949										
					167,699										
Darjeeling ...	Darjeeling	135,420	20	1,562	...	...	...	...	...	...	...	...	...	...	7 ,, ? *a*
Mungledye ..	Assam	161,280	10	1,487	253,858	171	...	? 1/4¾	12,466	1/2 5 16ths	...	5,346	...	2·44	...
Lower Assam ..	do	58,494	10	664	187,840	283	...	1/1	...	0/9½	...	2,680	...	3·50	...
					,, 4,146										
					173,694										
Assam Company	do	187,160	30	7,609	3,735,682	491	116,081	0/7½	143,607†	0/11¾†	27,526	...	4·25	...	14
Jhanzie Tea Association ...	do	36,000	5	1,471	309,455	204	...	? 1/1¾	...	1/0¾	...	535	...	0·91	...
Moabund	do	100,000	1	528	129,800	246	...	0/11¾	8,807	1/4¼	2,399	...	4·50	...	5 ,,
Lebong	Darjeeling	35,000	10	988	...	..	14,727	...	22,174	...	7,447	...	...	...	9 ,, *b*
Panitola	?	82,070	10	596	266,000	446	...	? 0/9⅞	13,891	1/0½	2,933	...	2·63	...	10 ,,
Chargola	?	28,800	100	...	296,063	...	11,883	? 0/9¾	16,768	1/1½	4,889	...	3·75	...	7½ ,,
Jorehaut	Assam	60,500	20	4,000	1,206,677	301	61,943	1/0¼	82,125	1/4¼	21,182	...	4	...	15 ,,
Mookhamcheera	...	...	..	...	...	...	...	...	...	...	...	...	...	...	9 ,,
					Av. of 11 Cos.	313	...	11·50 ⅜ lb.	...	1/1·33	Av. of 7 Cos.		3·86		8·36 ,,

* Draft and Tare. † These figures do not agree, but are taken from the Assam Company's report.

N.B.—Average price per lb. realized by tea from 3 Companies representing 9,638 acres yielding over 400 lb. per acre was 1*s* 0·33*d*; average cost of production being 8·27*d* per lb; profit 4·06*d* per lb. Average yield per acre of 3 Companies representing 5,439 acres, the teas of which sold at an average of 1*s* 4·21*d* per lb. was 277 lb.; average cost of production being 12·50*d* per lb.; profit 3·71*d* per lb.

REMARKS.—(*a*) Extensions out of Revenue. (*b*) Extensions to Capital.

Extension of Planting.

"The Jorehaut Tea Company tops the list with a dividend of 15 per cent, closely followed by the Assam Company with 14 per cent. Two Companies pay 10 per cent, viz., Tokai and Panitola, the Lebong and Mookhamcherra each 9 per cent, Chargola 7½ per cent, Darjeeling Company 7 per cent, Moabund 5 per cent, Luckimpore and Dejoe 3½ per cent and 2 per cent respectively.

"The average cost per lb. of the produce of 11 gardens for which our table furnishes the requisite data was 11·50 d, and the average price realized was 1s 1·33d, showing an average profit per lb. of 1·83d. Of these 11 gardens 7 paid dividends and 4 show a loss: the average dividend for the 7 was 9·29 per cent, the average cost per lb. 10·30d, the average price realized 1s 2·16d, average profit per lb. 3·86d. Turning to the yield per acre we find the average of 11 gardens in the table was 313 lb. The Assam Company tops the list with 491 lb. per acre off 7,609 acres, made its tea for 7½d per lb. and sold it for 11¾d, and paid the best dividend but one, viz., 14 per cent, the Jorehaut Company paying 15 per cent. The highest price 1s 4¼d was realized by the Jorehaut and Moabund Company's teas, the latter being made for 11¾ per lb. from an average yield of 246 lb. per acre off 528 acres.

Later information still referring to the working of the Indian Tea Companies in 1885 is given by the *Home and Colonial Mail*, as follows:—

We have the pleasure to lay before our readers an interesting table, showing the comparative results of operations during the past seasons in twenty-five of the principal tea concerns whose estates are found in the districts of Assam, Cachar, Sylhet, Darjeeling, and Kangra. From this analysis it will be observed that, although season 1884 gave good results, 1885, or last season, gave still better returns. Higher values were in most cases obtained for the teas of 1885—the highest average price realised last season for the crop of any garden in Assam, viz., 1s 5⅞d per lb. was scored by the Jhanzie Tea Association. Among Cachar gardens Borokai Company still bears the palm, the average price obtained for that mark being 1s 6¾d per lb. The Darjeeling Company's average, 1s 5¾d per lb., is also a handsome one.

Larger dividends consequently were paid to shareholders on the results of 1885. In 1884, as will be seen, dividends ranged from 1 to 15 per cent per annum. In 1885, however, they range from 1¼ to 20 per cent per annum, and only four concerns out of twenty-five pay no dividend, while in three of these profits were made, although circumstances rendered a division of the profits inadvisable. It is somewhat surprising that with such handsome results tea is not a more favourite investment among English people. The shares, it is true, are not quoted on the Stock Exchange, and for this reason probably little is nown among the general public of the advantages of tea as an investment.

INDIAN TEA COMPANIES (REGISTERED IN LONDON).

(Arranged according to Area of Cultivation).

COMPARATIVE RESULTS OF WORKING IN 1884 AND 1885.

NAME.	Capital Paid up. £	Present acreage of Cultivation.	Capital per acre. £	Crop of 1884. lb.	Crop of 1885. lb.	Yield per mature acre. 1884.	Yield per mature acre. 1885.	Value of Tea per lb. 1884. s.	Value of Tea per lb. 1884. d.	Value of Tea per lb. 1885. s.	Value of Tea per lb. 1885. d.	Dividend on Crop. 1884.	Dividend on Crop. 1885.
Assam Company	...187,160	7,710	24	2,735,682	2,588,775	359	340	0	11¾	1	1	14 p.c.	20 p.c.
Land Mortage Bank of India, Ltd.	...327,750	7,597	43	1,651,712	1,698,201	256	262	1	2	1	2½	nil.	nil.
Jorehaut Tea Company, Limited	...100,000	4,360	23	1,206,000	1,113,891	316	291	1	3	1	4	15 „	15 „
Upper Assam Tea Company, Ltd.	...194,224	2,456	79	936,783	1,016,962	443	414	1	0 11/16	1	1¼	nil.	nil.
Brahmapootra Tea Company, Ltd.	...114,500	2,340	49	904,893	965,470	444	463	1	2 5/6	1	2	15 „	16 „
British Indian Tea Company, Ltd.	...243,300	2,054	116	548,490	596,455	285	286	1	0	1	0¼	1 „	1¼ „
Noakacharee Tea Company, Ltd.	... 84,000	2,050	41	477,600	524,000	233	255	1	3	1	3½	nil.	nil.
Jokai Assam Tea Company, Ltd.	... 56,037	1,847	30	600,064	650,318	418	377	1	0¾	1	1	10 „	10 „
Doom Dooma Tea Company, Ltd.	...116,100	1,675	69	926,147	1,089,287	638	700	1	0¾	0	11¾	6½ „	13¼ „
Darjeeling Company, Limited	...135,420	1,661	81	473,206	511,037	298	307	1	5½	1	5¾	7 „	8 „
Mungledye Tea Company, Ltd.	...161,280	1,491	108	253,858	290,623	168	200	1	2¼	1	1½	nil.	nil.
Jhanzie Tea Association, Limited	... 55,000	1,487	37	309,455	369,316	387	312	1	0¾	1	5⅞	nil.	10 „
Lebong Tea Company, Limited	... 82,070	1,248	65	292,580	331,050	305	345	1	4½	1	3¼	9 „	9 „
Panitola Tea Company, Limited	... 31,300	1,162	52	264,200	508,293	660	535	0	11½	1	2	10 „	10 „
*Charcola Tea Company, Limited	... 65,500	1,074	61	296,063	—	304	—	1	1½	—		7½ „	10 „
Borelli Tea Company, Limited	... 78,170	973	80	360,477	310,695	503	417	1	2½	1	3¼	6 „	6 „
Luckimpore Tea Coy. of Assam, Ldt.	76,852	967	79	257,740	245,375	268	265	1	4⅞	1	4¾	3½ „	4 „
Borokai Tea Company, Limited	.. 43,560	938	46	238,400	248,960	297	273	1	8	1	6¾	15 „	16 „
*Mookhamcherra Tea Company, Ltd.	45,000	812	55	224,880	—	335	—	1	2	—		9 „	13 „
Indian Tea Company of Cachar, Ltd.	94,060	800	117	207,360	247,360	296	341	1	4	1	4	3½ „	6 „
Tiphook Tea Company, Limited	... 26,000	800	32	230,135	223,204	328	318	0	11¾	1	1¾	5 „	10 „
Scottish Assam Tea Company, Ltd.	... 79,590	712	111	212,762	187,805	319	281	1	3½	1	4½	5 „	5 „
Dejoo Tea Company, Limited	... 43,580	626	70	169,648	223,939	332	434	1	1¾	1	1½	2 „	6 „
Nassau Tea Company, Limited	... 36,000	574	62	140,142	158,645	244	276	1	0⅞	1	0¾	2 „	4½ „
Moabund Tea Company, Limited	... 35,007	560	62	129,800	132,515	363	307	1	4¼	1	3⅝	5 „	5 „

July, 1886.

* Reports for 1885 not received.

ERNEST TYE, 14, St. Mary Axe, E.C.

Tea in Ceylon.

As will be shown later on, the cost of putting tea f. o. b. in Colombo is from 30 to 35 cents* per lb., whilst the average price realized by our produce in London during 1885 was 1/3¼ against 1/1¼ for Indian tea. During 1886 the prices of Ceylon teas and of Indian teas as well have been much lower, though the former have maintained an advantage. No doubt the price fetched by Ceylon tea now is higher in proportion to Indian from the special demand that has sprung up for it, and if there is a fall in prices in the future, a result which most people consider inevitable, it may be that this fall may affect Ceylon teas proportionately more than Indians. However this may be though, the figures given here, and detailed further on, show that the margin we have to work on is a fair one, and it is to be hoped that the increased outturn of India and Ceylon will result in the displacement of some of the China teas which now reach the European markets, and that the fall in price will be such as not to seriously affect our Indian friends or ourselves.

Transport and other facilities in Ceylon.

As a tea-producing country Ceylon possesses many advantages over others. We have on the hills a climate eminently suited for tea, and as salubrious as can well be found anywhere. The lowcountry of Ceylon (I allude more particularly to the Kelani Valley), though very hot is not specially unhealthy. Residents have of course to take care of themselves, so that exposure to heat may not result in fever, but in general healthiness these districts compare most favourably with the plains of India.

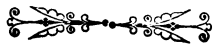
Transport facilities are very great, a railway into the heart of the Central Province, with excellent feeding roads into every district. Labour is abundant, and though not cheap, there is little or no cost attached to introducing it. Rainfall is well distributed and

*Of a rupee, worth at present 1s 4½d, therefore equal to 5½d per lb.

amply sufficient, so that the check to growth which causes the tea to winter in India does not occur so markedly here. It is scarcely correct to say though that tea flushes all the year round in Ceylon, for there are a few months in the year when growth is very vigorous and the yield abundant, but then comes the S.-W. monsoon, and in the hill districts exposed to its influence the ground loses its warmth, and a check to growth occurs, which is generally taken advantage of for pruning. Whereas in India the dry weather is the season when growth is arrested, in Ceylon it is the rains and the wind that accompanies them that have the same result. This period of wintering is however of very short duration compared to that on the continent, and hence no doubt the good yields of tea which are very generally obtained, and the phenomenal ones which have in certain rare cases been realized. The soil of Ceylon is comparatively poor, but it is undoubtedly fertile. To those ignorant of the district it seems incredible that such land as is found in the lowcountry should give the continued and abundant yield it does.

Transport and other facilities in Ceylon.

To the energy of Ceylon planters, aided by the advantages enumerated above, is due the rise of the Colony from the depths of depression into which it had fallen, owing to the extensive collapse of the coffee enterprise, and from which at one time there seemed well-nigh no hope of escape.



NOTES AND CORRIGENDA.

———o———

Note to "Chena" in page 1, line 4.—"Land cleared of forest for native cultivation and on which secondary jungle has grown."

Page 1, line 18.—*Delete* "it" and *read* "such soil."

,, 2, ,, 1.—*For* "they" *read* "the latter."

,, 3, para 3, line 5.—*For* "of it" *read* "of the district."

Note to *Symplocos Obtusa* on page 7.—The *Symplocos* referred to has been found, when the roots are left in the earth, to kill off tea plants, in patches of from a couple up to ten. Its existence in Ceylon was first noticed by a tea planter from Assam, who was familiar with its effects on the Indian Gardens. The tree can be easily identified from its large leaves and tuberous roots, and every trace of stock and roots should be burnt or removed.

Page 7, para 4, line 8.—*After* "therefore" *add* "have a sufficiency."

,, 9, line 3.—*At end read* "Occasionally a tea plant assumes the exact form and leafage of a *Camelia* being proportionately deficient in flush.

,, 9, ,, 10.—*For* "when" *read* "where."

,, 9, ,, 11.—*For* "doesn't" *read* "does not."

,, 9, ,, 13.—*After* "large" *insert* "corrugated."

,, 13, ,, 9.—*After* "and" *insert* "the seed."

,, 16, ,, 8.—*After* "grass" *read* "(Coarse indigenous lemon grass, prevalent on the upland prairies known as patanas.)"

THE TEA PLANTER'S MANUAL.

CHAPTER I.

SELECTION OF LAND.

Choice of Land.

The investor in tea land in Ceylon has two choices: he can either buy coffee land in cultivation or that has been abandoned, at medium to high elevations, or he can buy forest and chena land in the lowcountry. Both courses have their advantages. Coffee land is more or less roaded and drained, and has in many cases buildings on it which can readily be adapted to the requirements of tea. If in cultivation, planting tea on it is cheaper than in the case of forest land; on the other hand no land is so expensive to clear up and get clean as recently abandoned coffee. The soil on coffee estates which have not been washed, has been shown to be well adapted to the growth of tea, and wherever coffee makes wood freely tea is sure to be a success. The tea plant is a much deeper feeder than coffee, and may be expected to obtain nourishment from soil that the coffee roots have not touched where it has depth. Forest land is rarely obtainable in the hills now, government having reserved that which now lies at and near the tops of the mountain ranges, and to obtain such land one must go to the lowcountry. There are large acreages in the Kelani Valley, Kalutara, the Galle district, &c., and some fine land is to be obtained. At present very little is being put up for sale, but it is to be hoped that before long it will be more freely offered. The superiority of forest land over chenas,

especially if they are recent, is very marked at low elevations: this system of cultivation having a very markedly ill-effect on soil exposed to the hot sun and heavy rains of the plains. On the hills, old chena land, and rich patena that has a free soil, both grow tea well, and have been proved to grow it to pay. Much land of this description is now being opened. As a rule though, good coffee land on the hills is preferable to chena and patana that have not grown coffee; whilst on the plains, forest should be selected as much as possible.

Soil.

The soil for tea cannot be too rich, but it must be deep and friable. It is in the latter respect that some of the apparently poor lowcountry soils have the advantage. Shallow soils, especially if mixed with quartz and gravel, will not grow good paying tea. The first qualification therefore for a good tea soil is that it is friable, a sandy loam in fact, to a good depth, and this is more important than richness on the surface. Vegetable mould on the surface is a great assistance to the growth of young tea, but the properties mentioned above are of more lasting importance.

Lay of Land.

As to lay of land, this should be flat or undulating. Steep land will grow tea well for a time, but the loss of soil by constant passage of coolies plucking is a great drawback. In India the advantages of flat over *Teelah* land are considered very great in the plains. On the hills all sloping land is terraced and the cultivation carried out on a system diametrically opposed to ours. The great depth of rich loose soil in the Darjiling hills, characterised as it is by constant landslips, has to be terraced. Catch water drains on the Ceylon system would be obliterated at once, as there is not sufficient clay in the soil to make them hold. The system of holing, necessitated by the caking of the ground during the cold season, also leads to great loss of soil on steep land. Although, therefore, steep slopes have great disadvantages in Ceylon, these are not nearly as great under our system of cultivation, and with our conditions of soil, as in India, and much fine tea is and will be grown on slopes which Indian planters would hesitate to cultivate.

Exposure.

Exposure to wind is a certain drawback to tea as to any other planted product, but its ill-effects are

comparatively small, and the wind must be very exceptionally bad indeed, if, other conditions being favourable, it very materially affects its growth and yield.

The best tea climate is undoubtedly that of the wet portions of the lowcountry, as far as the yield of estates is concerned. The fine soil on some upcountry properties makes them give a large yield, bearing favourable comparison with what is obtained in the plains, but on the whole the growth and yield of tea when young is most promising in the forcing climate of the plains. As regards the permanency of the yield, it is an open question whether the better soil and less forcing climate of the hills will not have the advantage. Tea from the hills is characterised by flavour, that of the plains by strength. At the present moment both qualities appear to fetch about equal prices, and some of the most highly priced teas have been produced by estates in the lowcountry. Climate.

The climate of almost all the coffee districts is suitable for tea. There has been some discussion regarding Uva on this point, but there can be no doubt as to the eminent suitability of the greater part of it. It is to be hoped, however, that this portion of Ceylon will always remain in great part a coffee district.

A rainfall of 100 inches is sufficient for tea. Its distribution however is of more importance than its amount, and it is as regards evenness of distribution that Ceylon is favoured. A rainfall of even less than 100 inches if well distributed will be found sufficient. The following is the rainfall of some of the Assam districts from the official report:— Rainfall.

	1880.	1881.	1882.	Average for the previous 5 years.	1883.
Silchar ..	112·46	127·95	113·71	118·51	160·44
Sylhet ...	173·77	166·33	168·11	167·32	148·36
Dhubri ...	113·76	69·13	100·75	107·39	70·37
Gauhati ...	70·07	72·12	66·22	70·69	59·26
Tezpur ...	79·50	96·61	76·39	86·08	72·24
Nowgong ...	63·53	79·96	71·05	77·68	72·32
Sibsagar ..	99·06	95·32	80·55	93·33	85·44
Dibrugurh ...	120·09	116·28	99·85	114·78	104·26

Elevation appears the least important consideration of any, where aspect and exposure are favourable, Elevation.

From sea level to over 6,000 feet tea appears to flourish, each elevation having its own advantages, but the higher we go the greater the necessity for good soil and shelter from wind. Extreme wet has a greater ill-effect on the flushing the higher the elevation. In fact, at extreme elevations a comparatively dry climate is advantageous.

Shade.

Shade of any kind is most deleterious, at least that which is afforded by jungle trees, coffee, or cinchona. In very rich jungle soil tea will make a certain amount of growth though overshadowed by coffee or cinchona, but the poorer the land the sooner is it necessary to remove them for the sake of the tea. Apart from its effect on the young plant, shade affects the flushing, and causes the tea to give a weak liquor.

Sau Tree.

An exception to the general ill-effect of shade is afforded, it would appear, by the *Albizzia Stipulata*, or *sau* tree as it is called in Assam, and so satisfied are many Indian planters of its virtues that they are said to be planting it out amongst their tea at the rate of 100 trees to the acre. This tree is found up to 4,000 feet elevation in the Himalayas, and therefore ought to grow well on the Ceylon hills. Appended are extracts from the pamphlet issued by the Calcutta Tea Syndicate, as reprinted in the *Indian Tea Gazette* :—

The "Sau" (Albizzia Stipulata) is fully described in Gamble's Manual on Indian Timbers, page 160. It is common in most parts of Assam, and may be generally found on land lying rather low. Some years ago a gentleman in Upper Assam first drew the attention of tea planters to this tree (see "Tea Cyclopædia," 198), very properly calling it a tea fertilizing tree; but it is only within the last few years that experiments have been made to prove that the "Sau" tree possesses peculiar properties in bringing round exhausted soils thereby causing tea bushes to flush vigorously, in fact, imparting a vitality which we are now beginning to find old tea sadly deficient in.

I am not in a position to state the reason of the "Sau" exercising such an influence on tea, and I believe a thorough chemical analysis of the soil can be the only means of ascertaining the cause.

An area of three acres planted with "Sau" about 10 years ago has yielded for the last four years more than double as much tea as any other part of the garden.

I think we may put aside shade as the cause of this increase in yield; in fact, the generality of planters condemn shade. It tends to make the bush throw out long stalky shoots, racing with each other to reach the light, and the flushes from such trees are necessarily meagre and woody.

Such, however, is not the case under "Sau." The tea bushes under this tree, which casts a light shade, are broad in proportion to their height, have an even growth over the whole surface, and yield flushes equal to the finest tea I have seen in the open, where the condition of the soil and age of bush are both in its favour. I do not wish to contend that "Sau" is capable of improving tea plants, where the soil contains elements which in some instances nature has abundantly supplied for the support of the bush, but I do assert that the vitality of the tea bush is limited, probably in a great measure depending on the character of the soil, and unless we restore some of those essential parts, we are yearly, I may say weekly, abstracting them, and the tea planter in a few more years will find himself surrounded by tea which the very best cultivation and the most scientific pruning can never bring round.

The mere fact that blight has during the last few years been more prevalent than formerly, strengthens the argument that the soil is deteriorating, and there is the strongest proof to show that tea under the "Sau" is particularly free from blight when the surrounding trees are suffering.

Mr. Newington writes regarding the "Sau" tree:—

I was out at one of the out-gardens this morning and took particular notice of tea growing under the "Sau" trees. I feel confident that it is beneficial to the tea plant, and will increase the yield. In the first place, it is a cultivator, as the lateral roots grow so near the surface, which seems to open the soil and make it porous; then again I notice this tree does not thoroughly open its leaves until about 8 a.m., just when the sun is getting hot. When the leaves are quite open it gives a slight shade, while at the same time it does not exclude the sun; this is beneficial to the tea plant. Also this slight shade prevents the ground getting dried and baked by the heat of the sun. As far as the fact of the leaves acting as manure is concerned, this is very slight, as the foliage is comparatively light. I quite believe in the tree. For the last three days I have been planting out my "Sau" nurseries among the tea 50 × 50.

Dr. Simons writes:—

I will endeavour to give you all the information I can collect about the "Sau" (Acacia Stipulata). It is a tree worth cultivating among tea more than any other I am acquainted with, for in the way the branches spread, it does not keep the sun entirely off the plants, but moderates the strong heat of the sun's rays, through which evaporation from the leaves is lessened and the flushes come in quicker and larger than on those growing exposed in the open. The "Sau" grows to a very large size and quickly. Dr. Roxburgh in his "Flora Indica" states that one tree planted by himself had a trunk 48½ inches in circumference, 4 feet above the ground, when only 7 years old. Another tree in the Botanical Gardens 20 years old measured 13 feet in circumference. I do not know whether you took notice of the "Sau tree" which was growing in Borsillah Factory, not 100 yards south of the Iron Tea house; I once measured the trunk, and as far as I can recollect, 3 feet above the base it was 14 feet in circumference, and the branches spread over at least one-twentieth of an acre. There were no

vacancies among the tea plants growing underneath it even to within a few feet of the trunk. They always looked uniformly healthy with deep green leaves, while those growing in the open not far off had several vacancies; some looked healthy, but the greater portion looked scraggy with leaves of a pale greenish yellow colour, and would be often affected by blight, either red spider, green fly or fungoid spots on the leaves.

The "Medeloa" (Acacia Elata) which I presume you know as "Koroi" is another desirable tree to grow among tea, but from its slow growth and not having spreading branches, it does not answer so well as the "Sau."

The timber of the "Sau" is not useful for posts as it decays in the ground quickly, for marolies and planks it would answer, but it is rather brittle. Natives scoop out old trees for canoes, which they say last longer than those made of the Poona. It makes excellent charcoal as it burns slowly.

I would surmise, by your writing to gain information about the "Sau," that you want to plant it among tea as a shade. I think it is time that a move is made in this direction, for in consequence of the indiscriminate cutting out of all trees, and leaving none for moderate shade to the tea plants, all the blights now prevailing have been introduced. Fruit trees require planting in the open to receive the heat of the sun, but to treat a plant from which the leaf is required, moderate shading is necessary to prevent evaporation from the leaves.

Mr. Macdonald told me there are some "Sau" trees growing among tea in a garden named Burasoli of the Grob Company, and cover about 5 acres of plants. He is of opinion that the tea plants growing underneath the shade of these trees have looked uniformly healthy and kept free from blights, while those in the adjoining open land are generally affected by blight when prevalent. The yield of the whole garden has averaged 8 maunds per acre, but he considers the greater portion of this yield is plucked off the plants growing under the "Sau" trees.

Mr. Peel writes:—

Yours of 7th to hand, and I have noticed for many years what you allude to regarding "Sau." I first clearly noticed its value in tea at Bursali in 1868, and later on found that "Medeloa" was even better: I fancy it is peculiar to all that group, *i.e.*,

Medeloa	...	Albizzia	elata
Sau	...	„	Stipulata
Hiris or Siris		„	Procera or Sirisa
(Jati) Koroi	...	„	Marginata or Odoratissima

These used all to be called "Acacias."

The benefit to tea is obviously neither shade nor drip, but some chemical process due to the *roots*, as the effect on tea is often seen long after the tree has been felled, and the stump alone remains, at times "dead." I have planted "Medeloa" by fids of root best, and it grows easily. Yes, Hingori is bad, and Sawa which Dr. Simons calls "Englehardtia Roxburghiana," is "worse," and I have seen "Sum" bad. What is the chemical that the "Sau" and "Medeloa" roots evolve? Worth knowing.

Messrs. Philips and Lawrie write in the same strain. Mr. Walker objects to shade of any kind. Mr. Macdonald holds a contrary opinion and writes:—

This garden has been repeatedly attacked by red spider and

green fly. I have never noticed the former touching tea near a "Medeloa," although all around might be perfectly black; the green fly does attack it, but does not seem to do any thing like the damage it does outside the radius of the tree.

Another garden of the Company, 12 miles off, has a plot of indigenous "Sau" tree, probably not more than 10 trees to the acre. I have seen all sorts of blights in this garden, which is only a small one, but have never noticed any on this plot for the last nine years. I cannot say what the probable yield ot this plot may be, as it was never kept account of, but judging from the steady outturn of from 7 to 8 maunds an acre for the whole garden, including some very poor plots indeed, I should think it cannot be less than 10 maunds an acre. Many trees are good for tea such as "Amluckie," "Modar," &c., but not to the extent that these are. I am not in a position to say how tea is actually benefited by shade or chemicals in the soil genial to it. It is a subject that certainly should be brought to the notice of proprietors in a manner that would leave little doubt in their minds as to the experiment being at least worth a trial.

The tree in question is quite common in Ceylon, and is thus described by Mr. W. Ferguson:—

"The *Albizzia stipulata*, Boir., is quite a common tree in the Western Province of Ceylon, and is well-known under its Sinhalese names Kabal-mara or Hulan-mara. It is a high tree, and, as its specific name indicates, is remarkable for its large stipules. When in flower it is a very beautiful plant. The closing up of the leaves of this tree at night is common to the Leguminoseæ, but I think this group of plants is more sensitive to the want of light and the leaves droop as soon as the sun sets. The tree seeds freely, and seed can easily be procured. The tree that is so fatal to tea plants after it is dead is no doubt the large Ceylon form of *Symplocos obtusa*, Wall., and C. P. 1820. The specimens of roots of this tree sent from Abbotsford are very much affected with dry rot, and it is likely that this fungus affects all the living plants near it."

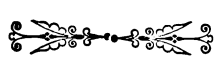
Fuel Supply.

The question of fuel supply is also a very important consideration in selecting land, and one which does not always receive the attention it deserves. Water power is a more important necessity for a tea than for a coffee estate, and being required most in the dry season, the majority of estates will not have a sufficiency of it; such as have therefore possess a special value on that account. When there is no dependable supply of water, and a steam engine has in consequence to be erected, forest reserves for timber are specially required, and failing them the question of transport from the nearest road or railway is an important matter. Coal, coke, or other fuel will have to be purchased and transported, and that in such large quantities that difficulties as to transport may make a large increase

in the annual working expenses. Where water-power is available, fuel will still be required for the driers, and these are matters which every planter who puts his estate into tea should face and allow for at the outset. With the keen competition that may be expected in the future, such considerations as the foregoing may make all the difference between profit and loss.

Size of Estates.

The size of estates is another point requiring attention when tea comes into bearing. The amount of supervision required for the proper working of a tea estate is a point which few coffee planters realize till they learn by experience. Attention to details of all kinds in the tea-house is necessary, even though the immediate conduct of the work may be in the hands of a native or burgher tea-maker or conductor, whilst in the field the plucking requires constant and close supervision. In the case of tea more than of coffee, the prosperity of the estate is entirely dependent on the capacity and hard work of the manager, and the system of supplementing salaries by percentages on profits, a system introduced into Ceylon from India, is one well calculated to incite the manager to do his very best for his employers, feeling as he does that their interests are identical. Liberality towards managers of tea estates is a duty from which proprietors will reap their own reward; whilst at the same time too large acreages should not be put under the charge of one man. A 250 or 300 acre tea estate in bearing cannot be properly worked by less than 2 Europeans, a manager and assistant, in addition to the conductor in charge of the factory.



CHAPTER II.

VARIETIES OF THE TEA PLANT.

The tea plant belongs to the natural order *Camelliaceæ*, it is in fact a Camelia, and the resemblance of its flower to that of the Camelia is noticeable. There are two distinct species or varieties as they are sometimes considered, the Indigenous tea tree of Assam and the China bush. The former in its natural habitat is a forest tree found growing in the jungles, attaining frequently a height of 30 feet or so, with a stem a foot or more in diameter. It is found in hot and moist situations when the temperature, in the coldest season of the year, doesn't fall below 40°. The chief characteristics of this plant are the single upright stem, the large light green leaves, acuminate at the tip and often with very strongly marked serrations round the edges. It is a delicate plant to raise and will not stand much cold without a serious check to its growth.

Indigenous Tea.

The China bush on the other hand has an entirely different habit of growth: though commencing with one stem only, it soon begins to throw up numerous suckers which grow to no great height, and which are supplemented as the plant grows older by stems springing up from the lateral roots. China bushes will in fact in a short time cover the ground with stems springing up in this way. Unpruned its height would not exceed 10 to 12 feet. The chief characteristic of the plant is its hardiness, as it will stand great vicissitudes of heat and cold, and yield abundantly at very extreme elevations. In the plains, China tea flushes little, if at all, and the growth is slow, but at high elevations in India it seems able to withstand frost and snow in the winter season. It matures

China Tea.

its wood very quickly and thus seeds very freely, to the detriment of its yield of leaf.

The Hybrid.

We now come to the Hybrid, a plant originated by cross-fertilization between the China and the Assam Indigenous tree. This is, as a rule, the most profitable plant to cultivate, it is endless in the variety of its form and foliage, being in some cases very closely allied to the original parent forms, and shewing every shade of gradation between them.

In the lowcountry it is probable that the best results would be obtained from the pure indigenous plant, though no considerable acreage has as yet been planted thus; or it would be safer to plant a class of a hybrid closely allied to the indigenous. Tea planters in Assam have arrived at the conclusion that it pays them handsomely to give R150 per maund and upwards for their seed, and many extensions are now being made there in which none but plants of the purest strain are used. In Darjeeling, on the other hand, the old estates consist very largely of China plants, which appear better able to withstand the very severe winter to which they are in some parts exposed than the less hardy hybrids. On extensions, however, a hybrid jât of a hardy character is mostly used. There is no situation in Ceylon suitable for tea where it would be advisable to plant China bushes. We are not liable to severe winters, accompanied by heavy falls of snow; exposure to monsoon winds and rain, where it is so extreme as to make the cultivation of a hardy hybrid a doubtful experiment, would, in my opinion, be little less hazardous with the China plant. At medium and high elevations in Ceylon, China tea, if severely pruned, will give a very satisfactory yield, though one considerably inferior to what would be obtained from good hybrids, the leaf is however more expensive to pluck, and the resulting tea, though characterised by a good flavour, is weak in the cup. I have also found, from considerable experience, that the leaf is very difficult to manipulate in unfavourable manufacturing weather, it being almost impossible to get an even colour in the infused leaf. The importance of obtaining seed from high class bushes cannot be overrated, for upon this depends in a very great degree the future success of the estate; and care in this respect is the more necessary in that the high class of plants

yield seed very sparingly, low class bushes seeding very abundantly. No amount of after care or skill will make up for a bad class of plant put into a garden at the outset. Those who can afford it should plant a type very closely approaching the indigenous in character, in the lowcountry; on the hills, a good hardy high class hybrid should be chosen. It is to be borne in mind that the pure indigenous Assam plant, the result of seed from the original trees in Assam, is very delicate and difficult to raise successfully, the second generation being much hardier. It will also be found that indigenous bushes compare unfavourably with their hardier brethren after a course of regular plucking, as they cease to flush, and in may cases lose their leaves and sulk. They require in fact different treatment in both pruning and plucking, which it is obviously impossible to give them unless they are in a separate field by themselves.

There is no difference in outward appearance between the seed from China, indigenous Assam, and hybrid bushes. Not uncommonly the opinion is held that the larger the seed the better the class of bush, but it is scarcely necessary to say that this idea is utterly erroneous. Nothing but an inspection of the source of seed, or a knowledge of the vendor, can be a satisfactory assurance of the quality of tea seed. From time to time there has been considerable discussion regarding the merits of Ceylon and Indian tea seed. The former is undoubtedly much smaller than the latter, and hence many more seeds go to the maund; whilst the advantage it possesses in point of freshness is of course greatly in its favour. Experience would appear to show that there is little if any advantage to be gained by planting Indian rather than locally grown seed. Ceylon seed is of necessity cheaper than Indian, it gives better results owing to its freshness and small size, and it allows the purchaser the opportunity of personally inspecting the trees from which it is picked: these are very material advantages, which would be conclusive, were it not for the possibility of a deterioration of stock under cultivation rendering the older plantations a more reliable source for seed than our younger trees.

It is most difficult to judge of the jât of tea plants from their appearance in the nursery, richness

of soil having a marked effect on the size of the leaf and vigour of the plant. Any plants which have their leaves close together on the stem are to be avoided; also plants with hard rounded leaves, and any which evince a tendency to "climb" along the ground.

CHAPTER III.

SEED AND NURSERIES.

The blossom of the tea plant springs from the axils of the leaves, and resembles a single white camelia in appearance. It is borne generally on wood of one year's growth. The seeds, which vary from one to four or five in number, are enclosed in a green capsule, which, when fully ripe, splits open and deposits the seed on the ground. In Bengal, the tea flower appears towards the end of the year, and ripens the following October and November, thus taking one year to form. In Ceylon, blossom, and consequently seed, is found more or less all the year round, and we have no regular time of year for harvesting tea seed. In consequence of this peculiarity, the gathering of fully ripe seed is a very difficult and expensive matter with us. The seed becomes ripe without any change of colour in the capsule, which in India becomes brown when fully matured, and hence the very greatest care is necessary in picking seed or a large proportion will be found immature and distinguished by a light yellow colour, ripe seed being quite black. It is scarcely necessary to insist on the necessity for planting fully ripe seed only, and to warn planters against what is immature. Like all soft fleshy seeds, tea seed is very perishable and cannot stand long journeys unless carefully packed. 30,000 seeds per maund is the ordinary calculation, and with good locally grown seed, sown fresh, 20,000 plants will often be got, though I have heard of much larger numbers being sometimes obtained. Indian seed, owing to the long journey it has to undergo, cannot be expected to give as favourable results as this, though in some

Seed.

cases, where it has been carefully and skilfully packed, results almost as favourable have been obtained. 10,000 plants per maund should be a safe calculation for imported seed, and 15,000 for locally grown seed, or to allow ample margin, a maund of imported seed will do 3½ acres; of locally grown, 5 acres planted 4 × 4. When picked, the capsules should on no account be put in the sun to split, as is frequently done, the effect of this treatment being to dry up, and consequently decrease the weight of the seed, which, if not so treated, will weigh heavier, and germinate more readily. Women should at once be employed in husking the seed, without allowing it time to shrivel.

Seed packing.

Seed that is to be transported any distance should not be floated, this being a frequent cause of rotten seed; it is better to pack it all as picked, making an allowance for light seed. Dry powdered charcoal is the safest material to pack in, and if each layer of seed and charcoal is kept separate by a sheet of brown paper, the sinking of the former to the bottom of the box will be prevented. Under any circumstances, the sooner the seed is put in the nursery or germinating beds, the better.

Where the seed is good and fresh it is cheaper and more satisfactory to put it direct into the nursery beds ungerminated. The cost of picking out germinated seeds from a large bulk is very considerable, the work having to be performed regularly, at short intervals, with great care. There is also considerable risk of careless planting when the seeds have developed long radicles, and a proportion of the germinated seed is always broken during the operation. Good fresh seed should therefore be put direct into the nursery beds, doubtful seed alone being germinated beforehand. Where seed comes from a distance, it is well to put it at once into water to soak for 24 hours, that which sinks can then be planted out, and the light seed put to germinate.

Germinating.

As to the best method of germinating seed there are many opinions, one system is described as follows:—

Having selected a small piece of flat ground, mark it off into a series of small beds, about 6 feet long and 3 feet wide. These are hoed to the depth of 5 or 6 inches, unless you prefer a foundation of small stones, which latter will certainly give you better drainage. The bed is now laid over with coarse nullah sand, to the depth of at least two inches, and smoothed over carefully. The

seed is then spread, one seed thick, over the surface, and above this again another layer of sand, one inch or one inch-and-a-half thick is laid; a good watering is given, and the beds are lightly sheltered by tatties, three or four feet from the ground.

The most important point to be considered now is that germinating seed is very intolerant of excessive moisture; in fact it must not have more in any one day than it can consume, and the most critical time is after four or five weeks, when the seed has swollen, and is on the very point of bursting the shell. For applying water, therefore, I use a greenhouse water-pot, made with a very fine rose, and damp rather than water the beds. Unless the quantity of water given is extreme, the sand will filter off all that is superfluous, but the beds should be looked to daily. Under ordinary circumstances the seed will have begun to germinate by the end of the fifth week. The planter should then at intervals of a few days remove the layer of sand, and pick out all the seeds that have burst their shells. and formed a radicle of say half-an-inch or so in length.

I have been most successful in germinating seed between coir mats simply. The seed is laid in a layer on a coir mat, care being taken that the layer is a simgle one, and on it another mat is placed. If kept damp, the seed will germinate freely and can be readily picked out. This method has the advantage of cleanliness. Another plan is to place the seed in alternate layers with black vegetable mould, and water constantly. Germinated seed should be picked out every other day, and be removed immediately the outer shell splits, and before the radicle appears, if possible, otherwise a large proportion is certain to be damaged in planting out.

Nurseries.

The formation of nursery beds is a matter which need not engage our attention very much here, as it is well understood by every planter. Sloping ground should be chosen, with water above it if possible, but in any case close at hand. The beds should be made about four feet wide to facilitate sowing, weeding, &c., and should be raised above the paths between them in the usual way, so as to allow superfluous moisture to run off readily. The soil of the nursery should not be dug too deeply, otherwise the tap roots of the plants will reach an inordinate length before they are put out, and be most difficult to deal with, but it should be thoroughly pulverised and cleared of all roots and stones. Soil with a good proportion of clay in it is better than what is gravelly, as it enables the plants to be removed with earth round their roots. Soil for nurseries should be rich, it does not answer practically

to make them in poor soil. As regards the distance apart at which the seeds should be planted, much depends on the class of plants and the length of time they are intended to remain in the nursery; 2½ to 3 inches apart is the most satisfactory distance when the plants are to remain in the nursery from 6 to 9 months. When first sown the beds may be covered with maana grass laid on them. This will keep the ground warm and greatly assist germination, but it must be removed and ferns be stuck in as soon as the young shoots appear above ground. Mr. Armstrong's advice on this head is so concise and to the point, that I quote it:—"Choose the site as near a stream as possible, for the sake of water. Let the land be as flat as possible, make your beds 5 ft. × 20 ft. with 18 inch walks (which act as drains) between them. If you are going to plant out at six months from seed, sow your seed 2 in. apart every way. I find a very useful little tool, for this is one I made many years ago for picking out cinchona—a flat board, with handle on the top and pegs—50—underneath, any required distance apart; press the board, the pegs being underneath, on to your prepared bed and you have it marked out in fifties to the distances apart you wish to sow your seed. If you are going to plant them out at 1 to 2 years 4 in. × 2 in. or, if space will admit, 4 in. × 4 in. apart; sow 1½ inches deep, if no shade. If your plants are to be forced to save a season, manure your beds, sow 2 in. × 2 in. apart and 1 inch deep, shade with flat tats of jungle stuff 18 in. to 2 ft. above the bed, or with ferns stuck *upright* in the ground, and water freely twice a day, this brings tea seed up more evenly and is advisable. You may begin to remove the shade by degrees, as soon as the wood at the collar of the plant hardens. Unless it is necessary for you to save the season, do *not* manure, nor pick out too good soil, as plants grown in better soil than it is intended to plant them out in, suffer a check from their first start in the clearing. Give your nurseries time; do not dig your beds more than 6 in. to 9 in. deep, or the tap root, always unmanageable, will run deeper than ever. Every tea garden must keep up a nursery for supplies, which is a work we have to attend to every year. Stumps are best for supplies, and should be at the least

two years old: even up to four, a permanent nursery can be kept up in *poor* soil sown 3 in. × 3 in. and the strongest plants taken out for supplies."

Table shewing size of Nursery required for seed at various distances.

Distance apart of seed in inches.	Area in sq. in. per seed.	Area required per maund of seed, including paths.	Size of nursery required for every 10 Maunds.
4″ × 4″	16 inches.	4,000 square feet.	400 feet by 100 feet.
4″ × 3″	12 ,,	3,000 ,, ,,	300 ,, ,, 100 ,,
4″ × 2″	8 ,,	2,000 ,, ,,	200 ,, ,, 100 ,,
3″ × 3″	9 ,,	2,250 ,, ,,	225 ,, ,, 100 ,,
3″ × 2″	6 ,,	15,00 ,, ,,	150 ,, ,, 100 ,,
2″ × 2″	4 ,,	1,000 ,, ,,	100 ,, ,, 100 ,,

The importance of watering nurseries in a liberal manner during the dry weather cannot, I think, be overrated. They should be done thoroughly twice a day if possible. Weeding and the covering with soil of exposed seeds and plants should also be carefully attended to. I do not think R2 per 1,000 is too high an allowance for the cost of raising good plants including cost of making a nursery, but much depends on the amount of watering necessary whilst the plants are growing.

CHAPTER IV.

LINING, HOLING AND PLANTING.

Lining.

The distance usually adopted on fair soil is 4′ × 4′, in poorer soil 4′ × 3′, and sometimes, as close as 3′ × 3′ even. On steep land it is well to put the plants closer than 4 feet apart, leaving that distance between the lines. It must be remembered that if the lines are too close together, the proper growth of the laterals will be interfered with through the pluckers and others forcing their way along the lines, whilst light and air will be excluded from the bushes. In the lowcountry, close planting has been tried in many cases, and there is a very general idea that it is a success, the chief advantage it has being that the soil is by this means protected from the scorching rays of the sun at an early period, whilst of course the returns of the estate when young are proportionately increased. There is great force in these two last arguments, but I question whether in the long run it will be found advantageous to have the lines closer than 4 feet apart, the plants being 3′ and 3½′ apart in the lines according as the land is poor and steep, or rich and of even lay. It must be borne in mind that these remarks all apply to hybrid plants only. Indigenous plants on good land I would plant 5 × 5 or 5 × 4, not closer certainly, whilst China bushes, if planted, should be very close indeed, 3′ × 2′, or 3′ × 2½.

The following extract from the *Tropical Agriculturist* is of interest in this connection :—

"The original tea-fields in Ceylon were usually planted 5 feet by 4, or 5 × 5; then 4 × 4; while now 4 × 3 has become the most common, and, perhaps, in our present want of early returns, it is the best, though we are duly warned by our Indian friends that this distance is rather close. It should always, however, be remem-

bered that a steep or rough piece of land may be planted much closer than a flat or clearing of somewhat even lay; though even on the steepest or roughest land the *working lines* should never be closer than 4 feet. Four by three permits, *practically*, the same number of plants per acre as $3\frac{1}{2} \times 3\frac{1}{2}$. and with the vigorous action of the tea root gives the advantage in its favour, resulting really in one-eighth less travelling by the plucker, to pluck the same number of trees. For instance, in a clearing 200 yards wide, there would be 150 lines if planted 4×3, and 171 if $3\frac{1}{2} \times 3\frac{1}{2}$, showing an increase of labour necessary in the latter as compared to the former. Considering the matter in this light, those who have planted 4×3 may ultimately benefit very largely, for there is no doubt of the plant being able to fully occupy the land with its roots It is merely a matter of time. Thus, in a clearing with lines 6 feet wide, 5 feet wide, 4 feet wide, and $3\frac{1}{2}$ feet, the number of lines respectively for 200 yards would be as follows:—

Lining.

6×3	100	lines	plucking	say 2,400	trees.
5×3	120	,,	,,	2,800	,,
4×3	150	,,	,,	3,600	,,
$3\frac{1}{2} \times 3$	171	,,	,,	3,600	,,

"Considering the immense area travelled by pluckers throughout the season, it is very desirable that this work should be made as easy as possible, the aim being the largest quantity of leaf for the least possible trailing. The writer remembers in the old days of coffee that coolies were told 'you must either bring in plenty of *palam*, or else finish a large stretch of land' implying most emphatically that the two results could not be attained. It will certainly be the same with tea, and the less we trail our coolies over the hills, the more leaf they will, in consequence, bring us.

"While upon this subject, has it never struck tea-planters how excessively the labours of our pluckers are increased upon steep estates by always having to go up and down the lines on the face of the hill, when, by transverse or oblique lining, the feature could be skirted, Ramasamy then having no more downright shoulder work than his *dora* when he walks along his well-traced, almost horizontal roads. Also, if the lines were far apart and the trees close in the line, so as to almost form a hedge, would there not also be a saving of wash? Would not the closely-planted trees help to protect the land from the rush of *debris* down its face?"

Some difficulty will be experienced in getting the lines even amongst coffee, especially where the latter is interspersed with cinchona, but if the rope is divided into sections, readily joined together by means of hooks, the work of lining along the ground will not be found very expensive. Lining 4×4 will cost about R3 per acre.

Various schemes have been suggested as to the best way of combining Coffee and Tea Cultivation until the latter begins to yield. Now I would strongly dissuade anyone from attempting to raise certain lines of tea before others as sure to lead to trouble. For instance, some people plant lines of tea up between the rows, with a plant between each pair of coffee trees up them, intending in two years' time to uproot the coffee and put a tea plant in

Lining.

instead. This or any similar method will infallibly give great trouble, and probably result in a patchy garden. When supplies abound, the difficulty and trouble of keeping pruners and pluckers from touching them is inconceivable to those who have not experienced it.

Steep land in India is very commonly terraced. The lines of plants are made across the face of the hill and not up and down it, and the terraces are formed by a succession of hoeings along the lines. On stiff land terracing is dispensed with, and though no drains are cut there is remarkably little wash. The ground is always kept covered with a thick growth of weeds, which in the flats are kept down by constant hoeings, on the hills by sickleing. The land is so thoroughly impregnated with weed seed and the growth of all vegetation is so rapid during the rains, that clean weeding is an impossibility, and these methods of cultivation are the only ones possible. Draining, too, is impracticable in many places where there is not a stiff subsoil to cut into.

This system of terracing, which appears the only practicable one in India, is, however successful there, quite unsuited to our requirements, and I shall not further refer to it.

Holing.

In holing for plants the great consideration is to give sufficient depth. I find 15″ deep and 9″ broad at the top a good size, and of such holes in easy ground a cooly can cut 120. For stumps, 18″ holes should be cut. In loose soil, especially in coffee, dibbling with a fork or alavangu will be found generally successful. One advantage of this is that the roots of the coffee will not so readily surround the young plant, as they always do when holes are cut. The general cost of holing 4 × 4 is about R8 per acre.

In filling in the holes it is important to see that no stones or rubbish are put in, and that the hole is filled with carefully cleaned soil only; coolies should not be too highly tasked for this work, for which I would allow R2·50 per acre on old land, or more in the case of a new clearing where the surface soil is generally a matted mass of rootlets.

Planting.

Planting is of course the most important of all works. In India the greatest care is taken over this operation, and what we call "ball-planting," or a similar system, seems to be universally adopted. In Ceylon this method is not very generally employed, our damp climate allowing us to put the plants out with only the small amount of soil which naturally adheres to the roots on them. The use of transplanters, paper cones, or some similar system out of the many we are familiar with, would I am sure

be found advisable in our case too. It is generally found that from 4 to 6 months elapse after the tea plant is put in the ground before it makes a fair start and commences growing; this time is occupied no doubt by the formation of roots under ground; but the general growth is greatly hastened where plants are put out with some of the nursery soil adhering to them. Some planters put the plants in the ground with the hand only, making the coolies clear out a hole to contain the root in this way. Amongst coffee, where it is exceedingly difficult to supervise this work closely, I consider this system dangerous, for if the cooly scamps his work, bent tap-roots will be the result. I prefer to use a stick, with which a hole to contain the plant is first made. The latter, having been put in carefully with the root straight, the stick should be driven into the soil four or five times round the plant so as to ensure the latter being surrounded with compressed soil to the bottom of the root, no space being left below it; on no account should the plant be put in too shallow. The soil of course ought to cover it exactly to the collar, but it is better for this to be covered than exposed. When plants are brought from a distance, an occurrence so frequent in Ceylon, no system but this can be followed. With a nursery close at hand, however, every care should be taken to ensure the plants having earth round the roots, as thereby several months' stoppage of growth will be avoided. The nursery beds should be cleared of plants by means of a trench dug at one end so deep as to be below their tap roots, into this the first row of plants should be turned by means of a fork and each plant be carefully taken up and placed in a basket without disturbing the soil round its roots. If taken to the field thus, and put into the holes without much further handling, very few vacancies will be found to result. **Planting.**

The size of plant most suitable for putting out is one about 6 inches high, or a little over, with the stem just matured and about the size of a lead pencil. Such plants do not suffer the same check as large ones, have not such unmanageable tap roots, stand the sun better, and get a better hold of the ground. Plants of this kind are generally those that have been 6 or 7 months in the nursery, though **Plants.**

Plants.

the exact time will depend on climate and soil. In the coffee districts I find that in 7 months from formation of nursery, if the soil of the latter is good, the plants are best suited for putting out. It is but fair to say that this opinion is by no means universally held, some planters preferring a 10 or 12 inch plant, that has been upwards of a year in the nursery, whilst others prefer a smaller one. The shock received by such large plants, and the necessary root pruning, are great disadvantages in the opinion of many. Better than all however are stumps of plants 2 or 3 years old. They should be stumped as in the case of coffee, 6 inches above the collar, and be put in an 18 inch hole. Such stumps are of course difficult to procure unless provision has been made for having them, but they can be topped and plucked at a much earlier age than plants, and are especially suited for supplies.

In doubtful weather, when planting has been done in the open, it is generally advantageous to shade the young plants with ferns; this, however, adds greatly to the cost of opening, but it is money well spent.

Stake planting.

Seed at stake, *when successful*, is I think by far the most satisfactory way of planting, but it is attended with so many risks that it is not very generally practised. In cost, there is some saving, that of making nurseries, but against this has to be put the extra amount of seed required. The seed as it appears above ground is very liable to be injured by rats, crickets, grub, wash, and weeding scrapers, and from these causes many failures are inevitable. Such plants as do grow, however get a great start over those raised in nurseries and transplanted, as they are saved the shock of the latter operation, and besides this, the almost inevitable injury to the tap root which takes place during transplanting is avoided; and this injury, where the tap root is well developed, is one that the plant takes long to recover from. With careful supplying a field planted at stake may be made even, and ample provision should be made for this contingency simultaneously with the original planting out of the seed. Two germinated seeds should I think be planted in each hole, one of which can be afterwards removed. On steep land this system should on no account be followed, it is only suitable for flat or gently sloping fields.

In practice, the system will be found useful when a clearing has to be planted at short notice, plants not being available or only to be got from a great distance; when possible, I should however always advocate the preparation of a nursery. There are certain localities where grub abound, such as virgin land surrounded by forest, where to plant at stake is to court failure. The system can only be successful in places where the enemies to young plants are uncommon. **Stake planting.**

This paragraph on planting would be incomplete without an allusion to that, for Ceylon planters, important subject, how best to get rid of the coffee. The pruning season for coffee arrives after the tea plants have been some months in the ground, and are beginning to make a start. Beyond all question the plants are most injuriously affected by shade at this stage of their growth, free access to light and air is most necessary for them. On the other hand, proprietors cannot as a rule afford to forego the returns which coffee will give them whilst the tea is coming on underneath, and it therefore becomes necessary to adopt a system which will get the utmost yield out of the coffee with the minimum of injury to the young tea. Various methods have been suggested by which the coffee shall be sufficiently thinned to give the tea a fair chance: lopping off the primaries on one side of each tree, and cutting out alternate rows have been suggested. The best method appears to be the lopping of the lower primaries close to the stem, leaving 2 or 3 only at the top of the tree, at the same time taking off all the primaries on non-bearing coffee trees. This will admit a fair amount of light and air to the young tea, and the effect on the coffee trees will be similar to that of a severe pruning, the remaining primaries in many cases giving a good crop when so treated. The effect of this lopping on apparently worn out coffee is in some instances remarkable, and equal in appearance to that resulting from an application of manure. The following year when tea will be 15 to 18 months old, the coffee must be eradicated. After that age the two cannot be grown satisfactorily together. The cheapest method is to top off the remaining primaries and leave them on the ground; these will soon be taken away by the **Planting in Coffee.**

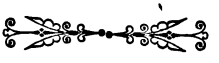
Planting in Coffee.

coolies for firewood and otherwise disposed of. The stems are difficult to deal with, however; they can be left for a year or so until labour is available to remove them, the suckers being taken off from time to time meanwhile, or left if their growth is not too vigorous. The stems may then be sawn or cut off, close to the ground, if of large size, or uprooted if small, they can then be stacked for firewood, or made into charcoal, for which latter purpose they are well suited.

In low districts where white ants soon make an end of coffee stumps so left, it is better to leave them, as firewood or charcoal made from coffee is somewhat expensive and certainly does not pay except where timber is scarce. In young land they are generally sufficiently vigorous to be troublesome unless removed.

In Cinchona.

The combination of vigorous cinchona and tea is most difficult to deal with, and on many coffee estates the former has shown itself a more serious enemy to the tea than coffee even. Tea will not grow and flush satisfactorily under its shade, and this ill effect is greater the poorer the land. It becomes a matter for the proprietor himself to decide what is best to be done in his individual case. Lopping up the cinchonas lets in light and air for a time, but eventually the greater part of it must be removed if the tea is to cover the ground and yield properly. The effect of such shade has a marked effect on the quality of the manufactured tea too, rendering the liquor thin and poor, apart from the effect it has on the yield. Succirubra is worse in its effects than officinalis owing to its larger foliage.



CHAPTER V.

FIELD CULTIVATION.

Staking is a work which is not generally considered very necessary for tea; at any rate, it is not commonly practised, and many plants are injured by the wind in consequence. Under coffee the tea plants are generally well protected, and this work is not so necessary, but in the open it is most desirable that they should be staked in windy situations, though the expense is great. Mr. Armstrong advises a stake driven straight through the middle of the bush without tying at 2 to 3 years, to be tied with aloe tape at 1 to 1½ years. Cutting down the bush to 12 or 15 inches for a year or two, until the roots get a good hold on the ground, is also frequently done on exposed faces. Staking.

The weeding of tea should certainly follow on the same lines as that of coffee: the system of keeping the estate absolutely clean from the first, or, where weeds have been let in, of eradicating them as soon as possible. The Indian system of hoeing the land over at short periods during the rains, or of cutting the weeds with sickles as is practised on the hills, would certainly not answer in Ceylon. The subject of clean weeding as opposed to any other system has been so thoroughly worked out here, that I will not enlarge upon it further. Weeding.

Forking the soil has been found to have a most excellent effect on the growth of tea at all ages, and I should strongly advocate the adoption of this cheap method of increasing the yield of the plants. The burying of prunings along the lines has also a beneficial effect. In India great importance is attached to the working of the soil by means of hoeing Forking.

Forking. and forking, and without this cultivation but little yield of leaf would be obtained after the winter season, when the soil becomes hard and caked and impervious to the rains. The perfection of cultivation in India is considered to lie in cutting the weeds with a sickle, at the same time forking up the ground, so that the cut jungle stuff shall be buried.

Roads. The Roading and Draining of tea land is an important point. It will be found that on many old estates the roads which sufficed for working them as coffee will be insufficient to allow of the efficient working of tea, requiring as it does such constant and close supervision by the manager, and so much attention from the coolies. In some of the old districts especially will this be found to be the case. In laying out new gardens it will be well to bear this fact in mind, and to make all portions of the estate as readily accessible as possible.

Drains. Draining should be done thoroughly, as the evils occasioned by wash are likely to be aggravated by the constant passing of coolies up the lines of tea. It is advisable to drain fairly close, good 18 inch drains at from 30 to 50 feet apart, according to the character of the land, at a gradient of 1 in 15. When coffee is converted into tea, and as the land becomes bared of the former product, it will often be found that the previous drains are insufficient for the wash which is caused by the disturbance of the soil in holing, aggravated as it is by the removal of the coffee branches shading the land. Attention to drains will in fact be an important matter at all times.

Manuring. Manuring is a subject on which there has been but limited experience gained in Ceylon so far. In India, even, this important branch of field cultivation is not practised as universally as might be expected. On the fine tea estates near Gampola and Nawalapitiya a system of very high cultivation has been followed, the places being systematically manured with the refuse from the neighbouring towns. The results of this have been published showing in the case of Mariawatte,—a yield of over 1,000 lb. made tea per acre,—and afford very conclusive evidence that high cultivation will pay in the case of tea as it has paid with coffee in the past. Of the value of cattle manure

for tea we have evidence in India, and lime is now attracting attention as a valuable fertilizer. Colonel Money's experience on this point has shown him that manuring nearly doubles the yield of plants, and adds greatly to the strength of the tea. Cattle manure is, in his opinion, the most valuable of all manures for tea. Applying 8 lb. of manure per plant the cost is put at R55 per acre, a lower rate than can be calculated on for most places in Ceylon; the increased yield is put at 200 lb. per acre, showing a profit of R70 per acre. Mr. Hughes' advice on this subject is as follows:— **Manuring.**

It has been very properly pointed out by recent writers in the *Ceylon Observer* that the actual yield of tea per acre must not be taken as a true guide to the special merits of one estate against another, for the *quality* as well as the *quantity* must be considered.

In these days of new production it would be a serious mistake to expect that quantity should be able to make up for an inferiority in the quality, more especially as the tea industry being comparatively new in Ceylon, and its character hitherto rendered famous in the Mincing Lane markets by reason of its fine flavour and dark-coloured liquor, it is most important that the consignments should only be of the best obtainable quality. These practical points will, of course. naturally occur to the minds of experienced planters, but with plenty of available labour, well-appointed machinery capable of turning out a large yield per diem, there is always a strong temptation to pick coarsely rather than finely and so increase the bulk. It should however be remembered that a yield of 1,000 lb. to 1,200 lb. of prepared tea per acre must be regarded as a somewhat exhausting crop, and that, while newly-opened estates may, and probably do, produce so large a quantity for the present, yet we must expect a falling-off in a few years' time as a result of continued and heavy cropping. Indeed, unless the soil is specially rich or some help in the form of manure be afforded, the peculiar forcing nature of a favourable climate only contributes to the more rapid exhaustion of the soil.

According to Peligot, a distinguished chemist, who has devoted particular attention to the analyses of tea, the leaves of this plant are specially rich in nitrogen; thus in perfectly dried tea at 110° C. he found:—

In 100 parts of	Pekoe	...	6·58	of nitrogen.
,,	Gunpowder	...	6·62	,,
,,	Souchong	...	6·15	,,
,,	Assam	...	5·10	,,

From analyses of Ceylon tea made by myself I believe the average proportion of nitrogen is somewhat less than is usually found in ordinary Assam tea, and I think we may fairly assume that in 1,000 lb. of Ceylon tea as sold we have:—

Nitrogen	...	45 lb.	Phosphoric acid	... 8 lb.
Potash	...	22 ,,	Lime ...	... 2½ ,,

Now, 45 lb. of nitrogen is as much as would be removed per acre by an average crop of wheat, barley or oats, allowing for the nitrogen contained in the straw as well as in the grain; and we

Manuring.

know that continuous corn-growing is very exhausting and can only be done under the most favourable circumstances. Further, it is always usual to return the straw in some form to the land, so that at least a quarter of the original nitrogen removed is really returned. Again, in the matter of potash, an average crop (30 bushels) of wheat removes 10 lb. in the grain, and 18 lb. in the straw,
also (40 bus.) barley „ 10 „ „ 24 „ „
and (45 bus.) oats „ 9 „ „ 30 „ „
Therefore, in respect of potash, we must regard a yield of 1,000 lb. of made tea twice as exhausting as an average crop of the above-named cereals, assuming that the straw of the latter is always returned to the land.

But Ceylon soils are somewhat poor in potash readily available for plant-food, and I should therefore think it most desirable that potash as well as nitrogen should eventually be applied to tea plantations in the form of some manure.

Next we come to the phosphoric acid which stands at 8 lb., which seems small, but practical experience plainly shows the good results of the application of phosphatic manures, and the analysis of a great number of Ceylon soils clearly indicates the necessity of supplying this most important constituent of plant-food.

Lime stands last and amounts to only 2½ lb. from 1,000 lb. of tea, but we find that an average yield of corn, whether wheat, barley or oats does not contain in the grain more than 1 or 2 lb. per acre, as against 8 or 9 lb. in the straw.

There is, therefore, no direct necessity to supply lime, though it may be indirectly useful in the preparation of plant-food, and for the retention of carbonic acid brought down with the rain, and thus assist in the future disintegration of the granite rock.

Having thus briefly noticed the few leading constituents which require to be applied in the form of tea manure, it is only necessary to remark that nitrogen can be most usefully provided either from castor, rape, decorticated cotton cake, dried fish, shoddy or cattle manure. That potash can be obtained either as muriate or as sulphate of potash; the latter probably being the most suitable to Ceylon soils.

Phosphoric acid can be applied either in small doses of concentrated super, containing 20 per cent or more of soluble phosphoric acid, or else in the form of finely-ground steamed bones which moreover are also rich in nitrogen. As the latter can be obtained at Colombo at a reasonable rate, planters can make a practical trial for themselves. Lime will be contained also in the super, and the bones will not in such a case have to be applied separately.

In conclusion, a mixed manure made from the materials can be so compounded that a 100 parts would contain

Nitrogen	...	...	4 per cent
Potash	...	...	3 „
Phosphoric acid		...	10 „

and this could be applied this next season by way of making a practical experiment.

Highly concentrated manures like sulphate of ammonia, nitrato of soda, and similar readily soluble compounds would be both toe stimulating, and tend to produce a coarse growth of leaf.

JOHN HUGHES. F.C.S.

Analytical Laboratory, 79, Mark Lane March 20th, 1885.

The following, from the *Tropical Agriculturist*, regarding some experiments in manuring tea with gastor cake and bones will be of general interest:— Manuring.

Mr. F. McL. Carter, the Manager of Chandpore Tea Estate, Chittagong, has communicated to the *Indian Tea Gazette* the results of an interesting and evidently a very carefully conducted experiment in the manuring of tea. The substances chosen were those so familiar to coffee-planters—bone-dust and castor-poonac—and it will scarcely excite the surprise of readers familiar with the subject of manuring to learn that, while the phosphatic substance alone told more effectually with us in increasing the fruit crops of coffee, the ammoniacal substance alone gave the larger increase in the leaf crops of tea. It is right to mention, however, that bone-dust alone was not used by Mr. Carter in his experiment, but that the comparison was between 18 cwt. per acre of bone-dust and poonac (in the proportions of one-third bone-dust and two-thirds poonac), and 24 cwt. of poonac alone. The increased yield may, therefore, possibly have been due to the 6 cwt. additional fertilizing matter. In both cases there was a very considerable increase of crop over the unmanured plot, besides improvement in the quality of the tea. The good effects of the manuring, it had become evident, too, would last up to the third year at least, and it seems reasonable to conclude that bone-dust would contribute materially to this lasting effect. But we trust similar experiments conducted in Ceylon may lead to certainty on this and other questions in regard to the manuring of tea. It will be curious if the extended cultivation of tea in Ceylon has the effect of reviving the large demand which existed in the best days of coffee for bones and castor-oil cakes.

Mr. Carter commences by explaining that the elevation of the land is "about 80 feet above *dhankets*," probably, creeks or sea inlets (?) perfectly flat, surface soil sandy loam and sub-soil ferruginous clay and sand. The climate is hot, moist and forcing, for although Chittagong is in 22° north, yet the mean temperature is as high as 77° (3° only cooler than Colombo). The average rainfall at the station is given at 106·50, and there are heavy dews and fogs at night. The estate on which the experiments were tried, some twenty-seven miles inland, apparently, has a lighter rainfall, and Mr. Carter complains that the season was unfavourable for quantity, and likewise for the quality of the crop, although the rainfall amounted to 91 inches 16 cents, which was only 6 inches 54 cents below an average in 15 years of 97 inches 70 cents annually. The rainfall, however, in August, one of our best leaf-producing months, was 10 inches 45 cents only, or about half the average.

"I attribute the falling-off in yield and quality to a great extent in consequence of the general lowness of the temperature throughout 1884 as compared with previous seasons, which was, so far as my register indicates, quite exceptional. Thus the average of the *three* previous years at 6 a.m. the max. and min thermometer on cold side registered 71°33, and on hot side 79°75 in the year, whereas in 1884 at 6 a.m. the thermometer averaged on cold side 68°75, and on the hot side 70°25, which shows how much cooler it was in that year; in fact the temperature in *daytime* was actually less than *in nights* of years 1881 to 1883."

The exceptionally cold season, therefore, makes the forcing effect of the manures on vegetation the more remarkable. Mr.

Manuring.

Carter gives the following interesting details regarding the property which was the scene of his experiments:—

Jât of plants, a fair Assam Hybrid, transplanted from nurseries in 1867, at 4′×4′ 2,722 per acre. Pruned down to 24 inches in January 1884, and all old non-leaf producible wood removed as usual. Prunings buried between lines when *green* as in all other seasons. Deep hoed to 12 inches *once* on 26th February and weeded at intervals three and half times subsequently = total 4¼ hoeings and weedings in season.

Average height of bushes at end of year on No 1 Plot = 29 inches.
Do. do. do. 2 „ = 33 do.
Do. do. do. 3 „ = 34 do.
therefore No. 1 plot had grown 5 inches in season.
„ 2 do. 9 do.
„ 3 do. 10 do.

Commenced plucking on March 18th.
Finished do. on December 31st.

Style of Plucking.—From former date to June 21st inclusive, or 3 months, two and three leaves with stalk, the bud counted as *one*, were taken from shoots that carried 3 and 4 matured leaves above pruning mark, and from 22nd June to end of season, the system of taking off three *leaves together with the stalk* was given up, and the usual method hitherto pursued on this garden of plucking off 2 leaves and 2¾ leaves (the bud as one) again reverted to as being the most profitable. There were 23 flushes in the season over entire area of cultivation of 550 acres.

It will be seen that 23 flushes were gathered at intervals of 12½ days, and that out of the 365 days there were only 77 days of rest. Our readers will notice that the growth of the pruned bushes on plot No. 2, where the mixture of bone and cake had been applied was 9 inches against 5 on the unmanured plot, and 10 against 5 where cake alone, but in larger quantity had been used: that is to say, that 24 cwt. of castor-cake per acre doubled the rate of growth of vegetation between pruning time and the end of the season. As our readers will see from the extract which we are about to take over, the yield of tea per acre was increased by bones and poonac, from 629 lb. to 825 lb., rising to 914 lb. where a large quantity of poonac alone was applied. The ready inference might be that poonac alone was the manure to use, but in this case there were 6 cwt. additional to pay for, carry and apply, and Mr. Carter's carefully arranged and analyzed figures would seem to show (?) that while in the case of the second plot the profit on the increased yield of 196 lb. was 55·3 per cent, the profit on an increase of 285 lb. in the case of the third plot was only 10·35 per cent (?).* But the smaller profit is a very good one, and the results of manuring are altogether encouraging. Here are the details:—

The experimental plots Nos. 1, 2 and 3 comprised ¼ acre or 680 bushes each, and were contiguous to each other, and properly fenced in. The three areas were always plucked by the same women (the best), and green leaf weighed accurately by beam scales: therefore I can guarantee the absolute correctness of the results.

On plot No. 1 no manure was applied.

On plot No. 2 { 4 oz. Bone dust p. b. = 6 cwt. per acre.
{ 8 oz. Castor Cake, &c. = 12 „ „

Total... 12 oz. of the combination = 18 cwt. per acre.

* This turned out to be a misprint for 103·5 per cent.

On plot No. 3...1 lb. Castor cake alone per bush=24 cwts. per acre. Manuring.

The manure on both foregoing plots was, previous to application, mixed with *three times* its bulk of dry earth (in the absence of anything better), to ensure equal distribution in the soil, and was put *round* the bushes about 12 inches from the stems and 4 to 6 inches below the surface of the ground and covered over on the 25th March, previous to which date the first flush in season had been gathered, but this was practically of no importance. If the manure had been applied earlier, say 1st or 2nd week in February, I am of opinion better results would have been obtained. The first flush from the plots was taken off on 8th April, and the last on 23rd December, making 22 gatherings from them in the season.

The outturn of green leaf was as follows:—

	lb.	oz.	lb.	lb.
From No. 1 plot of ¼ acre	=628	12	=2,515 per acre	or 629 tea.
,, ,, 2 ,, ,,	=825	8	=3,302 ,,	or 825 ,,
,, ,, 3 ,, ,,	=913	14	=3,656 ,,	or 914 ,,

On a comparison of plots Nos. 1 and 2 the increase of crop per acre on the latter, due to the manure, is equal to 196 lb. of tea, or 31 per cent; between Nos. 1 and 3, an increase on the latter of 285 lb. of tea, equal to 45½ per cent. To ascertain what the profits will be, if any, per acre; or what is the same thing, whether it pays to apply the abovementioned manures *according to the quantity specified in each of the two plots*, the cost of the same, and all the expenses for transport and putting it in the ground must be calculated.

The castor cake was obtained from Calcutta packed in bags which contained 2 *maunds each* or *one ton in* 14 *bags*, and cost R28 per ton. The bone dust was also procured from Calcutta packed in bags, and containing 2 maunds 5 seers in each or 1 ton in 13 bags, and cost R55 per ton.

The different items for a *ton* of each of the manures on garden are as follows:—

	R.	A.	P.
To 1 ton castor cake at R28 ...	28	0	0
,, Freight account per steamer from Calcutta to Chittagong at R16-7-4 per ton ...	16	7	4
,, Landing charges for do., at 4 annas per bag	3	8	0
,, Transport for do., via the khal in boats, (about 25 miles) from station to Pookareah godown, at As. 3-4 per bag ...	2	14	8
,, Transport of do. in carts (a distance of 2 miles) to Garden, and applying do., at 6 annas per cwt	7	7	0
Total cost per ton ...	58	5	0
,, ,, cwt ...	2	14	8
,, ,, maund ...	2	1	4
To 1 ton Bone dust, at R55 per ton ...	55	0	0
,, Freight account on do. from Calcutta per steamer to Chittagong, at R25 per ton	25	0	0

Manuring.

	R.	A.	P.
To Landing charges at 4 annas per bag ...	3	4	0
,, Transport from Station in boats to Pookareah-godown, at Ro-3-7 per bag	2	14	8
,, Transport of do. in carts to Garden, and applying the same, at 6 annas per cwt....	7	7	0
Total cost per ton ...	93	9	8
,, ,, cwt. ...	4	10	11
,, ,, maund ...	3	5	6

Cost per acre.

On plot No. 2.			
The Bone dust applied at 6 cwt. per acre will cost	28	1	6
And Castor cake applied at 12 cwt. per acre	35	0	0
Total cost of combined manure of 18 cwt. on plot No. 2 per acre	63	1	6
On plot No. 3			
Cost of Castor Cake applied alone at 24 cwt. per acre	70	0	0

Results per Acre.

No. 2 Plot—			
No. 1—629 lb. tea per acre, selling at say an average of 8 annas per lb.... ...	314	8	0
No. 2—825 lb. do do do ...	412	8	0
In favour of latter an increase of 196 lb. or 31 per cent at 8 annas	98	0	0
Less cost of manure at 18 cwt. per acre ...	63	1	6
Therefore profits per acre ...	34	14	6
or 55.3 per cent.			
No. 3 Plot—			
No. 1—629 lb. tea per acre, selling at say an average of 8 annas per lb.... ...	314	8	0
No. 3—914 do do do ...	457	0	0
In favour of latter by an increase of 285 lb, or 45.3 per cent.			
do	142	8	0
Less cost of manure at 24 cwt. per acre ...	70	0	0
Therefore profits per acre ...	72	8	0
or 103.5 per cent.			

In the foregoing calculations I have assumed that the realizations of a garden's tea will average annas 8 per lb., but if the crop exceeded that price, the profits derivable from the application of manure would also be higher, and *ceteris paribus*, of smaller amount if the tea averaged less than 8 annas per lb.

It should be pointed out that the quality of the tea will be improved, also, when the ground is adequately manured, enhancing the value by 2 pie per lb. and upwards according to the broker's report on the samples from the experimental plots; but I have not

taken this item into the account: otherwise, the results could be shown to be more satisfactory still. Manuring.

It would, therefore, seem that while an increased yield of 31 per cent gave a profit of over of 55 per cent, an increased yield of over 45 per cent gave a profit of R103·5. What we should now like to see, would be experiments with bones alone, poonac alone, and mixture of the two, at the rate in the three cases of one ton per acre, instead of the varying quantities of 18 and 24 cwt. But, in looking at the experiments from our Ceylon point of view, we suspect we must add very materially to the cost of both bone-dust and oil-cake, as compared with prices in Chittagong. Will anyone, possessed of the necessary information favour us with figures for bone dust and castor poonac, in the Colombo market at present? Our transport charges per rail and road would generally be heavier than the Chittagong boat charges.

In writing that a mixture of bones and castor cake gave a less profitable result than castor cake alone, Mr. Carter states:—

"On a comparison between the yield on plots 2 and 3 (the Castor cake costing R6-14-6, or 11 per cent more per acre on latter), the increase of crop over former was also 11 per cent, and the profits due to this excess equal 107¾ per cent, which is conclusive that notwithstanding the greater cost of the castor cake when applied at 24 cwt. per acre, it is much more remunerative than the mixed manures at 18 cwt. per acre on plot No. 2 that were less expensive. I do not say, however, that because these experiments have proved the castor cake alone in the proportions given per acre the more suitable of the two for this garden, it would answer similarly elsewhere.

"I would strongly recommend this manure, nevertheless, for tea bushes on soils akin to 'Chandpore,' where it is being used largely in the current season, and let me add with marked success. In order to convince my planting friends that if the castor cake can be laid down on the gardens, applying 24 cwt. per acre (I should not advise a lesser quantity on *worn out soils*)—at even *double the cost* I have stated, or R70 by 2=R140 per acre, there would still be a small profit of R2-8, or 1¾ per cent. per acre, subject to conditions stated further on.

"There is no reason why everyone of the Tea estates in Chittagong district should not be able to apply this manure at the price I have done, and may be for less; but for tea properties at a great distance from Calcutta, such as those in Assam, Cachar and Sylhet, &c., the cost of freight and local land transport, &c., will probably be much higher than it is here: therefore the profits will not be so remunerative.

"Now I do not suppose the cost of carriage, &c., to the more distant gardens situated in above provinces or districts will be so excessive as to increase the entire outlay by 75 per cent per acre above the price the article can be landed here for; but assuming such will be the case, then the profits per acre stand as follows, viz:—

No. 1 plot no manure, 629 lb. tea per acre, at Ans. 8	R314	8	0
„ 3 „ castor cake 24 cwt. do. 914 lb. at As 8	457	0	0
In favor of latter by 285 lb. at As.8	142	8	0
Less cost of manure per acre (increased by 75 per cent)	122	8	0
Therefore, profits per acre equal	20	0	0

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"I do not think those results are to be despised. I must again reiterate that the improved quality of the tea due to the manuring and consequent enriching of the soil has not been allowed for in this calculation either. In addition to what has already been recorded, I may notify that the experiments on plots 1, 2 & 3 in 1884 are being continued this season also and *without* any further application of the respective manures, in order to ascertain whether the bushes derive any benefit in the 2nd year; and so far as the outturn shows at present, *i. e.*, to 26th July, when only 11 flushes have been plucked out of the 26, there will be in this season the increase of leaf on plot No. 2 over No 1 of 13 per cent., and on plot No. 3 the excess amounts to 32 per cent. of leaf over the non-manured plot No. 1, which is most satisfactory, as it will still further augment the profits per acre."

It seems, therefore, that for the first year at least, the experiment is largely in favour of a heavy application of castor poonac alone, against a lighter application of a mixture of one-third bone-dust to two-thirds castor-cake. Mr. Carter then goes on to show his brother planters that he has obtained his castor-cake this season at a price 32 per cent lower than last, and he shrewdly suggests:—

"I am disposed now to think that a single application of 24 cwt. of castor-cake per acre will extend its beneficial influence in the soil for nearly three seasons; therefore it would be advisable at commencement of the 4th to manure again; otherwise the yield would fall off which is only natural when the plants or bushes find the food they have been accustomed to, and thrived upon, is no longer at their service. We all know the close analogy between the animal and vegetable kingdom, and I am sure if we had been for some time accustomed to good wholesome diet which agreed with us, we should suffer materially if suddenly deprived of it."

And he adds:—

"Judging from experience derived from trials conducted on this estate, there can be no doubt that when, once stimulating manures have been applied to an exhausted or even weak soil, the practice must be continued every 3rd to 5th year, dependent upon the description and quantity used per acre and age of bushes. If from any cause this is neglected the results will be disastrous, and the money expended on the previous manuring will have been to a great extent wasted.

"Those, therefore, who are thinking about supplying their Tea Gardens, with *stimulating* manures should, once resolved upon, make up their minds also to *continue* using them at *certain fixed periods*, which ought to be ascertained experimentally for each, as soils differ so much that no general rule would answer for all, especially when located in other districts, and I may say, also when gardens are situated some distance apart in the same district even.

Mr. Carter enters into calculations as to the ordinary yield" per acre of an estate which would justify manuring, and he sums up thus:—

"It will thus be seen by the above computations based upon the data actually obtained on experimental plot No. 3, that the ordinary or normal outturn of a garden must not be less than 4 *maunds of tea per acre.* [320 lb.—ED.] otherwise the cost of manuring with castor cake (whether in quantities of 24 cwt., 18 cwt., 12 cwt., or even 6 cwt. to the acre) will not be recovered. This holds good however, on the supposition, 1stly, that the cake costs exactly R70 per acre; 2ndly, that 24 cwt. for that area will bene-

fit the tea bushes for one season only; and 3rdly, that the tea is not improved in quality by the manure, and sells at the same price as the crop from bushes on land without any. Now I have shown previously that in this season the same quantity of castor cake per acre was put in the ground for R53, which is much less; and 2ndly, that the original application is increasing the yield also in following year; and lastly, experts have valued the tea 2 pie to 3 pie per lb. higher on manured plots in the 1st season, though I doubt if there would be any difference in the 2nd year; consequently, when these altered conditions are allowed for, the average outturn of tea per acre in an ordinary season on a garden that has *never been manured* need not be so high as before stated, in order to cover the cost of the manure. Manuring.

He then enters into calculations to show that it will pay to manure gardens yielding 2¼ maunds per acre or 180 lb., or even less, and then he goes on to add together the two years' profits on his manured plots, thus:—

"The nett profits I ought to have shown before, per *acre*, in 2nd season on plot No. 3 when the manure costs R70, I estimate due to an increase in yield of 30 per cent, at R99·8 ... 142¼ per cent.
To which add 45·30 per cent at R72·8 ... 103½ „
Total in *two* years 75·3 per cent equal R872 or ... 245¾ „

The nett profits per *acre* in *both* seasons, when the manure costs R53 as in 1885, I estimate as follows:—

The first year exactly.

No. 1 plot 629 lb. tea per acre at 8 As.	... R314·8	per acre
No. 3 „ 914 „ „ 8½ As.	... 466·8	„
Increase of yield, 285 lb. or 45·3 per cent ..	152-0-0	„
Less cost of manure per acre ...	53-0-0	„
Therefore, profit equals...	99 0·0	„
	or 186¾	per cent.

"The second year by estimation:

On this Garden ⅓ or 33·3 per cent of season's outturn, is generally made by 26th July, which happened to be the exact date the last flush was plucked from experimental plots; therefore the final outturn on these acres at end of season should be in

Plot No. 1, 663 lb. tea per acre, at 8 As. ...	R331	8	0
„ No. 2, 862 „ „ 8 As. ...	431	0	0
Increase in yield, 199 lb or 30 per cent ...	99	8	0
Less cost of manure	nil		
Therefore nett profits	99	8	0
per acre, or	186¾	per cent.	
Add profits 1st year	99	8	0
or	186¾	per cent.	
Total profits in 2 years	199	0	0
or	374½	per cent."	

Mr. Carter promises to give the actual results of the second year on his manured plots, and the valuable paper winds up thus:—

"It should be observed, by judging from the experiments with castor cake alone, at 24 cwt. per acre, that this quantity will not probably be of much benefit to the tea bushes beyond the 3rd year if so long; therefore at the expiration of that period a renewal of the application, or some other, will become a necessity, and I am not quite sure whether a larger quantity per acre would not be more remunerative, and continue to do good over a longer time; but this is merely conjectural, and cannot be made sure of

Manuring.

until ascertained experimentally. I hope next season to make trial of 30 cwts. and upwards per acre, and as many believe *small quantities* applied at shorter intervals will give the best results, and be more profitable than the former method, it will be as well at the same time to experiment in this way also. I hope, however, Mr. Editor, that some of your constituents will co-operate in the work, as I can assure you experimentalising, to be of any practical value, needs great care, constant attention, some expense, and not a little trouble. Those who contemplate manuring with castor cake can draw their own conclusions from foregoing trials, and I hope I have made everything clear and understandable; but if an *entire* garden is to be manured similar to Plot No. 3 from ⅓rd to ¼th at least of the area must be done *yearly*, and for the reason I have indicated. I hope to send you for publication trials with other kinds of manure, and on pruning and weeding, &c., when I can get the papers ready."

Tea planters in Ceylon, as well as in India, owe a debt of gratitude to Mr. Carter for the information he has furnished. Of course, manure made on an estate and collected in cattle sheds or otherwise is of great value. But to keep cattle merely for manure and occasional sales for the butcher is very expensive, and can only in rare cases be profitable. When the time to manure tea estates (in Ceylon) therefore arrives, and it will come early in the case of old coffee estates, "planted up" with tea, it is well to know that if we can get our old friend *white* castor poonac at a moderate price, it will furnish just the combination of ammonia and potash desiderated for the growth of flushes of vegetation, while, for the sake of wood as well as leaf, the addition of small quantities of steamed bone-dust or superphosphate would be advisable.

The following is a further account of the manuring experiments :—

"On a reference to the *Indian Tea Gazette* of 6th October 1885, page 257, para. 2, I assumed the cost of manuring with castor-cake alone 1 lb. per bush. = 24 cwt. per acre, as on plot 3, to amount to R70 per acre, and also that the increased yield of tea in *second season* and without any further application of the manure would be 30 per cent, and that in all probability it will be actually 32 per cent. But the results at end of season have not borne out either of these anticipations: nevertheless the registered increase is still fairly satisfactory, as the following returns testify :—

2ND SEASON.

			tea per acre.	
		lb.		lb.
Outturn of *green* leaf on Plot No. 1 of ¼ acre—*no* manure	equal to	796	equal to	796
Plot No. 2 of ¼ acre, manured with 6 cwt. bone dust and 12 cwt. castor-cake to the 18 cwt. of combination per acre ...	do	899	do	899
Plot No. 3 of ¼ acre, manured with 24 cwt. of castor-poonac alone per acre ...		960	do	961

Comparing one plot with another, No. 2 shows an increase (due to manure) of lb. 103 tea per acre, equal to 3 per cent, over plot No. 1.

And No. 3 an increase of lb 165 tea per acre equal to 20¾ per cent in excess of No. 1, whereas between Nos. 2 and 3 the latter gives an increase of lb. 65 tea per acre equal to 7 per cent only.

Manuring.

The profits per acre therefore are on Plot No. 2:

	As.	R.	A.	P.
Plot No. 1 of lb. 796 tea per acre at say ...	8 equal to	398	0	0
Plot No. 2 of lb. 899 tea per acre at say ...	8 do	449	8	0
In favour of latter, lb. 103 tea per acre at say .. ... 8 As. equal to	51 8 0			
Less cost of manure ... do	nil			
Net profits per acre in 2nd Season do	51 8 0 or 81·6 per cent.			
Add profits per acre in 1st Season do	34 14 6 or 55·3 do			
Total nett profits per acre in *two* Seasons ... ... do	86 6 6 or 136·9 do			

Cost per acre I should have said of combined manure on plot 2 was R63-1-6 in 1884.

Results from Plot No. 3.

	R.	A.	P.
Plot No. 1 of 796 lb. tea per acre at say 8 as.	398	0	0
Plot No. 3 of 961 lb. tea per acre at say 8 as.	480	8	0
In favor of latter by lb. 165 8 As.	82	8	0
Less cost of manure... ...	nil		
Nett profits per acre in 2nd Season	82 8 0 or 117·8 per cent.		
Add profits per acre in 1st Season	72 8 0 or 103·5 „		
Total nett profits per acre in two Seasons	155 0 0 or 221·3 „		

The cost of manuring per acre in 1884 on plot No. 3 being R70.

I have merely to add further, that the bushes on above plots were pruned down to 18 inches on 25th January, and that at end of Season 1885 their average growth was on—

Plot No. 1	25 inches
„ 2	28 „
„ 3	27 „

The areas were deep dug once on 21st December 1884, and light hoed and ridged combined four times subsequently in Season 1885.

The first flush was taken on 29th March, and the last on 29th December, making 26 flushes in Season at average interval of 10½ days. The rainfall in the year was close up 119·99—and average temperature 69° to 70° at 6 a.m. daily.

These trials will be carried on in 1886 also, which makes the third Season; and I expect the manured plots will still show an increase of crop over the non-manured adjacent area, and such a result will be eminently satisfactory.

F. McL. Carter, Manager.

Chandpore, 6th March 1866.

Mr. Hughes sends the following remarks on Mr. Carter's experiments:—

79, Mark Lane, London, E.C.,
23rd October 1885.

In my remarks upon Mr. Carter's experiments (contained in my letter of October 9th), I pointed out the probable reason why the results of the application of castor-poonac had proved more

Manuring.

satisfactory than those obtained from the use of bone dust, namely, that inasmuch as nitrogen was the principal manure ingredient required by the tea-plant, it was only reasonable to conclude that the fertilizer which supplied the largest proportion of this valuable constituent in a form suitable for assimilation was the most suitable and economical manure for tea plantations.

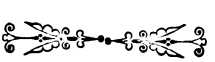
If therefore, white castor-poonac containing 7 to 7½ per cent of nitrogen can be purchased in Colombo at about R35 per ton, it is to be preferred for tea to bone-dust containing only 3·70 per cent of nitrogen, and which would probably cost R60 per ton. In addition to castor, other kinds of poonac will doubtless be found useful, thus dried blood, woollen refuse, fish guano (which is finely ground dried-fish), and many other materials of a similar character whose value, however, will be largely regulated by the proportion of nitrogen they may be found on analysis to contain.

Indeed, well prepared fish manure free from sand should be a cheap and readily procurable fertilizer for tea in Ceylon; but, if it is used, I should like to add a word of caution to the effect that, if planters wish to benefit the tree, and not to feed ants and grub, it will be necessary to treat the fish manure with some chemical such as sulphuric acid or soluble phosphate of lime. In other words, to mix the dried fish already finely ground into a meal, with some concentrated superphospate, say, 90 parts of the former to 10 of the latter, and allow the mixture to remain in a heap for some days before applying it to the land.

In the West Indies, I am informed, that in dry seasons on any soil fish manures have helped to feed ants rather than to nourish the sugar cane, and it is highly important that planters in Ceylon should take all necessary precautions to avoid similar results on their tea estates. Of course, the climate of Ceylon is naturally humid and long droughts are very unusual on the hills, still it is quite possible that many of the severe attacks of grub at the roots of coffee trees may be indirectly due to the previous use of cattle manure, fish, or even poonac—and that if such materials were mixed with some superphospate in a heap protected from the weather, for some days before application, the future results would be more satisfactory, and, while improving the character of the fertilizer, it would also make it unpalatable to insects and grubs. This is a matter certainly worth the careful consideration of practical planters, for it seems a distinct waste of manure to apply it in a condition in which it may contribute food for grubs, &c.

That tea plantations will require manure sooner or later there can be no doubt whatever, and the poorer the soil and more forcing the climate, the more immediate necessity will there be for its application, hence the importance that planters should select these manures which are likely to prove practically the most economical. Judging from the letters I have already received in connection with this question of tea manuring, it would appear that Indian planters, as well as those in Ceylon, are beginning to recognize the future importance of really suitable fertilizers.

JOHN HUGHES, F.C.S.



CHAPTER VI.

TOPPING AND PRUNING.

Topping.

On the subject of the topping of young tea much has been written during the last year or two, and much valuable experience has been gained. Many tea planters of experience are of opinion that the young plants should be allowed to run away for a certain time without any check to their growth, on the ground that this aids the development of the tap root. In support of this view they have as an authority Colonel Money, who advises the unchecked growth of the plant, till it is 18 months old, whatever its size. I cannot think that this is necessary, nor does the plant appear to benefit at all by being allowed to shoot up, as a single stem, to a considerable height, forming wood which has all to be cut off again. If we can divert this energy to the formation of laterals of breadth; if we can make the plant bush in fact, it would appear that the earlier this is done the better. Our present experience certainly supports this latter view I think, and however necessary it may be to let the plant run in India, it does not appear to be so in Ceylon. Having tried various methods of treating young tea myself, and seen the results attained by others, I am of opinion that young plants should not be allowed to run above 3 feet, but that boys should be sent round with a 2½ foot stick to tip all shoots running above that height. At about 18 months, when the bushes should have become fairly shrubby, they should be cut across at 18 inches. This is the system advocated originally by Mr. Hay, and it is now generally considered to be the most suitable one for our requirements. After this topping, the young

Topping.

growth should be allowed to develop fully, and only when it consists of strong fully-developed shoots rising up above the cut should they be tipped. To ensure this being done carefully the coolies may be given sticks of the desired length, and be allowed to pluck nothing under this height. It is of the utmost importance that at this period of the growth of the plant it should be easily treated. Plucking at this stage should be done merely with a view of forming the bush, and not for the sake of yield. On no account should the sides be cut with the knife or plucked, until the lateral branches reach the height of the centre of the bush. Regarding the height at which this plucking should be done, it is difficult to lay down a hard and fast rule, everything depending on the climate and vigour of the bush. If left too long it will be found that the shoots all turn "bangy" and make no further growth for some time, and it is evident that they should be tipped before this occurs. On the other hand, the better these shoots are developed, the larger will be the ultimate yield of the bush; in practice it will be found advisable to tip the shoots at a height of from 24 to 30 inches, according to circumstances, though the latter height is preferable, and to pluck all leaf above that height periodically. The effect of this treatment will be that the bushes will, at from 2 to 2½ years of age, have a number of strong vigorous shoots of young red wood which have sprung from the original topping at 18 inches. Upon this wood the first pruning should take place. The bushes should be cut across at 22 inches, through the young red wood, and all cross wood, small hard shoots, or branches growing into the centre of the tree, should be taken off, also all laterals trailing along the ground. On no account should any side branches be cut back below the level of the bush. By some this plan of pruning is to a certain extent modified, the centre stems of the bush being cut lower than the outer ones, on the ground that the growth in the centre is more vigorous, and unless started from a lower point, the bush will grow into a pyramidal form. Careful and regular plucking will, however, prevent this, and the effect of cutting out the centre of the bush is to cause a matted growth there which is very undesirable.

In subsequent prunings to the first just described, it becomes necessary for the pruner to be able to distinguish the various kinds of stems of which the bush is composed, in order to discriminate between wood which, if cut, will throw out vigorous flushes, and that which will be found comparatively inert. If the plucking has not been overdone, the bush will be covered with branches of the previous season's growth, mostly red or pink, and turning a silver grey in some cases near the main stems from which they spring. The tops of these branches are a mass of "crows-feet," or clusters of plucked twigs, which at the end of the season will be found matted together and excluding from the bush all light and air. It becomes necessary to cut these back, for they would soon cease yielding leaf, and become seed-bearing branches merely. In addition to this young red wood, there is the white wood of older growth which is not capable of bearing the numerous vigorous shoots we obtain from the younger stems. The principle of pruning is to eliminate the latter so as to renew the surface of the bush with as much young growth as possible. At the second pruning, or third occasion on which the knife is applied, abundance of young wood will be found on the surface of the tree through which the pruning should be done leaving a flat surface, but any white wood appearing, or any wood that has not borne vigorously during the preceding season should be cut down to the stem from which it springs. Whippy wood and cross branches should be taken out as before. In the case of China bushes a much more severe method of treatment is necessary. The growth of these plants is quite different, as they consist of numerous stems springing directly from the ground. These should be kept cut down low, to heights varying from 9 to 15 inches, and be well thinned. On the other hand, indigenous plants require much easier treatment, and should be cut at a higher level than hybrids. 2nd Pruning.

It is difficult to give hard and fast rules regarding the pruning of old tea, but there are certain principles to be borne in mind. The chief point is that sufficient wood should be cut out of the bush each year to cause a renewal of the surface which shall make it unnecessary at any time to cut the bush right down, with the result of a Old Tea.

Pruning Old Tea.

largely-lessened yield for that year. The following rules will be found useful:—(1) cut off all seed-bearing shoots, long wiry suckers and cross wood. (2) cut so as to get rid of all crows feet and the immature wood just under them, and so as to leave only matured wood of about the thickness of a pencil. (3) cut so as to keep the surface of the bush as nearly level as possible. (4) cut out all white wood appearing near the surface and bearing ill developed branches on it, also all old distorted stems where there is a new one near it to take its place. There has been some discussion regarding the advisability or otherwise of encouraging suckers on the main stem, and opinions differ on the point. I think they should not be allowed to grow from the main stem below where the principal laterals branch off, as being likely to weaken it, and divert the flow of sap from it. As to the season at which it is done, this seems to be generally determined by the period when the advent of the S.-W. monsoon rains has chilled the soil and caused a stoppage of growth, and July and August are generally the best months. Our experience of the pruning of old tea in Ceylon is very limited still, and it is doubtful whether some of the systems which work well in India are suitable to our circumstances. I have indicated above what is the general principle there, one which I have tried in Ceylon for some years, and which I think will be found suitable to us. Mr. Armstrong's advice on the subject is as follows:—

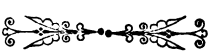
PRUNING.—This is a most important work, and in Ceylon must not be too severe, yearly, more especially if your bushes are topped early. It should take place from June to August, in any part of Ceylon, perhaps July is the best month. There are three ways of pruning:—1st, with a flat surface; 2nd, saucer shape, *i.e.*, hollowing out the centre; and 3rd, hacking down the bush. This last is murder, so I will pass it by without further remark. Saucer-shape pruning does well for a time, but inclines to too matted a growth in the centre of the bush, which leads to too heavy a pruning yearly, more costly, and bad eventually for the bush. I have no doubt myself that pruning with a flat surface is best, so I will only treat of this mode.

When our branches *after* topping have reached up to, say, 3 ft. 6 in. to 4 ft., having been kept down to this by plucking at 2 to 2½ years of age, according to whether the planting was done in the N. E. or S. W. (I am referring to tea at from 3,000 ft. elevation upwards), they should be again cut to a level surface at 3 ft. 3 in., or if topped lower, as explained above, 3 in. above the topping. Any thin whippy branches trailing on the ground should

be cut off close to the stems with a clean cut; and this is all for this year. Next pruning season, when our bushes will be 3 to 3½ years old, they should be first topped to 3 ft. or 2 ft. 6 in. according to elevation of garden, with a flat surface, all cross wood (*i.e.*, branches, growing *through* the bush), and all white barked whippy branches wherever growing, should then be cut off with a clean cut close to the main stem or branch, and growth encouraged outwards and upwards. No laterals should be cut back, except those growing into the bush which, as I have said, are to be entirely removed, but every branch should be topped or nipped back whether it has reached up to the limit of growth allowed, viz., 3 ft. or 2 ft. 6 in. or not. Thus we have given our bushes their first real pruning, and have got them into shape, which with very little pruning they will keep for 4 years. Our procedure yearly for 4 years is then as follows, always keeping a flat surface:--1st year, our bush being 4 to 4½ years old, top at 3 ft. 3 in.; 2nd year, at 3 ft. 6 in ; 3rd year, at 3 ft. 9 in.; 4th year to between 3 ft. 6 in. and 3 ft. 9 in.; or if topped at 2 ft. 6 in., or 24" as advised under *topping* new method, rising 3 in. yearly, keeping as much *red* wood as we can, and removing each year thin white-barked whippy branches, and cutting out all crow s feet from the surface, caused by plucking, leaving not more than a single fork on each branch of the surface; 5th year, cut down to 3 ft., or 2 ft. 6 in. at lower elevations, or just below the original cut, and proceed as before. Thus, low topping and heavy pruning is best done every 5th year. At our higher elevations, say from 3,500 ft. upwards, we can top our bushes far higher than at the lower elevations, and so get increased surface; the flush does not run up from the bush in the same manner it does lower down; our limit here, however, should be at the outside 3 ft 9 in.

Pruning Old Tea.

Exceptions.—Some bushes sulk, either from overplucking, or from bad wood, or from some other cause. These should have the knife freely, either by being cut down to 18 in. or by removing, with the aid of the saw, one or two of the main stems in the centre, cutting down the outer growth as well, to 2 ft. or 18 in., the centre thus opened out will send up a new growth. These bushes should not be plucked till they are well up, say to 3 ft., when they can be plucked and then topped with the knife to 2 ft. 6 in.



CHAPTER VII.

PLUCKING.

Plucking.

There are various objects to be kept in view in plucking, one of the most important being the formation of good pruning wood for the following year. To ensure this, the first shoots after pruning must be allowed to develop well before they are tipped, it is also necessary to leave a sufficiency of foliage on the shoot for its nourishment, and sufficient eyes to afford a succession of flushes during the season. In the case of young tea these considerations are most important, and it is very necessary to treat the bushes easily at an early age. I have already alluded to the plucking of young tea, it being as shown before, a necessary part of the early training of the bush. With old tea, the object is to get the greatest yield of leaf with the least amount of harm to the tree. The sides of young bushes should on no account be plucked until they have attained the full breadth of surface that is required. All shoots coming up through the bush, which may be expected to take the place of wood cut out during pruning, should be allowed to attain the level of the rest of the bush before being touched. The style of plucking must be made to depend upon the kind of pruning it follows on, and the weather; it also has to be modified as the season advances. The heavier the pruning, the lighter must the plucking be till the trees have recovered themselves, and *vice versa*. The system of plucking which I have found most satisfactory at an elevation of 3,500 to 4,000 feet is as follows :—The first flush after pruning I allow to develop at least 5 leaves and the bud; when the bud, the partially developed leaf below it, and ¾ of

the next leaf are taken by one action of the finger and thumb, leaving at least 3 whole leaves and 1 quarter leaf on the shoot. This is continued for 2 or 3 rounds of the estate. With subsequent flushes I allow 3 leaves and the bud to develop, and take the bud, 1 whole leaf, and $\frac{3}{4}$ of the 2nd leaf, leaving one fully developed leaf and an eye on each shoot. About March and April, when the flushes are smaller in size and more abundant, take all that have 2 developed leaves, leaving a shoulder on each shoot. When the rains begin take off all shoots with 2 developed leaves whole, until pruning. Shoots so taken, with no loose leaves, will wither better. Plucking.

Bangy shoots, or those which have had their growth arrested by cold winds or other causes should be nipped. The cost of plucking varies greatly in accordance with the style of work done, from 7 to 15 cents per lb. tea appear to be the usual limit, though very finely plucked tea will cost more than this. Bangy.

On the subject of fine and coarse plucking there has been some controversy from time to time, and the opinion formed by some of the Indian planters who have visited Ceylon has been that we are overworking our bushes. In some cases no doubt tea has suffered from being denuded of every small shoot as it appears at an early period of the season. Insufficient foliage means ill-matured wood for the next season's crop, and damage to the stamina of the tree. On the other hand unless plucking is regularly and systematically carried on bangy shoots will result, and in the low country the flushes will "run away." There is no doubt that the effect of *close* plucking as distinguished from *fine* plucking, soon after pruning, is most fatal in every way, and the way to attain a good yield and healthy bushes is to be very easy at first, and until strong matured wood is formed on them. Towards the end of the season severe plucking has less ill-effect: medium plucking, such as I have previously described, consisting in taking 2½ leaves, is what is most generally followed in Ceylon, and appears to give a good yield and a fair price. *Close* plucking except at the end of the season, results in very fine tea but in lessened yield and more or less damage to the bush. *Fine* plucking on the other hand need not be close; that is, fine leaf alone may be plucked, Fine and coarse plucking. Close plucking.

Fine and coarse plucking.

leaving sufficient leaf to nourish the shoots, and this, resulting in a smaller yield of better quality, is what is advocated by many. Mr. Christie, in his paper read before the Maskeliya Planters' Association, instances the case of an estate where fine plucking showed a very slightly diminished yield over coarse plucking, as follows:—

The information which I have received shows that the loss in quantity by fine plucking is not nearly so great as the coarse plucker—particularly the Indian coarse plucker—thinks. On an estate where the plucking, although never very coarse, was much coarser than it has been during the past 18 months, one patch has been plucked fine for 2½ crops, one field for 2 crops (and this field has kept up the quantity of its yield from the time it was plucked fine), and the whole estate plucked fine for 1½ crops. None of the bushes are in any way harmed, and now that they are being pruned, they look well for the coming crop, having plenty of fine clean "pipes" of young wood to grow new flushes on. From the primary shoots that grew on the wood left after pruning, only the bud and one leaf were taken, and the yield in the beginning fell behind the previous year's yield by about 4,000 lb. of tea, but since then the yields have been alike, and the yield for the year will not be more than 4,000 lb. under the previous year's yield,—which was the largest the estate ever gave. Besides, the fine tea made from the first plucking left far more profit than would have occurred from the larger quantity which would have been obtained had another, but harder, leaf been taken.

Fine leaf of course costs more to gather than coarse leaf, but manufacture and other charges are the same in both cases, hence, if the point is established that fine plucking does not mean a diminished yield, the evidence in its favour is great. For fine plucking need not injure the bush in any way, as has been shown before. A coarse plucker, who takes off whole shoots when developed, would do nearly as much injury as a close plucker who took the same shoots when young. Both would leave bushes with insufficient foliage on them for healthy growth and development. Also, a fine plucker may take fine leaf only, and yet leave as much foliage on the bush as a coarse plucker, provided always, and here is the difficulty, that the coolies are carefully supervised and prevented from taking young shoots. As regards injury to the bush, the case is one of coarse versus close plucking alone: that is, the picking of all shoots as soon as they develop the required number of leaves, and it is this system which has done so much injury in certain cases.

Weighing.

Leaf should be weighed in twice a day and great care must taken that it is not allowed to heat,

Small baskets are most generally used for plucking into, and the leaf in these should be constantly stirred and not pressed down; when full the contents should be emptied into larger baskets which the cooly leaves on the road, and which are brought to the factory. Here the leaf is weighed by the assistant or tea-house conductor, who must carefully examine each basket to see that there is no coarse leaf, that the contents have not been allowed to heat through being unduly pressed down and not turned over, and that there are no whole shoots, the result of stripping the bushes. **Weighing.**

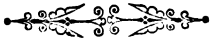
Mr. Armstrong's advice on this subject is as follows:— **Plucking.**

As a rule, plucking can be begun at 30 to 40 days after light pruning,—I am speaking of coffee-zone teas, be it remembered,—and should not be begun till the bud with opened leaf attached, and half the next leaf, can be plucked at one operation *leaving on* one, or sometimes two, fully formed leaves to carry on the young shoot. The shoulder of the half leaf plucked remains on and protects the eye at its base which in its turn throws out a shoot. Shoots, according to elevation, will measure 6 in. to 9 in. long *before* the first plucking, after pruning, takes place. In after plucking, a good deal depends on the number of leaves on the shoot. If, with the bud and its partially opened leaf, we have four full leaves, then I should pluck at the second leaf down (leaving on the shoulder of this leaf, which protects its bud, and will probably give red leaf if removed), at one operation, half, and again the 3rd leaf at another operation, leaving one fully formed young leaf on the shoot. Towards the end of the season, when the bushes are well up, I would act as above, only plucking at the 3rd leaf, leaving its shoulder on the stem, and thus removing at one operation a half leaf and the shoot consisting of two leaves and the bud. One simple rule in plucking is to avoid having a bare shoot without a single leaf to help it on. As in most things a practical lesson is best in plucking. As for the number of days in which it is necessary to go round the garden, I learn at a low elevation, it is considered necessary, according to the time of year, to get round in 7 to 10, up to 12 days at the longest. At high elevations, I have found in my *best* months, I should get round in 10 to 12 days to keep pace with my flush, and again, in 15 to, in the very cold weather, December to January, 20 days I do not think any hard and fast rule should be laid down, at any elevation, as to time. It is for the manager to watch his flush, and wait on it, *just* long enough but no longer, and not to rush violently round his estate in a given number of days, which *must* lead to over-plucking, which means a reduction in yield sooner or later, although perhaps higher prices, for the time being; the benefit of this is also in a way nullified by a smaller outturn.

My average runs this season from (in my worst month) 10 lb. up to 29 lb. of leaf per cooly, including children. Some of my best pluckers have brought in from 36 to 47lb.; ordinary months, I average from 20 to 26 lb. My plucking last season 1881-82 cost

Plucking.

5 3-5ths cents per lb. of tea. This season it will cost 6 cents. Leaf should be weighed in twice daily, at midday and at knocking off time; it is best plucked into the ordinary cooty sack, and emptied into cane or bamboo baskets of the following dimensions, to avoid any chance of tight packing:— 18in. high, 18 inches across bottom, by 1 foot across top. Cane baskets cost me 62 cents each, bamboo 25 cents to 37 cents, but cane are the cheapest in the long run, and nearer the cane country than I am would probably run from 37 to 50 cents each. Leaf must not be pressed down in either cooty sack or basket. Each basket is best kept by its owner in the line he is working in, the cooty sack should be repeatedly emptied into it to avoid any risk of fermentation. As soon as weighing-in begins, leaf should be removed without delay to the withering shelves. Both baskets and cooty sacks should be taken in after the last delivery, or the cooly may use them to carry bazaar stuffs which may taint the leaf, and in any case they get smoked in his lines. *Bangy* tips, *i. e.* a hardening of the bud and stoppage of growth, should always be plucked; if the single leaf of which it consists is soft, it can be utilized, if not, it should be thrown away. It is as well to take the opportunity of any small plucking to nip off all bangy, the next eye will then nearly always throw out a free running shoot.



CHAPTER VIII.

MANUFACTURE.

Withering is the first process of manufacture to engage our attention. It is not only the *first* but the *most important* of any, for badly withered leaf will not make good tea however carefully it may be treated subsequently. The best arrangements of the factory for this purpose are treated of elsewhere, but I may mention here that iron roofing over a withering room is not a good covering, the extremes of heat by day and cold by night being too great for the purpose. An arrangement by which the withering of leaf can be artificially expedited is desirable, especially in a wet climate, as the sooner the leaf is manufactured the better. Wet leaf does not make as good tea as dry, and the sooner the water is got off it the better. In dry weather leaf that comes in during the morning, has generally to be rolled before day-light the next morning, but in wet weather it is very difficult to finish off all the leaf the day after it comes in; some of it has often to be left until the succeeding day. By spreading leaf thick or thin, withering can be delayed or hastened to some extent. Constant turning it in wet weather also hastens the process. In showery weather, a quarter of an hour in the sun will be found to hasten the withering greatly, but this sunning should not be carried to excess or the tips will become blackened, and the liquor seriously weakened. Previous to the rolling process, the leaf should not be allowed to lie about in heaps on any account; if from this cause it should heat, the resulting tea will be sour. Before rolling some planters are in the habit of sifting the leaf through a No. 4 sieve, and

Withering.

Withering.

manufacturing the small leaf and tips that fall through separately. This will add to the appearance of the tea, by making it more tippy, but unless fancy teas are being made will not pay for the time and trouble incurred. Leaf should be well withered. Under withered leaf breaks in the rolling, and gives a poor liquor and ugly tea. Well withered leaf takes a good roll, will ferment well, and shew a good colour in the infusion. To be able to distinguish well withered leaf requires a little practice. When pressed into a ball it should retain its shape, the stalks should be flaccid and bend without breaking. To a practised hand the feel is the best guide: that of a silk handkerchief. I quote Mr. Armstrong's advice on the subject:—

Withering.—Leaf can hardly be spread too thin, provided the day is not too hot or dry. 6 feet will hold 1 lb. of leaf *thinly* spread, a shelf 24 ft. by 3 ft. 9 in. will hold therefore 15 lb. of leaf thinly spread, or up to double this should necessity arise, make your calculations at 20 lb. say, and you will be right. Leaf cannot have too much light and fresh air, and the best results will be obtained from leaf withered naturally, in a temperature of from 75° to 80° with all windows open. In our wet, cold weather, withering is our one great difficulty, and at present we have no machine to help us here. Charcoal won't do, nor will Siroccos, with leaf applied direct. Hot moist air is what is required, drawn rapidly through our leaf, and I hope to obtain the desired result by drawing the hot moist air through my withering loft from the T. Sirocco after it passes through the roll it is firing, with the aid of a Blackman's air propeller, to which our friends of the *Observer* have so often called our attention. The Siroccos are spread throughout the whole length of the ground floor as already shown; there are doors in the upper floor above each Sirocco, so that the heat may be closed off if not required. Should we have no roll to fire, we can get our moist heat by spreading a blanket over the Siroccos kept damp by an occasional sprinkling of water. I have every faith in this succeeding, and am now thus adapting my own factory The sooner after plucking the leaf can be withered —naturally—ready to roll the better, but as night work should be avoided if possible, it is best for us to arrange to have our morning's delivery ready for rolling by 4 to 6 o'clock the next morning, when our wither from the morning's leaf will be found perfectly sweet, even up to 10 o'clook. We can generally manage during the dry hot weather to keep our leaf from first delivery till morning, by excluding light and spreading it a little thicker than is usual. Improperly withered leaf cannot result in good tea, either as to liquor or outturn, and our careful attention is necessary in the withering loft. When leaf is properly withered it is soft and silky to the touch, and should not be hard or dry, pricking the hand when squeezed. If from leaf getting ahead of us, our plucking is coarse, separate the finer from the coarser leaf with a No. 3 sieve, and wither each separately. Do not allow your pluckers to bruise or squeeze the leaf in their hands or baskets, and as

they empty their plucking basket or cooty sack, as the case may be, into their store basket, make them turn over the leaf in the basket, so that it lies lightly. Do not collect your withered leaf for the roller till just before it is wanted. If necessary leaf may be sunned to bring it up to the proper point. In cold weather I have found no harm result from withering my leaf entirely in the sun. Care must be taken to see the leaf does not get dry, and it should be moved indoors before it is quite fully withered and allowed to cool, by which time it will be withered to the degree required. Sun-withered leaf gives a reddish make and fine strong liquor. A reddish make is not disliked in the Lane provided it is well twisted. *Underwithered* leaf gives a thin light-coloured liquor with a light greenish outturn. Overwithered or dry leaf gives a thin liquor fairly pungent with a dark irregular outturn. Leaf spread too thickly and allowed to get sodden gives a dark thick mawkish liquor, strong and flavorless, sometimes sour, and a dark outturn. Allow yourselves double the withering space you estimate you will require, even if a temporary shed has to be built, or when your best months come, you will find yourselves with lots of leaf and nowhere to put it, or so overcrowding it as to make your worst teas when you should be making your best. A strong healthy flush, resulting in heavy pluckings, will give the best tea. And simply for want of withering-room you may stand to lose 2d per lb. on your teas. Four to six coolies will attend to 1,600 lb. of leaf, with an occasional time off, for picking out red leaf or work at tea below stairs. Withering.

It is a question whether withering cannot be more effectually done by dry air, than by hot moist air as Mr. Armstrong recommends and the subject of withering and appliances for hastening this operation, is one well worthy the attention of inventors.* The chief difficulty being that leaf withered at a high temperature, say over 100°, will not make good tea.

Rolling is sometimes done by hand on young estates that have not sufficient tea to justify the purchase of a machine. Now, however, that so many machines are before the public, worked by hand and by power, the number of factories in which hand work is carried on may be expected to decrease greatly. Rolling tables should be slightly roughened only, so as not to break the leaf too much, and 3 feet in height. The method of rolling by hand cannot well be described, it must be seen and practised to be understood. Any one beginning manufacturing can generally have a few coolies taught the work at a neighbouring factory. Coolies rolling should be made to break up and mix the leaves thoroughly, picking out all course leaf that will not take a twist, and this latter should be rolled separately afterwards. Rolling.

* Mr. Gow, of Messrs. Gow, Stanton & Co., has patented an invention for this purpose, which is likely soon to be placed on the market.

Rolling.

Hand rollers are now however so cheap, and they save their cost in such a very short time, that few planters are likely to spend money on making rolling tables, and doing the work by hand. Besides this, there are few places where leaf cannot be sold to a neighbouring factory, and it would be well to do this until the crop of leaf is sufficiently large to justify the erection of buildings and machinery. There are of course certain advantages in commencing manufacturing early on the estate, the coolies being thereby trained to the work, but on the whole it will be found more satisfactory to sell leaf to a neighbouring factory at the current rates than to erect temporary arrangements for manufacturing it.

Machine Rolling.

Mr. Armstrong's hints on the subject of Rolling are as follows, and these apply to the "Universal" and "Excelsior" rollers: –

The roller box should be packed evenly and not too tight. Do not put too much pressure on to begin with, but keep on taking it off for the first five minutes, to let your leaf work well; for the second five minutes put on more pressure, only occasionally easing it; at the end of this five minutes take all pressure off, and turn your leaf well, thoroughly breaking it up, aiding the machine in doing this, by the hand; when for the last ten minutes (we are supposed to finish our roll in twenty) allow full pressure, taking it off, half way up, twice, to break the roll. It is only necessary to see that the press works with the leaf, rising with a jump now and then as the roll turns, if the press is not working with the roll, take off pressure for a little and break up the roll; if after this it does not work, remove some of the weights on the press, which are arranged to allow of this being done. Work with full weights if you can, but the press must work with the leaf or an uneven roll, or a mash will be the consequence. It takes me with ordinary leaf 20 minutes, working at 100 revolutions with the Universal. The Excelsior should be driven at about 90 revolutions. All the rollers from the hand to the Excelsior are worked in the same way and take the same time to complete their work. On some gardens it takes 30 to 45 minutes to complete the roll: this is owing to some local peculiarity in the leaf, stoutness or toughness. Once find out the right time for each class of leaf, and it need never be changed. Rather over-roll than under-roll. Under-rolled tea, although it may have a good appearance, opens smooth in the outturn, and does not give out its full strength. Well-rolled tea shows a crinkly outturn, and gives out its full strength. Very tippy tea, from light rolling, pleases the eye, but will not give as good liquor as the same leaf, heavier rolled with the tips stained out of all recognition, and it is liquor we want more than appearance nowadays, although a good make, *i.e.*, a tight even twist, is a great thing, and this with Jackson's roller will always be the case, with good liquor. Our roll, if properly finished, will show a well-twisted leaf—not in any way mashed—soft and gummy to the touch. If tippy tea is wanted, when the roll is half finished, sift it through a No. 4, and ferment off what comes through,

re-rolling what remains in. Directly the days work is done, thoroughly wash the roller, easily done then, but very difficult if left till the juice begins to harden. Have the top table always turned over when out of work; it is then easy to be seen whether it is clean or no, and gives no chance to the cooly to leave his work half done. Machine Rolling.

I also extract Mr. Agar's hints on the subject, and these also apply to Mr. Jackson's rollers it will be seen:—

Wither leaf well, without allowing to dry; fill up roller well without ramming, and roll gently, without any extra weight for 15 minutes. After this put on some extra weight, say 25 lb., and roll for other 15 minutes. Take out roll, spread on table, break up by hand, and sift through No. 4. Below No. 4 spread thinly on table and cover with blanket, and in about two hours this should be ready for firing. Above No. 4, roll off by hand quickly as sifting will be found to open the twist slightly; after which put this too on table, spreading out thinly—say three inches deep, and cover with blanket. Keep on table for one hour, until partly fermented, aud put back into roller for 15 to 20 minutes of very hard rolling. Whilst rolling and fermenting, "roll" should be stirred up, turned over every ten minutes, the former to give even roll and prevent heating, and latter to give even fermentation. To get strong liquor, juice must be squeezed well out of roll, but mopped up again of course, and it should be of a red colour and not too watery.

Mr. Grigg of Maskeliya gives the following data regarding Jackson's hand roller, as altered by him:—

This roller cost R475 nett. It is fitted with pulleys, circular cross action bars of box, also four on each side under base sliding plate of table, which decidedly makes it work lighter, as I found, by trying it at first by mistake without the pulleys. Since I have had the machine I took off the hopper fixed on top of box and deepened the box 6″. The original size of box when received was 14½″ high, 16½″, wide each way; increase 6

present size of box ... . 20½″ × 16½″.
(The measurement given is outside; the correct for inside is 19½″ × 15½″ × 15½″.) The box as first received rolled about 50 lb. withered leaf; now it will roll 85 lb., viz., experiment on 3rd April 1885:—1st roll 85 lb. withered leaf in 1 hour; 2nd 76 lb. withered leaf in 1 hour: or 161 lb. in two rolls in 2 hours, or 229 lb. green leaf in 2 hours. This was rolled by 4 coolies, 1 cooly tending, total 5. On 19th March it rolled 566 lb. green leaf in 5 rolls with 6 coolies. On 2nd April 419 lb. green leaf in 4 rolls with 5 coolies: that is 4 coolies rolling, 1 cooly tending leaf. When the quantity of leaf requires over two rolls, one or two coolies extra are taken on to spell the others.

* * * * *

When I deepened the box of the hand-roller I increased the weights by 7 lb. each side, or 15 lb.

Well rolled tea should be distinguished by a close twist, which is not altogether lost after infusion, and the large leaves, after infusion, if held up to the light, should not have a mottled appearance, but should be of an even coppery brown

Machine Rolling.

colour. A mottled leaf shows that the leaf cells have not been effectually broken, fermentation not having taken place where they are intact, and such appearance is caused by insufficient rolling. The same principle of commencing rolling lightly, and increasing the pressure as the leaf becomes macerated applies to all other forms of rollers, which will be described later.

Fermentation.

Fermentation, or, as many prefer to term it, oxidation, is a very important process indeed, but it is one on which those who are unacquainted with the practical part of tea manufacture are apt to lay too much stress. Unless the leaf has been well withered and rolled it will not colour properly, and not only this, but at certain periods of the season leaf will not "ferment" properly whatever may be done to it. This is more especially the case for the first 2 or 3 rounds after pruning. The shoots are full of sap and the fermentation is not so satisfactory as later in the season, when the growth is less luxuriant and the shoots smaller and more abundant. Leaf gathered wet will also be found less satisfactory to deal with in this respect than what comes into the factory dry. This portion of the manufacture of tea is one about which there is much to be learnt. It is affected by the state of the leaf, the temperature, and the moisture in the air, and to such an extent is it affected by these varying conditions that it is impossible to lay down hard and fast rules for the guidance of others.

When the leaf has been rolled it must be broken up well, and placed in baskets to ferment. Some planters always compress the roll as much as possible at this state, but it will be generally found that a more even fermentation is obtained by putting it lightly into the baskets, as the centres of any compressed lumps do not colour as quickly as the rest. The roll, after it leaves the machine, is sometimes put through a No. 3 or 4 mesh sieve and what remains above and what goes through are fermented separately. I think it is decidedly advantageous to do this, the small leaf colours much quicker than the large, and the danger of over-fermenting the latter is avoided. The time for fermentation cannot be laid down, sometimes in the low-country half-an-hour suffices, on the hills 6 and 7 hours is occasionally found

insufficient. In good weather and late in the season from 1 to 3 hours will generally be found sufficient. A second and hard rolling by hand or in the machine for the large leaf before it is fired is found advantageous as restoring the twist and adding strength to the tea. Fermentation.

As to turning over the roll during fermentation, this will be found to make the colouring more even in a warm climate, but the effect is not so favourable on the hills. In Assam the roll is often coloured in heaps on the floor which are kept constantly turned over by boys. Mr. Armstrong writes as follows on this subject :—

Fermentation, or, as it is now expressed, oxidisation (I think though we should hold to the former), thoroughly sift the roll through the hands and break up all lumps and put *lightly* into a basket 18″ × 9″ × 6″ at bottom, or into a tray 2 ft. × 2 ft. or 3 ft. × 3 ft. and 3 inches deep, occasionally shaking it down, not pressing it. This, covered with hessian or blankets, not damped unless the weather is very dry, should be put in the coolest part of the factory and left alone for an hour. Roll thus treated should not be turned during fermentation, nor should fermentation on any account be hastened. No time can be fixed for fermentation to reach perfection; if kept as cool as possible, it will take any time from 1¼ to 6½ hours, the longer the time the more constantly must it be examined. Examine it after the first hour, and directly, without too close an examination, it shows a bright copper colour; turn it out on the tables, break it up well, a light hand rolling will do it no harm, and put it in your driers. With properly withered leaf well rolled, except in very dry weather a bright copper outturn is a certainty. In very dry weather we cannot get a bright outturn, and there is no use in waiting on the roll to get it. Young leaf, *i.e.*, leaf for the first three to four rounds after pruning, will not give a good outturn, being a dark olive green in color, with a smoky burnt flavored liquor. In deciding on our color we must use the nose as much as the eyes. So long as the roll has a bright appearance and smells sweet, we may wait to get color; but without gaining color (copper color) should it begin to look dull, wait no longer or the nose will next tell us we have waited just too long—and decomposition has begun.

Firing over charcoal, and dimensions of stoves are thus described by Mr. Armstrong :— Firing over Charcoal.

The bottom of the tray which is covered with 24 to 26 brass mesh should be 21 inches from the fire-grate which is again 9 inches above the level of the floor, or the stoves are from the level of the floor to the top 30 inches high 3 feet wide, at the top inside measurement, sloping to 1 ft. 2 inches at the grate, which rests on ledges 1 inch wide, making below grate to floor level 1 ft. wide. There should be an opening in front of each grate 6 inches wide by 9 inches high for creating a draught to keep the charcoal alive. It takes 40 minutes to complete the firing of each tray of roll, as thus: –

Each tray 3 feet square inside measurement will hold 5 lb. of roll, which when fired equals about 2 lb. of tea. The tray should

Firing over Charcoal.

be constantly removed from the stove, and the contents well turned (on no account should any turning or fingering be allowed when the tray is over the fire, as dust drops through, burns and smokes the tea at once) after about 15 minutes drying, being constantly turned the while, the partially fired roll should be sifted through a No. 8 sieve; that which remains in the sieve is again placed over the stoves, being, as before, constantly taken off and turned, and in 15 minutes is ready to be again sifted, this time through a No. 6. It then takes 10 minutes to finish off, being constantly turned the while. The siftings are left on the table till all teas is finished firing; these represent broken teas, broken pekoe, pekoe No. 2, and dust; and are finished off over the hot stoves by the expiring fires—this takes about 10 minutes.

It will be found better in all cases where possible to purchase a cheap drier rather than to erect stoves. Mr. C. Shand has invented an arrangement which seems to obviate all necessity for erecting them.

Machine Firing.

There has been much complaint of late amongst brokers regarding our teas being "overfired:" this fault must be avoided, as also that of stewing the roll by putting it on the trays too thick, and not firing it briskly enough. It must be remembered that the process of fermentation is carried on more or less for some time after the roll is put over the fire and allowance must be made for this. Tea is properly fired when it is crisp to the touch, when bent it should break or resume its shape. It may be put into the bins slightly underfired, as the warmth it retains will cause sufficient evaporation to make it crisp by the morning. It is important that this process should be completed as quickly as possible, and the work of the factory should be so arranged that more leaf is not rolled and fermented than the driers can work off; if however more leaf has been rolled than can be disposed of, it is better to half fire it and leave it until the surplus is worked off than to allow it to over-ferment. The desirability of completing the firing during daylight when possible is also very obvious. Mr. Armstrong describes a very convenient style of bin:—

Bins.

At the side of each Sirocco we should have a receiving bin. On no account should freshly fired tea be turned out on the floor. I find a very convenient arrangement is this. A bin 3 ft. 6 in. high and say 7 ft. long by 3 ft. wide. The lid opens in two halves: on one half the spare tray ready loaded rests; the other half is opened, and the tray just taken from the Sirocco is put in bodily; the newly-filled tray takes its proper place on the Sirocco, when the tray previously emptied and left in the bin can be cleared and placed ready for refilling and the bin-lid shut down. The back of the bin should have an edging, say 4 in. high, on which the

back rim of the tray rests, causing the tray to slope and so allowing any fine tips to drop through. As the lid is lifted these tips fall into a trough fitted at the back of the bin to receive them, and are fired separately. Each half of the lid should have an edging 1½ in. high round sides and front. This form of table bin is most useful also in final firing, receiving any dust or fine tea remaining in the pekoe souchong, and which will fall through the tray as tea is spread, which may be turned out into the trough at the back by opening the lid. **Bins.**

Tasting of each day's make should be carefully performed the following morning, and any tea which has been burnt, over-fermented, or otherwise damaged, kept separate from the rest. A whole break of tea might be spoilt by a bad day's make being mixed with it, and the possibility of this should be carefully guarded against. **Tea Tasting.**

The following valuable hints are taken from the *Tea Planter's Vade Mecum* :—

A correspondent of the *Tea Gazette* asks for information on the subject of Tea-tasting. Our correspondent has not expressed himself very clearly, but we surmise that the question he wishes answered is the following: is it necessary for a tea-taster to have the three senses—sight, taste, and smell, *jointly* exercised, to form a correct judgment; or, can he dispense with any of them, as for instance sight, and yet arrive at a correct conclusion?

We are of opinion that a Tea-taster cannot do justice to his profession unless he possesses the three senses above-mentioned unimpaired.

In valuing tea for the market, the chief characteristics which a tea-taster looks to, are—

(1) its liquor.
(2) its infusion.
(3) its leaf.
(4) any distinctive characteristics it may possess.

In deciding as to its intrinsic value, he has to consider the following qualities with regard to—

(*i*) Its liquor: whether strong, rasping, pungent, brisk, flavoury, full, thick, malty, dark; or, wanting in strength, dull, insipid, thin, burnt, soft, &c.

(*ii*) Its infusion: whether of bright or dull color; or mixed with green, or any dark or burnt leaves; over or under-fermented, &c.

(*iii*) Its leaf: its make and appearance; whether black, wiry, even, regular, good, well twisted, flaky, bold, tippy; or grey, brown, dusty, little or badly open-twisted, irregular, wanting in tips, &c.

(*iv*) Any distinctive characteristics it may possess: as *e.g.*, its "nose," *i.e.*, the character of its aroma; whether of a strong rich scent, or musty, burnt, highly fired, dull, &c.

In testing the qualities of a tea, therefore, the mind exercises the following faculties:—

(i) the taste. (iii) the sight.
(ii) the sight. (iv) the smell.

Thus the faculty of sight bears an important part in the process of tea-tasting when valuing for the market.

Tea Tasting.

Our correspondent perhaps thinks that by the sense of sight being used, the mind exercises a certain amount of prejudice, either in favour of, or against the tea—according to its make and appearance, before the sense of taste comes into play: in other words, before it is tasted. But this is an erroneous notion, as is well known by any planter of experience. Teas which would be condemned were they to be judged of and valued by their appearance, often fetch the best prices. If the liquor and infusion of tea are good, its appearance and make will in very few instances tell against it, or lower it in value; if, however, in addition to the above good qualities it possesses a good appearance and make, the fact may increase its intrinsic value considerably. Thus the faculty of sight, though in itself important when placed in comparison with that of taste, holds a subordinate position.

To judge, therefore, of the real merits of a tea, and to enable one to arrive at its intrinsic value, it is essential that the three senses should be used *conjointly*. But, in addition, the senses of touch and hearing are also brought into play. A tea-taster as a rule, whenever the sample permits, takes up a portion of the tea he is tasting, to *feel* whether it is crisp; and, moreover, generally puts his hand to his ear to *hear* whether it crackles when pressure is exerted. By so doing he is enabled to report whether the tea has been efficiently fired or not. A tea-taster, therefore, in order to be an adept at his work, requires the full and unimpaired use of all his *five* senses. None of the senses can be rightly used by themselves without the aid of the others; each requires the help of the other in action, to enable one to form a true and correct judgment of the merits and value of a tea.

Sifting.

Sifting is the next operation that has to be performed, and each day's tea should be sifted into the various grades the day following that on which it was made. Where a garden makes small quantities only it will pay to sift into as few grades as possible, so that sampling breaks may be sent away at as short intervals as possible. "Unassorted" teas from some gardens have sold very well, and may consist of all teas sifted though No. 8 sieve, say, and what remains above it broken through, the whole being bulked together, dust being taken out and sent separately. Mr. Armstrong's directions on sifting are as follows:—

All being found as it should be, on tasting, we will now proceed to turn out all our receiving bins, and put the bulk into a No 8 sieve. Teas retained by No. 8 are souchong and red leaf; this is put aside to have the red leaf picked out, after which the souchong is broken through No. 8, broken tea and dust removed, and then mixed with pekoe souchong natural, made in a No. 10. Teas passing through No 8 are then put into No. 10 which retains pekoe souchong natural; pekoe, broken pekoe, broken tea and dust passing through. These are then, according to make, put into a No. 12 or a No. 14; if fine the latter; if coarse the former; which retains pekoe; broken pekoe is then separated from the broken tea and dust, with the shologoo (ordinary rice winnower) and dust separated from broken tea by No. 24. This will be

pekoe dust. In firing quite 50 per cent of broken pekoe, dust, &c., passes through the Sirocco tray and is not of course mixed again with the bulk, but sorted by itself and then mixed with its class. In cleaning the souchong, broken through No. 8, the dust taken from it is tea dust. The broken tea is mixed with broken tea natural taken from the broken pekoe. Souchong is best cleaned through a No. 12, or if only a little of it, by the shologoo as with broken pekoe. If our plucking is at all coarse, congou, a round knobby-looking make, will be left in No. 8 after breaking souching through; this may be shipped as congou or broken by the machine and mixed with the broken tea. So much for sifting by hand, resulting in broken pekoe, pekoe, pekoe souchong, and broken tea, or 4 classes. With tea dust and pekoe dust which need not be looked upon as a class, and are unavoidable. Sifting.

After sorting for the day is finished our teas are packed away in bins. A skeleton framework 7′ × 3′ × 6′ high, inside measurement, of wood 3″ × 2½″ lined with zinc sheeting which costs about R20 per cwt., 8 to 9 sheets running the cwt., makes the neatest and best bins. There may be a wooden partition in the middle, of ½ inch planking, and the bottom should be of 1 inch planks; there should be a sliding door of ½ inch plank at the top through which tea is put into the bin, and directly underneath it, at the bottom, another sliding door by which the bin is emptied. So that one padlock may suffice for both doors, the lower door may have a handle reaching level with the top of the bin, the staple is fixed on to this handle, the hasp on to the top door, and all can be made secure with one padlock. A bin of the dimensions above will take seven zinc sheets to line it top and sides. Bins can be made of any size to suit the factory, but should never be less than 7 ft. long, and in large factories to save space may be 8 ft. high. All bins should be raised off the floor say 6 inches to allow of the floor underneath being swept. Stale tea lying about in corners or under bins may be the cause of ruin to a break, or breaks, by getting mixed accidentally, during the packing or bulking.

Bulking on the estate is now becoming common in India and Ceylon, and is a great improvement on the old system of leaving this operation to be done in the London warehouses, where the chests were emptied on to the floor, the tea turned over with shovels by men in dirty boots, and then rammed into the chests again anyhow. The loss in value occasioned by this process need not be pointed out. At certain warehouses revolving drums are used which make the process less injurious, but it is obvious that any tampering with the packages is to be deprecated, and if we can get the chests direct into the buyers' hands intact the advantages are great. According to the old system of weighing in London every package was turned out and the tare and gross weights taken; under the new Customs' Regulations tea can be weighed nett, a small proportion of the break only being turned out to test the ac- Bulking.

Bulking.

curacy of the statement of contents. It therefore now becomes a most important matter to bulk on the estate, and save the loss in value and extra charges which are incurred if this is not done. It is most important however that this work be thoroughly done, and so particular are the trade that the slightest variation in the quality of the tea in different chests will result in the whole break being turned out, and also lead to future doubt as to the accurate bulking of the teas from that garden. To prevent the slightest variation in quality it therefore becomes necessary to final fire before bulking, although the tea cannot thereby be packed quite hot, as is desirable. Final firing must be carefully done, the tea may be put quite thick on the trays and left till it feels quite hot, care must be taken that it is not burnt, of course. Final firing on Siroccos should be done at 260°. This work is necessary to drive out any moisture the tea may have taken up whilst in the bins, and it also adds briskness to the liquor. Before bulking the tea must all be fired as quickly as possible on all the driers, and from them put into a heap, coolies then surround the heap and with their hands throw the tea outwards. When the whole bulk has thus been thrown outside, it is again collected into a heap. If this operation is repeated again the tea will be found sufficiently mixed.

Customs Regulations.

According to Messrs. G. White & Co.'s circular of March 20th 1886 the new Customs' Regulations for weighing nett are as follows:—

Net weighing appears to be approved of by most buyers, and we annex the last set of rules for guidance, but this system is but a poor substitute for average weights and tares.

REVISED CUSTOMS REGULATIONS.

(Dated 9th November, 1885.)

(For ascertaining the weight of Indian and Ceylon Teas on importation in lieu of previous orders.)

1. The packages on arrival to be weighed to ascertain the gross weight of each package.

2. The importers to give with each entry a statement that the teas in each break have been bulked in India, and that the chests of each break contain even net weights.

3. In order to test the accuracy of this statement, ten per cent of each break to be turned out and weighed net, but in no case are less than three chests to be turned out.

Customs Regulations.

4. If the variation in weight of the test packages, from each other, be found to exceed two pounds, the whole parcel is to be tared. For instance, if the test packages weigh net 79, 80 and 81 lbs. respectively, the variation would not exceed two pounds, but if one package be found to weigh 79 lb. and any other 82 lb. or more, then the whole break to be tared, unless the importer and surveyor consider that an average tare can equitably be given, in which case the tarers must not vary more than two pounds, as in the case of the net weights.

5. Duty is to be charged on the average weight of the packages weighed net, provided that, when the average of the packages weighed net amounts to so many pounds and a half or more, the half or more will be charged as a full pound; when the fraction is less than a half, it may be disregarded.

6. All Indian Teas bulked in this country are to be weighed gross and each chest tared.

Importers to be allowed the option of having Teas dealt with under the above regulations or under the general regulations on this subject laid down in *General Order* 19, 1882.

The great difficulty in getting the tares even, is that the chests, if the wood is not thoroughly seasoned, are very apt to absorb moisture and will be found to vary in weight greatly on arrival in London. This can only be obviated by using thoroughly seasoned wood. Unless the tares can be got fairly even, it is of no use bulking in Ceylon, but every endeavour should be made to reduce the variation to a minimum. It is a good plan to line with lead and partially hoop iron all the chests to be despatched, and then weigh them empty. In each class of tea a sufficient number of chests should be selected whose weight most nearly approximates. Thus out of say 100 packages, the 20 weighing the heaviest might be taken for Broken Pekoes, the next 20 or so for Pekoes, and so on, the differences of weight in each class being thus reduced to a minimum. Where bulking is not done in Ceylon, or is so imperfectly done as not to be recognised at home, the old system of weighing gross and tare is followed; in this case the packages are weighed gross, fractions of a pound being neglected. They are then emptied, and the packages with their hoop-iron and lead are weighed; in this case fractions of a pound being counted as one pound. From this it is evident that a very serious loss may occur to the shipper if the chests are not

Customs Regulations.

properly filled, or if any great variation takes place in the weight of the wood, and this possible loss must be carefully guarded against. For instance, a chest weighing gross 70 lb. 15 oz. and taring 20 lb. 1 oz. would be returned as gross 70 lb. tare 21 lb. or nett 49 lb., whereas the actual contents were 50 lb. 14 oz. —a loss of 1 lb. 14 oz. of tea on the package. Had it weighed 71 lb. 1 oz. gross and tared 19 lb. 15 oz. the Customs would return it as 71 lb. gross and 20 lb. tare or 51 lb. tea. It is therefore as well to put ¼ lb. or thereabout extra in every half-chest and a little more in every chest endeavouring to make the tare slightly under the even pound. These remarks it must be borne in mind apply to the old system of weighing gross, and not to the new system when the teas are factory bulked, and are weighed nett as previously described.

Size of Packages.

As to size of packages, the rules for draft are that all packages weighing over 28 lb. gross are subject to a draft of 1 lb. per package. Thus when boxes are sent, and it pays to pack fancy teas in such packages, care should be taken that the gross weight does not exceed 28 lb.; otherwise the proportionate loss is very great. When breaks are small it pays to pack in half-chests, for the smallest quantities placed in show at the Warehouses for public sale are 8 chests, or 8 half-chests, or 20 boxes; and thus a small quantity of tea, say 500 lb. if packed in ½ chests would be a sampling break; if in chests it would not. Such considerations apart, all ordinary teas should be packed in chests of 90 to 100 lb., even though this necessitates poles and ropes for carrying them. The draft, a loss of 1 lb. tea to the shipper, is the same for a 50 lb. and 100 lb. chest. Freight on two 50 lb. chests will be more than on one, 100 lb. chest. Whilst an examination of the following dock charges will show the disadvantage which small packages labour under.

Warehouse Charges.

The increased dock rates last year which fell heavily upon importers are to be reduced from the 1st July, as per table, from which the private warehouses will allow a discount of 5 per cent:

Warehouse Charges.

Revised Charges on Tea from 1st July 1886.

PACKAGE WEIGHING GROSS.

	160 lb. to 199 lb.		130 lb. to 159 lb.		90 lb. to 129 lb.		80 lb. to 89 lb.	80 lb. to 129 lb.	60 lb. to 79 lb.
	1886.	1885.	1886.	1885.	1886.	1885.	1886.	1885	1886.
	s d	s d	s d	s d	s d		s d	s d	s d
Landing & Housing Rate	2 3	2 6	1 10	2 0	1 6	In 1885 one rate was charged from 90 lb. to 129 lb.	1 4	1 6	1 3
Management Rate	2 9	3 2	2 3	2 6	1 10		1 8	2 0	1 5
Bulking and Taring	2 0	2 3	1 8	1 10	1 5		1 3	1 6	1 2
Bulking, Taring or Weighing Net separately	1 6	1 6	1 3	1 3	1 0		0 11	1 0	0 10
Weighing Net and Bulking*	...	3 0	...	2 6	...		...	2 0	...
Rent per Week	0 1	0 1	0 0¾	0 0¾	0 0½		0 0½	0 0½	0 0½

	60 lb. to 79 lb.		45 lb. to 59 lb.		35 lb. to 44 lb.		17 lb. to 34 lb.		Not exceeding 16 lb.	
	1885.	1886.	1885.	1886.	1885.	1886.	1885.	1886.	1885.	1886.
	s d	s d	s d	s d	s d	s d	s d	s d	s d	s d
Landing & Housing Rate	1 4	1 0	1 2	0 10	1 0	0 6	0 7	0 3	0 3	
Management Rate	1 6	1 2	1 4	1 0	1 2	0 7	0 8	0 4	0 4	
Bulking and Taring	1 3	0 11	1 0	0 8	0 10	0 6	0 8	0 4	0 6	
Bulking, Taring or Weighing Net separately	0 10	0 8	0 8	0 6	0 7	0 5	0 6	0 3	0 5	
Weighing Net and Bulking*	1 8	...	1 4	...	1 2	...	1 0	...	0 10	
Rent per Week	0 0½	0 0½	0 0½	0 0¼	0 0¼	0 0¼	0 0¼	0 0¼	0 0¼	

If we compare these charges on a 100 lb. and 50 lb. package we find.

	100 lb. Net.	50 lb. Net.
Managment rate	...1*s* 10*d*	...1*s* 5*d*
Bulking and Taring	...1*s* 5*d*	...1*s* 2*d*
	3*s* 3*d*	2*s* 7*d*
	or ·39*d* per lb.	or ·62*d* per lb.

A difference of ¼ per lb. in favour of the larger package. If to this is added the saving in cost of packing chests, saving in freight, and saving in draft, the case in favour of large packages as a rule will be found very strong. It will also be noticed that the gross packages should be, as nearly as possible, 59 lb., 79 lb., or 129 lb. to save the increased charges when the weight exceeds those amounts.

Cost of Transport.

The following data regarding tea transport, communicated by Mr. Rutherford, are of great interest:—

Railway freight on Tea per lb. calculated on a basis of 1,680 lb. of tea to a ton of gross weight:—Kalutara to Colombo ·20c; Peradeniya ·70c; Kandy ·74c; Gampola ·78c; Wattegama ·82c; Nawalapitiya ·86c; Matale 92c; Galboda 1·04c; Watawala 1·18c;

* As shown by Rule 6. Weighing Net and Bulking is no longer allowed.

Cost of Transport.

Hatton 1·37c; Kotagala 1·44c; Wattegoda 1·66c; Nanuoya 1·85c. From Patupowla, Kalutara, by canal to Colombo ·30c per lb.; from Yatiyantota by river ·56c. per lb.

Ocean Freights and Insurance.

1 ton of shipping = 50 cubic feet—an average of 917 lb. of tea. Cost of freight per lb. of tea in cents = freight in shillings × ·067 cents. Insurance at 1s 3d per lb. value; cost of insurance per lb. of tea in cents = shillings per £100 + ·038 cents.

Freights.				*Insurance.*			
Rate per ton.			Per lb. tea.		Per £100.		Per lb. tea.
s.	d.		cents.		s.	d.	cents.
25	5	...	1·67	Exchange at 1s 7½d.	10	0	... 0·38
27	6	...	1·84		11	0	... 0·42
30	0	...	2·01		12	0	... 0·46
32	6	...	2·18		13	0	... 0·50
35	0	...	2·34		14	0	... 0·53
37	6	...	2·51		15	0	... 0·57
40	0	...	2·68		16	0	... 0·61
42	6	...	2·85		17	0	... 0·65
45	0	...	3·02		18	0	... 0·70
47	6	...	3·19		19	0	... 0·73
50	0	...	3·36		20	0	... 0·77

Size of Breaks.

As to size of breaks it has already been stated the Customs will not allow the trade to sample less than 8 chests or ½ chests and 20 boxes, whilst large buyers will not take the trouble to sample small breaks. These are now put up for sale after the large lots have been disposed of, when the large buyers have left the sales room. Again the charge for catalogues, printing, &c. by brokers is 1/6 or 2/ per lot whether the lot is one package or 50 packages. All these considerations point to the necessity—1st of factory bulking, 2nd of sending large breaks, 3rd of packing in chests. Marking of chests should be as simple as possible. The name of the estate and "Ceylon" on one side, with the No. of the chest and grade of the tea on another is sufficient; complicated marking is to be avoided—some shippers put the nett contents of the package on one side, but this is unnecessary, as the average weight is ascertained by the Customs, and if the net weight marked on the package differs from the weight the grocer has to pay for, it may cause dispute.

Tea Chests.

Wood for tea chests is a subject that has caused great discussion in India owing to numerous cases in which the lead, from being enclosed in unseasoned wood has become corroded and the tea spoiled. Apart from the necessity for using seasoned wood in order to maintain the tares even, it is necessary to avoid the

possibility of corrosion from the sap of unseasoned timber. Some litigation at home, and much discussion, was caused a few years ago by some tea from India which was entirely spoilt through corrosion of the tea lead, and that this still occurs we had proof at the London docks last year, the lead of some chests lying there being covered with a white dust which had eaten through it and destroyed the tea. Some published experiments by a gentleman in India proved that this corrosion could be caused by the unseasoned timber of the common wild mango. The following results of experiment's by Mr. A. Pedler, F. C. S., published in the "Journal of the Asiatic Society of Bengal" are interesting:— Tea Chests.

The conclusions that my' experiments have led me to form are as follows:—

1. That tea properly manufactured in the ordinary way has no power to corrode lead.

2. That if unseasoned and damp wood is used for the manufacture of the tea boxes, corrosion of the tea lead is, under favourable circumstances, almost certain, but that some varieties of wood act more violently than others.

3. That even if seasoned wood be used to make the tea boxes, and if it be allowed to become saturated with water, and then placed in favourable circumstances of heat and moisture, corrosion of the tea lead may occur, though not to so great an extent as if unseasoned wood had been used.

4. That the active agent does not exist ready formed in unseasoned wood, but is produced by a secondary action from the constituents of the wood.

5. That the corrosion is not usually due to contact action between the lead and the wood, but that a volatile substance is gradually produced from the unseasoned wood.

6. That the corroding agent is usually acetic acid in the presence of moist air and carbonic acid, but that other acids of the same series are sometimes produced and also act on the lead, and in the case of butyric and valeric acids a greenish yellow incrustation is formed differing entirely from the whitish or yellowish incrustation produced from acetic acid.

7. That the acetic and other acids are produced by the decomposition (probably by a kind of fermentation under the influence of heat and moisture, and perhaps started by decomposing nitrogenous matters) of certain substances which are known to be present in wood. Such bodies are fermentable sugars, starchy matters, malic acid, etc.

8. That the lead linings of the tea chests having been corroded and perforated by the corroding action of these acids in the presence of moist air and carbonic acid, the tea can easily take up the disagreeable odour which the wood itself will possess, after it has undergone the change in which acetic and butyric acid, etc., are formed, and thus the quality of the tea will be deteriorated.

Until recently chests were very commonly made on the estates from jungle timbers, Mallebodde being

Tea Chests.

very largely used, and when thoroughly seasoned and not kept lying in stock too long, they answered very well; now, however, tea chests are chiefly procured from Colombo. "Hal" is the wood commonly used and makes good chests; but Mr. Deane's Japanese chests (sold by Messrs. J. M. Robertson & Co., of Colombo) appear likely to prove the most satisfactory article in the market. The appended list of prices, weights, &c., shows many points of superiority possessed by these chests over others. The tares are small and even, and these chests make a very neat looking package. It is better, however, to err on the side of safety and hoop-iron all but No. 5. Economy in securing tea chests from damage is most mistaken.

No.	Size Outside.	Price of Cedar.		Price of Mome.	Capacity.	Weight. Cedar.		Mome.
		⅜″ c.	½″ c.	½″ c.		⅜″	½″	½″
1	23″ × 20″ × 18″	80	95	92	90 to 100 lb.	16 lb.	19 lb.	21 lb.
2.	22″ × 18″ × 17″	77	90	87	75 to 90 lb.	13 lb.	16 lb.	18 lb.
3.	19″ × 16¼″ × 15¼″	65	85	74	50 to 70 lb.	9 lb.	14 lb.	16 lb.
4.	16¾″ × 15″ × 13¾″	60	82	70	45 to 50 lb.	7 lb.	12 lb.	14 lb.
5.	14″ × 12″ × 10″	51	—	—	18 to 20 lb.	5 lb.	—	—

The Capacity of course depends on the quality of Tea packed.

These boxes in ⅜″ wood have been favourably reported on by most of the London brokers and many of the leading planters as being most satisfactory in every way. For half-chests we strongly advise the use of Nos. 2, 3, or 4 in ⅜″ wood, as these are quite strong enough if nailed with 1½″ nails, &c., hoop-ironed, and the saving in tare is nearly 50 per cent on the usual Ceylon-made boxes. The half-inch boxes in Mome or Cedar-wood are perfect in every way, and are so strong that hoop-iron is considered unnecessary if 2 inch nails are used.

We are now prepared to book orders, and hope to be able to make continuous deliveries after 1st March next. Other sizes, such as 16 in. × 16 in × 16 in to contain 60 to 65 lbs., will be ordered if required.

Tin tea boxes have been greatly advocated by many, and instances are given in which tea packed in Messrs. Harvey Bros. and Tyler's lacquered boxes has fetched higher prices than the same tea in chests. Apparently, however, their prices render their general use improbable. The use of papier maché has also been advocated, and it is to be hoped some invention to render its use practicable may be made, anything which would obviate the necessity for using tea lead would be a boon.

Andrew's patent metal tea chest is a substitute for the present lead-lined wooden chest, and is now offered to the public. It is said to have many advantages, the one that is most obvious being that as the weights of the packages are regular, average tares can be taken. Tea Chests.

		Rs.	As.	
Chests, 18 × 18 × 23	... ... at	1	11	per package.
Half Chests, 14½ × 14½ × 17	... at	1	00	,,
Boxes, 11 × 11 × 14	... ... at	0	10	,,

If a thicker gauge of metal is used the cost would be proportionately higher.

The following appeared in the *Grocer's Chronicle* of 10th April 1886:—

"A New Metal Tea Chest.

"A novelty in tea chests was exhibited in the market this week in the shape of a metal tea chest made by machinery and intended to meet a want long felt.

"The inventor claims for his new package a variety of advantages over the ordinary wooden chest: amongst which may be noted economy in a variety of ways. The first cost is about one-fourth less than the present chest with lead lining. It occupies smaller space in the hold of the ship, and consequently costs the importer less freight. Likewise being little more than half the weight of an ordinary chest the carriage from London to the country grocer will, of course, be considerably lower (perhaps 15 per cent), which, in these days of keen competition and heavy transit charges is a point well worthy of consideration. It is impervious to moisture, and may be placed in a pool of water without the slightest damage to the contents. It will not allow the contents to leak out, and herein is perhaps one of the most attractive features in the invention to our readers. It can be very quickly opened by removing four screws in the lid, and as it does not require to be lined in the inside as an ordinary chest is with lead, all danger of the contents losing part of their fragrance by getting out between the lead and the outer wooden case is done away with. Every tea leaf in the package will be in equally good condition. The first arrival consisted of 25 cases Assam Broken Souchong, which were bought by Messrs. Harrisons & Crosfield, of Great Tower Street, at whose sale-room, we believe, one of the packages may be seen. These packages are made of strong tin-plate, but we understand that Mr. Arthur Andrews, the inventor, has made arrangements for having them manufactured of steel-plate on a very extensive scale. The extreme durability of steel, combined with lightness, makes it a very valuable material for the purpose, and as so many improvements in its manufacture have been arrived at during the last few years, it can be produced now at very little higher cost than sheet iron.

"It is most likely next season may see the new steel tea chest in full supply, and we confidently anticipate for it a very favourable reception by the trade."

The agents for these packages are A. Andrews, 110, Cannon Street, E. C., or Messrs. Barry & Co., Calcutta.

Packing.

Packing is best done when there is no other work going on in the factory, as it is a very dirty, dusty operation. The empty chests must first be lined with lead, and this may be done by having a shape to fit the chests on which the lead can be fitted and soldered, the soldering fluid is then applied to the outside of the package and not the inside, and hence cannot come into contact with the tea. On the other hand the following is advocated in the *Tea Planter's Vade Mecum*:—

The following is the easiest and cheapest way of soldering tea-lead. and one that an ordinary native understands, and does very well:—First cut the lead so as to exactly fit the inside of the box: edges of sheets must slightly overlap. Three pieces are required: one long piece, that covers two sides and the bottom, and two small side pieces. Now, with the fingers or a flat bit of wood the packer smears the overlapping ends with rosin (native name *Gunda Boroza*). After this he takes a heated soldering-iron and rubs it in a vessel containing soldering-lead, and then runs the iron along the ends of the lead sheets where the rosin had previously been placed. The sheets immediately unite, and form a perfectly close-fitting and air-tight case inside the box. An experienced man can cut and solder up the lead for an 80 lb. box in from 10 to 15 minutes.

In packing, a pad of hessian to fit the box is put over the tea, which is pressed down by coolies' feet: this system appears to answer very well. When a required amount is to be put into each chest it is a good plan to have a marked stick, the depth of the chest, and marked so as to show the proportion which has been filled. Thus for a 50 lb. chest, a gauge the depth of the box, divided into 5 equal parts, will show when the tea has been sufficiently pressed if 10 lb. are put in at a time. Great care must be taken that there are no holes in the lead, and no places where the solder has not adhered properly. The contents of the chest should also fill it completely. A packing machine has been invented by Mr. Gilruth which will be described later, and which appears likely to be a success. Clamps are used largely in India for strengthening tea boxes and are nailed across the corner outside, but hoop-iron is more generally used in Ceylon. Triangular pieces of wood nailed inside the corner of the chests will be found to add greatly to their strength. As regards the subject of hoop-ironing chests it will be found well to err on the side of caution. It constantly happens that unhooped chests arrive in

Colombo broken and split, to the great detriment of their contents, and it will be found well to use hoop-iron in all cases where there is not absolute certainty as to the security of the packages without it. **Packing.**

The following data are from the *Tea Planter's Vade Mecum*:—

SIZES OF TEA-LEAD.

Size of Lead, Solder, &c.

Sizes are 37 inches by 22 inches, boxes of 2 cwt. = 126 sheets.
25 ,, by 19 ,, ,, ,, = 210 ,,

A full-sized Tea-chest of five cubic feet takes two sheets of each of above sizes. For 100 chests 1·58 box of large and ·95 box of small lead are thus required; or, for all practical purposes, one-and-a-half box of large, and one box of small lead per 100 Tea-chests.

SOLDER.

There are 44 sticks in a box of 28 lb., and one stick fastens up 8 Tea-chests—say 352 chests to a box of 28 lb.

SOLDERING FLUID.

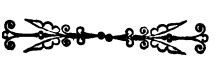
1 quart Baker's Fluid is sufficient for 300 tea-chests.

NAILS.

French, $1\frac{1}{2}$ inches, 64 are used to fasten a full-sized chest (5 cubic feet)...or $18\frac{3}{4}$ lb. to 100 chests.
$1\frac{3}{4}$—(300 nails to 1 lb.) ...,, $21\frac{1}{2}$,, ,, 100 ,,
Hoop-iron, French, of $\frac{15}{16}$ inch size, 56 go to a chest when clamps are employed (880 nails to 1 lb.) ... ,, $6\frac{1}{2}$,, ,, 100 ,,
Clamp Tacks, $\frac{1}{2}$ inch ... ...6 bundles ,, 100 ,,

Teas are sometimes made up in small packets for local consumption, or for special orders home, and for this a set of blocks and moulds to correspond to them are required. The sizes of the blocks are as follows:— **Packet**

3 lb. packets	...	...7″ × 6″ × 6″
2 ,, ,,	...	...8″ × $4\frac{1}{2}$″ × $4\frac{1}{2}$″
1 ,, ,,	...	...$7\frac{1}{2}$″ × $4\frac{1}{2}$″ × 3″



CHAPTER IX.

BUILDINGS AND MACHINERY.

I will commence this chapter with a few remarks on Buildings taken from the Prize Essays for 1878, extracts from Mr. Ballardie's being in inverted commas. The prices here given for all works are such as ruled when the essays were written (1878), and are higher than at present; as, however, there is every probability that work will become more expensive again in the immediate future, I have left the figures as they were.

When permanent buildings are to be erected, it may be taken as an axiom that the more masonry and less carpentery work that is done the better, and it is to the materials used in the former that we will first give our attention.

Building Stone.

Most of the masonry work in Ceylon is of stone, though in some places where it is scarce, bricks are employed.

The rock most commonly found in Ceylon is gneiss, it consists of the same materials as granite, namely quartz, felspar, mica, and hornblende, but in a more or less stratified form; it is very useful for building purposes, but is not as strong and durable as granite. The presence of felspar in gneiss makes it red and hard, whilst much mica gives it a grey colour, and makes it less hard. Quartz rock is sometimes used, but its extreme hardness makes its use in masonry frequently impracticable, it is also a stratified rock; if used, however, it should not be employed for bonding, as it is too brittle. Calcareous rocks, or those in which carbonate of lime predominate, are common, and are very useful for building; their durability depends on their compactness, and they are very easily worked.

Mr. Ballardie says as follows:—

"The desirable properties in a building stone are that it should be compact, insoluble, not easily affected by the atmosphere, and not liable to take on a vegetable coating. And a simple rule in building, which should have great attention, is, that stratified stones should be laid on their natural beds, for if set on edge they are sure to scale off, and decay under the influence of weather."

Bricks.

The manufacture of bricks requires great care and attention, and a knowledge of the best kind of clay to use is essential. The presence of silicate of lime in clay is bad, as it causes the bricks to soften in the kiln, whilst carbonate of lime in any quantity

loses its carbonic acid whilst being burnt, and the quick lime which remains, by absorbing moisture, causes the decay of the brick. The presence of protoxide of iron, giving a blue colour to the clay, and which turns to red by burning, is beneficial, as it promotes the strength and hardness of the bricks. Sand in moderate quantities prevents the shrinking of the brick; in excess it makes it too brittle; one part by volume of sand to four or five of clay is a good proportion. In making bricks, the clay freed from all stones is mixed with half its volume of water and thoroughly worked until it forms a homogenous paste; on the efficiency of this the quality of the bricks depends. The wet clay is then put into moulds, which are about one-tenth larger each way than the brick is required to be, as the clay shrinks in burning. The bricks are then dried in the open air, and burned in a kiln, the temperature being raised to a white heat, and maintained at that till the bricks are sufficiently burnt, when they are allowed to cool gradually. If steeped in water and then submitted to a second burning, their quality is improved. Good bricks should be regular in shape, with sharp edges and parallel surfaces, should give a clear ringing sound when struck, should show a uniform structure when broken, be free from airbubbles and cracks, and should not absorb more than one-fifteenth their weight in water. A superior quality of bricks could be made from kaolin, a white clay formed by the disintegration of felspar, which is commonly found in this country. Bricks.

Of lime Mr. Ballardie speaks as follows:— Lime.

"Generally speaking, it is advantageous to use Colombo coral lime, of which a plentiful supply can always be had for about 50 cents per bushel, slaked. This is richer in carbonate of lime than ordinary stone. If, however, it be determined to use estate-made lime, care must be taken that, while burning, the stones be brought to a red heat, and maintained at the same till all the gas has escaped, which process will take several hours, according to the size of the pieces of limestone, but the exact time required can only be decided by experience. The smaller the pieces of stone the better; and in building the limestone into the kiln the larger pieces should be placed in the centre, thus allowing them to be exposed to the greatest heat. Where wood is used as the firing agent, about 90 cubic feet more or less according to its nature are required to burn about 35 cubic feet of lime."

Pure Lime is made by calcining limestone, consisting chiefly of carbonate of lime; it loses 44 per cent of its weight by burning, and leaves 56 per cent of its weight of lime. The residue from the kiln in this case is called quicklime, and is remarkable for its violent caustic properties. If left exposed to the air it slacks, or combines with the aqueous vapour, at the same time absorbing carbonic acid to form carbonate of lime, having the same constituents as the pure limestone before burning. To guard against this deterioration, the quicklime should be kept in barrels, in a dry place, until required for use; or it should be sprinkled with water, during which process it swells up, evolves great heat, and falls to a white dry powder, which is slacked lime or hydrate of lime.

To pass into a paste fit for mortar, the powder will again absorb 1½ times its bulk of water, and is then from 3½ to 4 times the bulk of the lime. The hardening of slaked lime is a very slow process, and is caused by the absorption of carbonic acid from the atmosphere, and the crystallization of the carbonate of lime so formed.

Mortar.

Mortar is the binding material used in stone and brick work, and consists of lime and sand formed into a paste with water; it hardens slowly by the evaporation of its moisture, and by the absorption of carbonic acid gas to form crystallized carbonate of lime. Slow evaporation is best, as, if too rapid, the mortar falls to powder.

The sand for mortar should be clean, sharp, and coarse; if clay is mixed with it, it should be washed in a running stream. The uses of the sand are to diminish the bulk of the lime, and thus save expense; to increase the resistance of the mortar to a crushing force; and to lessen the amount of shrinking during the drying of the mortar. With the ordinary lime prepared in Ceylon, which is by no means pure, I have found proportions of two of sand to one of lime answer well.

Rubble Masonry

In stone masonry, the following rules are to be observed:—1. The stones are to be laid in a series of courses as nearly as possible perpendicular to the pressure they will have to bear. 2. The joints of one course must each be as nearly as possible in the centre of the stone in the course below. 3. The largest stones must be used for the foundation. 4. To moisten the surface of dry or porous stones, so that the mortar may not be dried too fast, and become pulverised by the stone absorbing its moisture. 5. To make the spaces between the stones as small as possible, but to take care to fill them with mortar. 6. Not to allow the use of any small chips until the final plastering. 7. To see that in every course long stones are used, which shall bind the two faces of the wall together. The reason of these rules is obvious; if, for instance, the joints between the stones are superimposed one on another, a little abnormal pressure on the top of the wall will cause a crack to extend down it, following the line of the joints; again, if the two faces of the wall are built separately, the centre being filled with rubbish (a system often followed by careless and ignorant masons), one face of the wall will probably give way, and fall down independently on the other. The cost of stone masonry of this description, rubble as it is called, is R25 per cube of 100 cubic feet, which requires about seven bushels of lime.

Brick Building.

In building with bricks, the following rules should be observed:—1. All mis-shapen or unsound bricks must be rejected. 2. The courses or layers of bricks should be perpendicular to the pressure they have to bear, as in stone masonry, and the joints in each course should be on one side of those in the course immediately above and below them, each brick overlapping to the extent of at least a quarter of the length of a brick. 3. Before laying the bricks they should be scraped and immersed in water, so as not to absorb moisture from the mortar too rapidly. 4. Every joint should be filled with mortar, whose thickness should not exceed ¼ inch. 5 No pieces of brick should be used, except to finish off a corner, and then they should not be less than half a brick. The volume of mortar used should be about one-fifth the volume of brick. The terms headers and stretchers have the same meaning as in stone masonry, the former is a brick having its length perpendicular to the face of the wall or pier, the latter has its length parallel to it. The size of bricks is variable in this country; they are either 12 in. × 6 in. × 2 in., or 9 in. × 4 in. × 3 in. The latter is the size usually used for building, and with mortar

it is obvious that two headers will occupy the same area as one stretcher on the surface of a wall, including the mortar. Brick Building.

There are two systems of brickwork called respectively *English* and *Flemish bond*. The former is the stronger. It consists of entire courses of headers and stretchers, sometimes placed alternately, sometimes one course of headers only occurring after two, three, or four courses of stretchers. When the wall is required to have great transverse tenacity, courses of headers should predominate; when the tenacity is required longitudinally, the courses of stretchers should predominate. One course of headers to two of stretchers forms a wall having equal tenacity lengthwise and crosswise, and is the best in ordinary cases. In *Flemish bond*, a header and a stretcher are laid alternately in each course, and the outer end of each header is made to lie exactly in the centre of the stretcher in the course below. As the number of side joints is the same in every course, there is no difficulty in laying the bricks correctly. A wall of this kind looks neater than one in English bond, but is not as strong. Pieces of hoop iron are sometimes laid flat on the top of the courses, through the wall, to increase its tenacity, the ends being bent down on each side. A cube of brickwork costs about R40, employs four masons and eight coolies, and requires 1,422 bricks and 8 3-5ths bushels of lime:—

Mr. Ballardie writes as follows:—

"In brickwork the whole of the wall should be built up level to permit it to settle properly: if this be not attended to, rents are apt to take place, as the mortar in drying shrinks. It is also objectionable to carry a wall up any great height at one time, as the heavy weight on that part will have brought it to its bearing before the adjoining parts are built. If it be found impossible to build level at one time, long diagonal breaks should be made. As each course is finished, the mortar should be floated on the top, and care taken that all vertical joints be filled."

The use of cement requires a great degree of skill and attention, for if too much or too little water be used, or if not used immediately it is made, it solidifies unevenly and cracks. A small quantity of water only is necessary to attain the greatest degree of resistance, and the best proportion has been found to be one part of water to three of cement by volume. A small quantity only should be prepared at a time, and should be thoroughly mixed and turned over until used. Cement which is to dry exposed to the air should be mixed with sand to prevent unequal drying; the mixture varies from one measure of sand and two of cement, to three of sand and one of cement. An increase in the quantity of sand diminishes the tenacity of the cement; economy, therefore, is the only reason for an admixture of sand to cement which is not exposed to the air, as the greatest tenacity would be obtained by the use of cement alone. When the cement is used instead of mortar for brick-work, a mixture of one part of cement to two parts of sand is sufficient; for foundations, or walls in damp situations, two parts sand to three of cement should be used; whilst for works under water, the most satisfactory result may be obtained by the use of cement alone. Cement.

In floors exposed to the air, I have found a mixture of equal parts of cement and sand answer well. The thickness of the cement varies from ½ to 1 inch, but the former is of course more econ-

Cement.

omical, and is quite sufficient. I take the following from Molesworth's pocket book:—

	1 in. thick.	¾ in.	½ in.
1 bushel cement alone, or 1·28 cubic feet will cover	1 1/7th sq. yd.	1½ sq. yd.	2¼ sq. yd.
1 cement and 1 sand ...	2¼ "	3 "	4½ "
1 cement and 2 sand ...	3⅓ "	4½ "	6¾ "

Portland cement improves by age, if kept from moisture. The longer it is in setting, the stronger it will be.

At the end of a year, one of cement to one sand is about three-fourths the strength of neat cement; one to two about half strength; one to three, about one-third; one to four, one-fourth; one to five, about one-sixth. Strong cement is heavy, blue grey, slow-setting. Quick setting cement has too much clay, is brownish, and weak.

Bricks, stones, &c., used with cement should be well soaked.

Cement setting under *still* water will be stronger than if kept dry. Salt water is as good as fresh for mixing cement.

The cost of cement ½ inch thick is R10·50 per square, where two parts sand go to one cement; R13·75, one cement one sand; R18 for three cement two sand; and R22·25 for neat cement. The cost of cement being R3·50 per bushel.

Asphalte.

On the subject of asphalte Mr. Ballardie writes as follows:—

"Asphalte is generally heated in portable boilers; and when at boiling point a quantity of fine sharp sand in proportion to the quantity of work required should be added. Great care must be taken before applying the asphalte that the surface to be covered be perfectly dry, otherwise it will blister and crack. A bottom of good sand previously heated over a fire to draw out all damp should be spread over the floor; and as small sections only can be laid at a time, it is advisable to have planed sticks rubbed over with chalk or whiting placed round the part to be laid. Oil is frequently used for this purpose, but the sections of asphalte cannot be got to join so closely with it as with chalk. The asphalte mixture should then be poured in, and smoothed over with a wooden trowel previously rubbed with oil to prevent its adhering. When all air bubbles are expelled, fine sand should be sprinkled over the surface, and worked in with the trowel; care being taken to fill the air holes not with sand, but with asphalte only. The joints of sections should afterwards be smoothed with a hot iron."

The usual thickness for asphalte is 1 inch, and 4½ cwt. are required per square, which can be laid by one mason, assisted by four coolies. The cost, with asphalte at R70 per ton, is about R20 per square.

Concrete.

Concrete is a mixture of mortar with gravel or small stones, and is useful for foundations of all kinds; it should be about 4 inches thick when it underlies asphalte or cement. The best proportions are four of gravel, to a mortar composed of one of lime and two of sand.

The cost per 100 square feet is about R7.

"The best mode of compounding the concrete is to thoroughly mix the lime, previously ground with the ballast in a dry state;

sufficient water then being thrown over it to effect a perfect mixture, it should be turned over at least twice with shovels, and then wheeled away instantly for use. In every case it should be used hot. Only a sufficiency of water to bring about a perfect mixture ought to be applied, as the concrete should set as quickly as possible, and more water than will just moisten the whole is in excess." **Concrete.**

A good concrete floor for tea factories is made by laying 4 inches of cement concrete, consisting of 4 parts by bulk of broken metal (1½ inch), 2 parts sharp sand, and 1 part cement, over a paving of flat stones; and upon this again ½" to ¾" of cement mortar, consisting of 2 parts gravel, with the small sand sifted out of it, and 1 part cement. This floor will possess a roughish surface which will not be slippery, and the danger of a polished cement floor where machinery is at work is obvious.

Plastering. Plastering is the finishing off of the inside of stone or brick walls; it consists of the application of a mortar, formed by mixing one part of lime to three of sharp live sand. This is laid over the wall to the depth of about ½ an inch, and upon it three coats of lime-white. To render the surface of the plaster smooth, a "float" should be employed; this is a long piece of straight wood, which is worked up and down on the wet plaster to render its surface level.

Shingles. In Ceylon, the large majority of roofs are covered with shingles, for the employment of which there are great facilities on estates, as the materials are on the spot. This style of roofing will last for several years, the exact period at which a renewal is necessary depending on the climate, the nature of the shingles, and the pitch of the roof—that is, on the rapidity with which the moisture is drained off it. Shingles are prepared in two ways, by splitting and by sawing: those used on estates are as a rule obtained from jungle trees by the former method. The best trees for this purpose are Dun, Dawata, Keena, Hora and Madool. But all the shingles in a roof should be of the same description, as otherwise some will become rotten sooner than others. The method of splitting is very simple: the tree is first sawn into the required lengths, the bark and outer sap wood are then cut off, and the logs split up with a large knife made for the purpose, into pieces of the required breadth and thickness. The shingles thus prepared are shaped with a small axe before being used. In the rough, all the shingles should measure at least four inches in breadth, and those with large knots in them, or twisted in shape, should be rejected. This work is usually given out on contract to Sinhalese, the rate for splitting and trimming being R5 to R6 per 1,000. The reapers for a shingled roof should be six inches apart, from centre to centre, their breadth being two inches, thus from the bottom of one to the top of the one below it is four inches. Taking the shingles as averaging three inches in breadth, a square of 100 superficial feet requires 800 shingles, and 4 lb. shingle nails. To finish off the roof, the lowest row of shingles should have six inches of their length sawn off so as to show a double row at the bottom; and the ridges of the roof, where different planes of roof-

Shingles.

ing meet, should be covered with a flashing of galvanised iron. A shingled roof should form an angle of 45° with the horizon to last well, but we frequently in practice make the angle less than this. The *sawn shingles* used in Ceylon are usually of *teak*, and are imported from Burmah and elsewhere. Their cost in Colombo is about R30 per 1,000. The size of a teak shingle is 15 inches by five inches, the upper edge being about half the thickness of the lower. The reapers should be six inches from centre to centre, and each shingle should touch one reaper, and cover the two immediately below it. A square of roofing takes 480 teak shingles.

Thatch.

The method of covering a roof with thatch is a very simple one; but its employment is not advisable except for temporary buildings, as every year it becomes necessary either to renew it entirely, or to put a fresh surface of thatch on. The pitch of a thatched roof should be 45°; if the slope is less than this, it will probably leak and water lodging will cause it to rot. The cost of thatching depends chiefly on the facilities for obtaining grass, and it is difficult to say what the exact cost should be, but it will generally be found that a roof suitable for a set of temporary lines, thatch six inches thick, and framework of jungle sticks, should not exceed R3 per square, when transport of material is the chief item.

Tiles.

Tiles are very commonly used for roofing where their transport does not make the expense excessive, and I will shortly describe the method of manufacture. The clay for tile-making requires more care than for brick making, as it should be purer and stronger. A mixture of sand is sometimes made with the clay, but only when the latter is too strong. For weathering, the clay is spread out thinly in the sun to open its pores, and cause it to absorb more water in mellowing. The clay, thus weathered, is thrown into pits, covered with water, and left for a considerable time to mellow; it is then passed through the pug-mill, after which all stones, &c., are picked out, when it is again ground. The clay, as it issues from the mill the second time, is cut into lumps, which are staked in a shed; these lumps are then cut in half, and taken to the pantile table, where the clay is moulded. The tiles are then burnt in a kiln, in the same way as bricks are. Pantiles in this country are usually made with a single curve only; they vary in size very much, but usually are 15 in. long, 6 in. broad at the bottom, and 4 in. broad at the top.

The pitch of the roof for tiles should be an angle of 26½° to 30°; 600 tiles are required for a square of roofing.

Iron Roofing.

In stores, when freedom from leakage is necessary, iron roofing is generally employed.

There are three sizes of sheets sold in this country; those 6 ft. × 27 in., of which 127 pieces to the ton; 7 ft. × 26 in., with 118 to the ton; and 8 ft. × 26 in., with 100 to the ton. The first of these sizes is most generally used on estates. For a lean-to roof, the rafters should be 27 in. apart, and reapers across them 56 in. apart, onto which the sheets of roofing are fastened. For a trussed roof the purlines should be 6 ft. apart, common rafters 27 in. apart, and on them reapers 5 ft. 6 in. apart, the sheets overlapping 6 inches at the ends, and the breadth of one corrugation at the sides. The sheets are fastened together either by rivets or clips, the former should not be used, as the hole becomes enlarged in time by the expansion and contraction of the metal, and a leak is the result. The latter are curved pieces of hoop iron,

which embrace the top, bottom, and lower side of the reaper, where they are fastened with a screw, bend round the top of one sheet of iron, clasping it to the reaper, and by another bend upwards, secure the lower end of the upper sheet, and this without the necessity for drilling any holes in the iron roofing. Iron Roofing.

A square of roofing requires about nine of these sheets, and fewer of course of the larger size; the price per ton is about R250; which brings the cost of the smaller sheets to R24 per square. The other sizes differ but slightly in cost. It is a good plan to coat the iron roofing with tar, as this seems to preserve it better from the effects of the weather.

Next to the construction of roofs, floors are the most important work of the carpenter; their construction in this country, however, is very simple, as they are usually situated on the ground level. The principle upon which wooden floors are laid is always the same; girders are placed across the building from side to side, and resting on piers or whatever may have been built to support them; across these girders, joists are placed longitudinally, and above them again planks are nailed transversely. The size of the girders depends on the weight they will have to support, and their length, but the depth should always be greater than the breadth. This applies also to joists, which need only have a sufficient breadth to allow room for the nails. Floors.

Where floors are *boarded*, it is always better to have the boards as narrow as possible, as they are then less likely to shrink, warp, or split. The thickness of floor boards is as a rule 1½ or 2 in. The floor boards are fastened to the joists by floor brads, driven straight through from the surface; or where the boards are sufficiently thick they may be edge nailed, or nailed at the edges in a slanting direction, but this can be done on one side only. Ordinary boarded floors cost about R10 per square, exclusive of timber; if tongued and grooved, so that the boards fit into one another, R15.

Exclusive of the cost of timber, which in most cases amounts only to the cost of sawing and transport, the following are approximate rates for various works connected with buildings from which estimates may be drawn up. A square is 100 square feet, a cube 100 cubic feet. Cost of various Works.

Rubble masonry...		R25 per cube.
Brickwork in mortar (bricks R20 per 1,000)		40 ,, ,,
Cement floor ½ in. thick	cement R3·50 per bus. 1 cement 2 sand ...	10·50 per sq.
,, ,, ,, pure cement		22·25 ,, ,,
,, ,, ,, 3 cement 2 sand		18·00 ,, ,,
,, ,, ,, 1 cement 1 sand		13·75 ,, ,,
Gravel floor		1·00 ,, ,,
Asphalte. Asphalte R70 per ton		20·00 ,, ,,
Concrete, 4 in. thick		7·00 ,, ,,
,, ,, with lime polished		9·00 ,, ,,
Plastering or rendering. 1 of lime 3 of sand		3·00 ,, ,,
Rendering with floating and setting ...		6·00 ,, ,,
Rendering with rough cast		4·00 ,, ,,
Including every thing but cost of timber.	Floor boarded	10·00 ,, ,,
	,, tongued and grooved	15·00 ,, ,,
Ceiling cloth		7·00 ,, ,,

Cost of various Works.

Line doors, 5ft. by 2ft., with frames	R2·50 each.
Roofing tiled lean-to. Tiles R20 per 1000	20·00 per sq.
,, ,, trussed	22·50 ,, ,,
Corrugated iron lean-to R250 per ton ...	24·00 ,, ,,
,, ,, trussed	26·00 ,, ,,
Jungle-shingled lean-to { 800 shingles per sq.	17·00 ,, ,,
,, ,, trussed { R10 per 100 ...	20·00 ,, ,,
Roofing teak-shingled lean to { 480 shingles per sq.	25·00 ,, ,,
,, ,, trussed { R35 per 1000	28·00 ,, ,,
Weather boarding feather edged	4·00 ,, ,,
Trellis work	4·00 ,, ,,
Louvre boarding	14·50 ,, ,,
Partitions, exclusive of timber and plastering—	
4 in. thick...	2·50 ,, ,,
6 in. thick...	3·50 ,, ,,

Cooly Lines.

In selecting the site for cooly lines some care is necessary, as the health and comfort of the labourers depend in great measure on its suitability. An open commanding site should be chosen, with a good supply of pure water close at hand for bathing and culinary purposes: when possible, a site should be chosen on patena land, so that there can be no difficulty in the way of the coolies forming gardens. It is also better to fix upon a piece of level ground for a set of cooly lines, as then no earth cutting is necessary; this rule applies to all estate buildings. The arrangement of a set of lines is very simple: it consists usually of a row of rooms, varying in number from 4 to 10, all under one roof, with a verandah running along one side. It is better, however, to construct double sets, the end rooms opening on to the sides of the building, so that every side becomes a front. The size of these rooms is usually 12 × 12 or 10 × 10, though it varies of course, but the former is a good size for permanent, and the latter for temporary lines. The materials for the construction of lines are various, their suitability depending greatly on the facility with which they are procured. It may be borne in mind, however, that when extremes of temperature are to be encountered, thatch is the best covering; as, being a bad conductor of heat, it will both keep off the heat of the sun in hot weather, and preserve the internal heat in cold weather better than other coverings. The chief objection to its use is the continual repairs which are necessary for its up-keep, as a fresh layer of thatch is necessary every year, even though the whole roof does not need repairing. Where thatch is obtainable, it forms the best material for covering the roof of a temporary set of lines, the construction of which I will describe. In temporary lines, no sawn timber nor masonry work should be employed, the building consisting of jungle posts only, connected by mud walls, with a roof of smaller sticks and warrachies, supporting a cover of grass. The size of the rooms should be 10 ft. × 10 ft., with a verandah 3 ft. in width, the pitch of the roof being 30°; were the pitch steeper than this, the thatch would last longer, but for a temporary building, where economy is a great consideration, this angle will decrease the cost of the roof considerably. A set of lines of this description should cost from R10 to R20 per room, according as thatch &c., is near at hand or not. This is exclusive of doors and door-frames, which cost about R2·50, exclusive of timber, which has to be provided. Lines of a more permanent description, with pitch of roof 45°, rooms 10 × 12, or 12 × 12, will cost from R25 to R40 per room complete.

Mr. Ballardie suggests solid earth walls (without wood) 15 in. thick, as suitable for the construction of lines, also the employment of iron where wood is scarce. He writes as follows:— Cooly Lines.

"Good tenacious earth (not surface soil) or clay is required for this work. To build walls in this manner, two boards of the length between pillars having been selected and joined, as shewn in plan, by bolts and nuts, are laid in their proper line on either side of the proposed wall; the kneaded earth or clay is then forcibly thrown in; and as the earth hardens, the boardings are removed by unscrewing the bolts to the next portion to be done. These lines should cost from R40 to R50 per room.

Another style, where wood is scarce, is to build of brick and iron. Stone foundation 1 ft. square, walls of brick and mortar 4½ in. thick, pillars 14 in. square, roof framing of angle iron with tie rods and king posts of common round iron—one on top of each pillar, roof of galvanised iron 24 cwt. Cost of iron framing for roof for single-room-wide set of lines with verandah—R17 to R19 each complete. The only wood-work required for these lines would be wall plates, doors, and door-frames. This style would be permanent and could not possibly take fire. Cost, from R90 to R110, according to cost of carriage. A ventilator between each two rooms takes off the smoke and heated air, rendering the lines more comfortable and healthy. In iron-roofed lines the ridging plate, being raised about two inches from the roof, acts as ventilator."

The site for a bungalow should be chosen with regard to view, shelter, water-supply and drainage. It should be situated on the gentle slope of a hill, the front commanding a view of as extended a stretch of country as possible, though shelter from the monsoon winds and rains should be secured at the same time. The disadvantage of a site on the top of a knoll is that it is seldom possible to secure an efficient water-supply in that situation. On the side of a hill, a water course can usually be cut from a neighbouring ravine, which should on no account pass in close proximity to lines, however far away. The drainage of the bungalow should be carefully attended to, and no swamps or damp places should be allowed to exist near it. The best soil is a quartzy or gravelly one, and a stiff clay should be avoided. Trees should always be planted immediately the site is fixed on. The stable and cow-sheds should be a short distance off, and if possible out of sight. I need scarcely say that cuttings should always be avoided, and a level piece of ground chosen. Temporary bungalows can be constructed at very small cost, where timber is plentiful, of posts supporting a shingled roof, the inside being protected by mud walls, with or without weather boarding. Bungalows of this kind are usually put up on young clearings, and afterwards superceded by a more permanent building. Their cost is from R300 upwards. Bungalow.

Permanent bungalows are usually built chiefly of stone masonry, sometimes of brick. The main walls should always be of this description, with a coating of plaster; but some of the inner partitions may be of mud, carefully smoothed. In climates where timber is exposed to the attacks of white ants, the floors should be of cement or asphalte; the former, if well laid, is the best; it is cleaner, and looks better. Where boarded floors are laid, they should consist of well-seasoned planks, at the most six inches wide, tongued and grooved together, and nailed on joists which are

Bungalow.

supported by girders. The chief preventive against decay in a wooden floor is a free circulation of air. Iron gratings should therefore be fixed in one or two corners of the rooms, and the space underneath the floor should communicate with the outer air. I have found boards last for many years when thus treated. To improve the appearance of the floor, as well as to guard it against decay, it should be polished with turpentine and bees-wax at least once a week. The ceilings of the rooms and verandahs should be covered with ceiling-cloth, and whitewashed as previously described. Lath and plaster ceilings are seldom seen in Ceylon, and never on estates as far as I know. Boarded ceilings are more expensive, but far better than anything else, and Mr. Ballardie has given some beautifully executed designs for their ornamentation.

Verandahs should be enclosed by trellis-work, about three feet high, along which creepers should be trained; above this point it is better left open. When the sides of verandahs are exposed to the weather, as is frequently the case, they should be boarded. Creepers should on no account be allowed to grow over the roof, as their stems, enlarging by growth, move the shingles and cause the roof to leak. All timber exposed to the weather, such as verandah posts and trellis-work, should be painted or varnished.

The style of roof to be erected depends entirely on the shape of the building: when it is rectangular in shape and compact, a high roof on the centre walls, continued beyond them to protect the verandahs is the best. Several materials are used as coverings to the roof, of these shingles are the most common, and doubtless the best. Split shingles are generally employed, and last well, where the pitch of the roof is steep. Teak sawn shingles do not form as water-tight a covering as split shingles; they make a much neater looking covering, but invariably leak, and this fault appears to increase with time. The lasting quantities of split shingles cannot be compared with that of teak sawn shingles, but, putting appearance aside, the balance is decidedly in favour of the former.

Tiles are sometimes employed, where they are close at hand, and make a very good roof.

Metal is seldom used on account of the extremes of heat by day, and cold by night, which it causes. This may be obviated in a great degree by the interposition of felt under the metal but the expense is then very great.

To keep a bungalow dry, fire-places with chimneys or stoves should be erected, except in very hot climates. The former are preferred by many people on account of the cheerful homely appearance a good fire gives to a room; the latter are becoming generally used, and are more convenient than the former in many respects.

The construction of a chimney requires a little care. The flue should be of the same size all the way up; say, about 1 foot square. The fireplace being about 2 ft. 9 in. wide, 1 ft. 6 in. deep, and 3 ft. 6 in. high. The sides of the fireplace should be further apart in front than at the back, and the flue should get narrower gradually until it is the minimum size, which dimension should be continued to the top. In windy situations, a cowl of one kind or another should be placed on the top of the chimney to prevent the smoke being blown down it.

There are several operations for plastering, which have not been previously described, as they are employed solely for finishing off the walls of bungalows. Rendering and floating has been con-

sidered under the heading masonry, as the walls of most buildings are finished off in this way. To obtain a fine surface above them, "setting" is laid on. This is made of pure lime mixed with sufficient water to bring it to the consistency of cream. It is then allowed to settle, and the superfluous water poured off. When the plaster is about half dry, this is laid on with a trowel, and alternately wetted with a brush and smoothed, until a fine surface is obtained. When an outer wall is to be painted, it is coated with stucco, composed of setting, as just described, and sharp sand. This is alternately wetted and smoothed with a trowel, until it becomes very hard and smooth. Buildings.

Rough cast is another method of finishing outside work, by dashing over the coat of plaster while still wet, a coating of rough-cast, composed of sharp gravel, mixed with lime and water until it is in a semi-fluid condition. As has been shewn before, rendering costs about R3 per square; with "floating" and "setting," it will cost R6 per square; if rough-cast only, R4 per square.

BUILDINGS.

In choosing the site for a factory, apart from the obvious necessity for choosing one where much cutting is not required, and which is near the outlet of the estate, we have to consider the question of water-power. If this can by any possibility be made available, it will pay to go to great trouble and expense to obtain it, even though available for part of the year only. As regards transmitting power by a steel wire rope, Mr. Jackson says:—

What I advise is, if possible, get the Turbine in the factory, but if this is not possible, and a suitable fall or site for the Turbine is within 500 yards, then use the steel wire rope rather than put down a steam engine.

A steel wire rope, say five-eighths of an inch diameter, will transmit about 30 horse-power if driven at the rate of one mile a minute, and such rope would probably wear out every second year. These, however, are not very expensive to replace.

The possible use of a wire tramway to convey the produce of the estate from the factory to the cart road is also a point that in some cases requires consideration in choosing a site. The cost of such tramways is, however, very great, its amount depending greatly on the lay of land.

The subject of central factories, and the transport of leaf to them, is one which has engaged the attention of planters from time to time, but with little practical result. Many large factories buy leaf from estates which are only commencing plucking, but

Buildings.

it is generally considered only a temporary measure, convenient until the yield of the gardens justifies the erection of factories for their own requirements. There are many practical difficulties in the way of central factories for the manufacture of leaf from surrounding estates belonging to different proprietors, and in spite of the saving in expenditure that might be effected by such a system, these difficulties will probably prevent its adoption. That leaf can be transported without injury from considerable distances has been proved conclusively by the good prices obtained for the teas from a well-known large factory which freely buys all the leaf offered it.

Factories.

The construction of the factory on a tea estate is a most important matter, and one which requires all the thought and consideration that can be given it. In a large number of cases the erection of a new building is not necessary, there being on the estate an old coffee store convertible into a tea factory at comparatively little expense. It will be found in practice, however, that unless a store is in good order, with a watertight roof, and sufficient height in the lower storey, the saving in the conversion of such a building over the cost of a new one will be surprisingly little. Many of the old coffee stores were built on columns intended to support great weights of coffee on the upper floor, and these columns will be found unnecessarily large and cumbersome for their new purpose. In many cases also the centres of the floor beams, spanning a breadth of 22′ to 24′ as a rule, have a post or other support to strengthen them, and these are very much in the way indeed in the lower chamber of a factory, devoted as it is to machinery, packing space, &c. In many cases I feel sure it will be more economical in the end, as it certainly will be more satisfactory, to demolish old buildings that are in bad order and of unsuitable dimensions and construction, and to build entirely new ones, using such material of the old as is available. The sound timbers from such buildings, after their years of seasoning, will make capital doors and windows, and other fittings for which dry timber is requisite.

And now regarding the general plans of factories, it is most essential that these should be such that there should be as little transport of material as

possible, the leaf being received at one end of the building, and being taken to the withering shelves, rollers, driers, sifters, and packing spaces, without more carrying backwards and forwards than can be avoided. To attain this object Mr. Jackson recommends buildings in the form of three sides of a square: "one main building in which the machinery should be arranged; then one wing passing out at right angles to the main structure at one end for withering, and at the other end of the main structure another wing for packing and sorting." I venture to think that such a building will not be found most convenient for its purpose. It is of importance that the withering accommodation should be above the drying machines, so that this process should be hastened in damp cold weather by the heat rising from them, and in Mr. Jackson's plan the leaf is withered in a separate building, presumably on both ground and upper floors. In the plan of building here advocated, the leaf is conducted to the rollers by shoots from the upper floor, with a canvas bag leading directly into them, and causing a minimum of transport. If the sorting and packing is in a separate wing, the tea will have to be brought back to the main building for final firing before packing. Again, the cost of clearing sites and preparing foundations for a building with wings will be found very great in this hilly country; on the large majority of estates it is by no means easy to find good sites for buildings, and there are very few cases where the cutting and levelling for them does not involve considerable expense. To expose the end of the building, with as few doors and windows in it as possible to the fury of the monsoon winds and rains is a desideratum, and is all in favour of the long, comparatively narrow building which time-honoured usage leads us to construct in Ceylon. In spite therefore of Mr. Jackson's advice on the subject, which on such a subject deserves respectful attention, I would advocate in most cases a long building, its length depending on the work it has to perform, and with a breadth of 24 feet between the main rows of columns. Such a breadth as this can be spanned by floor beams (12″ × 6″ or 14″ × 7″) without any centre support, a great desideratum as mentioned before. Where iron factories are erected, and there is sufficient room, a broader building may be planned.

Factories.

Factories.

In converting old stores it will be found well worth while to go to some expense in order to do away with any centre post there may be supporting the main floor beams. If jointed above the beam they may be strengthened by two pieces of flat iron (6′ long by 4″ wide), one on either side, bolted tightly together with 4 or 6 bolts. To give additional strength, struts may be laid from the pillars, where they should rest in a long upright beam, to abut on the under surface of the floor beam and give additional support. This system is bad in theory as it gives a lateral thrust to the pillar which it is not calculated to bear, but in most old coffee stores these pillars are so massive that they will easily stand it. On either side of the building verandahs should run, 12′ or 14′ broad, making the extreme breadth of the factory 48′ or 52′. Mr. Jackson says on this point: "Verandahs to tea factory buildings are a mistake. They exclude the light from the ground floor, and are an expensive kind of roof for the space they cover." If proper windows are put in the walls of the verandah, an ample amount of light will be found in the centre of the room, whilst as to the economy of these erections, they require no walls, the verandah wall being one which otherwise would form the wall of the main building, and hence apart from the floor which costs the same in all cases, the only expense is the roof iron, and a very simply constructed lean-to roof, one with far less complicated framing than is required for the main building. I think it will be found in practice that verandahs are an economical and most serviceable addition to the ground floor of a tea factory. In constructing them it will be well to make the rafters spring from a wall plate one foot at least above the level of the upper floor, but not so high as to interfere with the upper windows. This will give extra height, and hence admit more light to the main building, and also form an opening along its length connecting the ground and upper floor, by which the warm air generated in the former may find its way to the withering shelves. It will also be found very convenient to place the machinery in the verandahs in some cases, driving them from a shaft attached under the floor beams, and running along the build-

ing as far as necessary. Mr. Jackson states that a fruitful cause of the destruction of belts is too short centres between the pulleys over which they run, and he advises that the driving pulleys of the rollers be fifteen to twenty feet away from the line shaft; the main driving belt, that connecting the line shaft with the engine or water-wheel, being from twenty-five to thirty feet from centre to centre of pulleys. The length of such a building as I have described will depend on the acreage of the estate, but it will in most cases be found more convenient to construct a building of this kind from 80 to 120 feet long, and when necessary erect a supplementary withering house, to be used when there is a rush of leaf, the main building being alone used under ordinary circumstances. If the factory be made sufficiently large to afford all the required withering accommodation on its upper floors, the ground floor will be found unnecessarily large in proportion. Regarding the number of floors that a factory should have, it is generally admitted that two only are best, the ground floor for machinery and all appliances connected with the manufacture of leaf after it is withered, the upper floor being devoted to weighing in from the field and withering. A third floor is inconvenient in many ways, and adds greatly to the risk of fire; on the other hand it is economical, and in situations where the space is limited there is sometimes no option in the matter. Except therefore where circumstances make a three-storied building necessary, it will be found more satisfactory to confine it to two.

Factories.

The windows in a factory should be large enough to admit abundance of light. The withering room especially should be well provided in this respect, as light is an active agent in hastening this process. Windows may either be made to slide back from the window frames into a frame parallel with and inside the wall, or they may revolve on pivots or hinges. Single large windows revolving on pivots are, I think, preferable in every way, though those sliding back are cheaper to make. The latter will however be found very troublesome if the wood is not well seasoned. If extra light is desired a fixed frame with panes in it may be fitted above the window. It will be found very convenient to have

Factories.

all doors and windows in a factory fitted with the same sized panes of glass, in case of breakage they are then easily replaced, and for this purpose a stock of extra glass should be kept on the premises: 10″ × 14″ is an economical size of pane, as each is a square foot. Larger sized panes, though preferred by many, are more expensive in proportion. Windows 5′ high and 4′ wide, containing each 12 panes 14″ square will be found of a convenient size and look well. If the pillars of the factory are 12′ apart, two of these may be hung in each opening.

Doors should be large (8′ × 4′) where they close the main exit from the factory; and double, so as to occupy less space in the building when open. They should always open inwards. If half glass, they will assist in admitting light. Both doors and windows should be made thicker than Ceylon carpenters are wont to cut them, and not less than 1½″ when planed. There is one means of ensuring efficiency which should be impressed on any one erecting a tea factory. Do not attempt to erect machinery without the advice and assistance of a competent engineer; amateur efforts at doing engineer's work generally result in extra expense, and frequently in injury to valuable machinery.

Leaf should be weighed in on the upper floor, to which a double flight of steps should lead at one end, so that coolies may come up on one side, hand in the leaf to be weighed, and go down on the other. After weighing, the leaf is turned over into a heap on the floor, and from thence carried to the withering shelves. To facilitate this, and for taking withered leaf to the shoots which conduct it to the rollers, small trolleys, running on wooden rails, will be found useful. The most popular withering shelves at present are those invented by Mr. Megginson of Carolina. They consist of jute-hessian, cut into lengths not greater than 24 feet (12 feet is a convenient length), nailed to reepers 1½″ square at each end; the ends of the reepers projecting 1½″ beyond the hessian. One end of the reeper is rounded, and the other left square. To support the shelves there are uprights, generally 45″ apart, arranged according to the breadth of the hessian. In the one upright, at distances apart of 6 inches (the distance generally adopted between withering shelves), there

Factories.

are 1½″ auger holes to take the rounded end of the reeper. In the other upright are keyed slots to hold the square end of the reeper in position. To stretch the shelves, a cooly fixes one reeper into the uprights at his end, another cooly then fixes the rounded end of his reeper into the hole cut to receive it, and then having stretched the hessian as hard as he can, he slips the squared end of the reeper into its slot, which holds it firmly in position. 24 feet shelves require support in the middle to prevent sagging. An upright, with reepers nailed across it 6 inches apart, will give the necessary support. In collecting withered leaf, each shelf is lifted out by two coolies, the contents thrown on the floor, and the shelf replaced. This system is beyond all comparison the most economical one, as so little carpentry work is required. The system of hanging shelves is preferred by some. The framework of the shelves is made of reepers 2½″ wide by 1″ thick, and this is covered with jute-hessian. The trays themselves are 6 feet long and as broad as the staff with which they are covered. The front and back reepers project 1½″: these projections are rounded so that the back reeper can be fitted into holes in an upright post, the front ones being supported by ropes suspended from the roof with knotted loops to hold them. These trays are emptied by simply pulling out the ropes at each end, when they hang down flat on their hinges depositing the leaf on the floor. A modification of this system was invented by Mr. Armstrong, who describes it as follows:—

I have now adopted a cheaper method than above, dispensing with the framework of reepers, as thus: nail 12 reepers at 6 inches apart across uprights, on to these reepers nail 6 feet lengths of jute-hessian leaving a space of 6 inches between each length. Hem the sides and front of the hessian, run a ¼ inch rope through the front hem, with ends say 9 inch longer than our shelf, pull these ends through a notched upright say 2 inch in front of the width of our shelf, and we have our shelves ready stretched for our leaf. The advantage of this style of shelf is its cheapness, and the advantage of being able to roll up every other one when full space is not required, thus allowing more light to our leaf. The notched uprights should be 6 inches wide by 2 inches thick, and notched thus:

The rope of the right hand shelf passing through the notch on the left and that of the left hand shelf through the notch on the right.

Factories.

One disadvantage of these systems is that the upper trays have to be filled with leaf first, and this it is obviously difficult to do with a tray 6 inches above the one being filled. By Mr. Megginson's system this difficulty is overcome, the lower trays being filled first. Another system, the invention of Mr. Fairweather, is preferred by some. The lengths of withering cloth can be rolled up on rollers, or extended by means of a wire attached to a roller at the other end. This plan is of course more expensive, but if the frames are substantially made, it should prove very lasting. "Gilruth's continuous withering webs" have been described, and according to the published description will supersede all others. It is claimed for them that

1st and most important, the great saving of labour brought about; 2nd, smallness of space it occupies; 3rd, large amount of leaf it will take. Having no part of the level web but what can receive leaf; 4th, leaf easy to spread, as all parts of the webs pass within easy reach of the leaf spreaders stationed at the ends of the apparatus and who are able to spread while the webs are in motion which can be made to go fast or slow at the will of the leaf spreader; 5th, easy to handle and not liable to get out of order; 6th, the machine can be made any size, length, or height; 7th, by themotion or action of one wheel all webs are equally moved for receiving or delivering leaf and which last operation can be performed by one man whether there is a large or small quantity of leaf; 8th, the web is *never rolled up* whether leaf is on it or not: if the web gets wet through wet leaf it is not liable to rot through the web never being rolled up or doubled together or covered close up; 9th, the machine can be increased in width every year as the tea garden increases its yield by lengthening the rollers or web drums at a very small cost; 10th, the webs have pliable galvanized strand wire sides which run into grooves cut into the side, of each roller, preventing the web from slipping or bellying in any way.

Withering shelves may be arranged either longitudinally or transversely across the building. Megginsons' trays are better suited for the former arrangements. They can be placed in a double row down the centre from end to end, and occupying, with the centre support, 8′ 6″ of breadth. A row of falling trays may then be arranged along the walls, between the windows, leaving the space in front of these clear, except at night, when short trays may be put up in front of them and be removed in the morning. The row of trays along the wall occupy 4′ 6″ of breadth, these with the centre rows therefore take 17′ 6″ and leave 6′ 6″ for the two passages if the room is

made 24′ clear. Six square feet are generally allowed for each lb. of leaf. Factories.

Regarding the arrangement of the ground floors, the motive power, whether water-wheel or engine, should be outside the building, and at the end opposite to where the leaf is weighed in. The rollers should be arranged next to the driving power, and space be allowed for all machines of this kind that may possibly be erected in the future. The driving shaft is attached overhead, to the underside of the floor beams, or is supported by brackets fixed to the columns, and it must extend sufficiently far to drive all sifting machines, driers, &c. Mr. Armstrong gives the dimensions of pits to hold two Sirocco's, 18′ × 8′ × 5′ 6″ deep, and he advises that these be put at intervals of 24 feet down the building to distribute the warmth as much as possible. For single Siroccos a pit 10′ × 8′ × 5′ 6″ is required. If Jackson's driers are erected they must come next to the rollers and be driven from the main shafting. Beyond them will come the sifting machines, leaf cutters, &c. The rest of the space on the ground floor can be devoted to bins, fermenting shelves, bulking and packing space, &c. The chimneys of all driers should be taken out through the verandah roof and not up through the withering floors.

Blackman's Air Propeller is a very effective machine for drawing the warm air from the driers into the withering rooms.

Regarding the materials of which a factory is made, one of the first considerations is to make them as little inflammable as possible. An iron roof is not a good cover to a withering room, as it causes extremes of heat and cold; it is however not liable to catch fire, it is permanent, and therefore makes a better factory roof than shingles. The withering floor must of necessity be of inflammable materials, requiring as it does a quantity of woodwork and jute-hessian material. The walls of this floor have generally to be made of weather boarding, and the floor must be boarded. A cement floor, and stone walls and columns in the lower story, minimize the danger where the machinery is. Iron rails make very good columns and beams, and have the advantage of occupying very little space. They are however more expensive than masonry.

Factories.

In constructing a factory attention must be given to the requirements of Insurance Companies. The rates at which insurances are effected vary greatly according to circumstances. Steam-power or water-power make a great difference, and so do the materials of which the factory is made. No supplementary buildings, such as carpenter's workshops or wood sheds, can be erected close to the main building without affecting the insurance rates, and if such are built after the insurance is effected, notice of the fact must be given at once, at the risk of invalidating the policy in case of fire, if this is neglected. The presence of unnecessary woodwork about a Sirocco, for example, will be the subject for enquiry by the Insurance agents, and the fact of this being so is good evidence of the danger of such erections. Mr. Jackson advises that fire buckets be hung up about the factory, and is of opinion that these are a safer precaution than any of the patent machines before the public. He appears to make an exception of the Harden Star Hand Grenades, which certainly seem very handy and effective, and which are now largely used in England. It is found that machines of any kind for extinguishing fires are very liable to get out of order from long disuse, whilst buckets, if kept full, are always ready for use and can be used by any untrained cooly.

The subject of *iron tea factories* is one which may well be considered of great importance, especially so when timber is scarce. An iron factory is indestructible by white ants and various forms of decay, whilst the lessened risk of fire means a low insurance premium, and the annual saving, if capitalized, would justify a certain amount of extra initial expense. In every case where timber has to be purchased, it would be well if the cost of erecting the building of iron throughout were enquired into, and in many cases there can be little doubt that the latter system would be found preferable. Mr. Rutherford, who is agent for Messrs. A. & J. Main & Co., has furnished some very valuable practical information on the subject. The cost of iron factories varies considerably in accordance with their design and size. Mr. Rutherford has erected several of Messrs. Main's buildings in Ceylon, and he instances three in particular as being types of the various

plans and sizes. On Mariawatte estate, Gampola, the factory is of the following dimensions:— Factories.

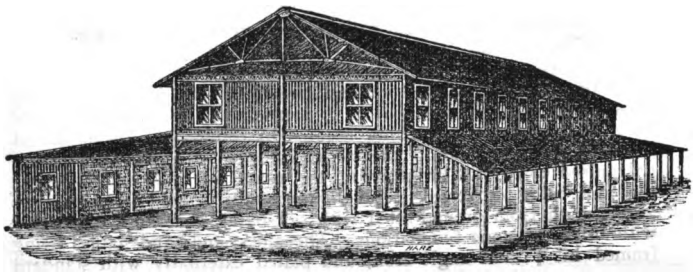
			Sq. ft.
Ground floor	...	230′ × 72′ =	16,560
Upper ,,	...	200′ × 42′ =	8,400
Including verandahs—Total...			24,960

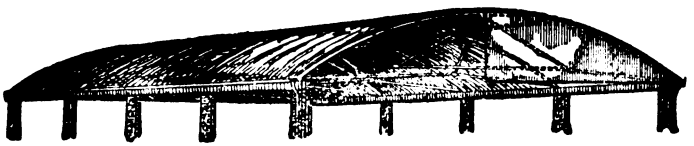
The iron work of this building, including corrugated iron, cost £953 in Colombo, or at 1/6 exchange, say 50 cents per square foot of floor, including ground and upper floor. On Kanangama estate, Kelani Valley, there is a small store with upper floor and no verandahs.

			Sq. ft.
Ground floor	...	38′ × 42′ =	1,596
Upper ,,	...	38′ × 42′ =	1,596
			3,192

Iron work in Colombo cost £163, or 68 cents per square foot.

In the case of a simple ground-floor for machinery, Mr. Rutherford instances the building on Denesworth estate, Kelani Valley, 60′ × 40′ = 2,400 sq. ft., exclusive of corrugated iron, £89 in Colombo or 50 cents per square foot. Pinewood flooring, as used in some factories for the withering lofts, is quoted at R16·66 per 100 square feet of floor surface with exchange at 1/6. This is sent out ready planed, tongued, and grooved, and for those who have no timber and find difficulty in procuring it, it might prove useful. The buildings here shown are two types of iron factories as supplied by Messrs. Main & Co., the first one, with the upper floor for withering and verandahs, being ot the form generally erected.





PLANS OF FACTORIES.

Factory Plan I. Appended to this work will be found two plans of factories. The first of these is a design for an iron factory kindly supplied to me by Messrs. Brown & Co. of Hatton. This factory is suitable for erection where timber is scarce, and where a thoroughly permanent indestructible building is required. The upper storey 108′ × 40′ × 8′ 6″ high is intended for withering. It can be fitted with two double rows of trays, covered with 45″ jute-hessian, down the centre of the room; and a single row of the same, removable in the day time to admit light, along each wall. Down the centre, between the double rows of trays, is a 6-feet passage, and a 5-feet one separates the double rows from the single rows along the walls. Allowing a space at the end of 8 feet, with trays 6″ apart, this room will provide 35,700 square feet of withering accommodation, or sufficient for about 6,000 lb. green leaf. In case of necessity a large quantity of leaf could also be spread in unoccupied spaces on the lower floor. The machinery consists of 2 Excelsiors, 2 Venetian Driers, a 25-ft. water-wheel, and a sifter and breaker. The shafting is carried along the building so as to enable the firing and sifting machinery to be fixed beyond the rollers and fermenting tables.

Messrs. Brown & Co 's specification and estimate for the building is as follows:—

FOR ONE IRON TEA FACTORY WITH UPPER STOREY.

Dimensions of ground flat 108 ft. × 62 ft.
Do. Upper Storey 108 ft. × 40 ft.

Covered by a pitched principal roof, the roof principals being constructed with T iron rafters and struts and round iron Tie and king rolls, angle iron purlins secured to rafter back by means of angle iron chains rivetted thereto and plated with standard quality galvanised corrugated iron having the usual side and end lappage: the roof being supported at sides on wrought iron H section pillars 20 feet high from ground fitted with self-fixing bases thus dispensing with bricks or stone foundations. The sides, ends and gables being framed in T and angle iron, and plated externally with standard

Factory

Factory Plan I.

quality galvanised corrugated iron, spaces being left in ends for timber windows, including rolled iron joists for attaching to the rolled iron pillars, by means of iron knees, and prepared to receive timber fillets and timber flooring—also half round wrought iron eaves guttering and 2 stocks of painted cast iron down spouts provided to each side of building: the tops of the pillars to be connected together by means of lattice girders 12″ deep. One pair folding iron framed doors with corrugated iron panels, on one side provided with fittings and fastenings. The cast and wrought iron works painted one coat of specially prepared metallic oxide paint.

Delivered in Colombo £675 0 0

NOTE OF COST OF THE FOLLOWING WORKS :—

1st.—*Concrete filling in for bases of Columns.*

37 barrels Portland cement at R11	407 00	
50 yards broken metal at R1·50	75 00	
20 ,, Sharp sand at 25c.	5 00	
Coolies for digging foundations 50 at 37c. ...	18 50	
Masons making and laying concrete one man per column per day at R1	50 00	
	R555 50	
	say	550 00

2.—*Concrete Floor.*

Floor = 108′ × 62′ × 6″ thick = 124 cubic. yards (*Note*: 1 yard concrete takes 1 barrel cement, 1 yard metal, about ½-a-yard sand, when mixed all going into the bulk of 1 cubic yard)		
124 barrels cement at R11	1364 00	
124 yards broken metal at R1·50	186 00	
50 yards sharp sand at cents 25	12 50	
For laying bottoming of large stones 50 days of mason at R1 (or equivalent of coolies)...	50 00	
This includes bringing from a reasonable distance, making and laying concrete, and floating with cement.		
1 cubic yard (= 54 sq. ft. of flooring) = 1 day of mason and cooly = 124 days at R1·37 ...	169 88	
	R1782 38	
	say	1750 00

3.—*Flooring of Upper Storey.*

Joists 1127 sq. ft. (Sawyer's measurement).
Planks 5164 ,, ,, ,, ,, allowing 20 % wastage in working.

6291 at R12·50 for timber and R3·50 for work including nails = at R16 per 100 ft. 1006 56

say 1000 00

4.—*Windows.*

Top Storey	Ground Flat.
1 Side = 424 sq. ft.	Front = 376 sq. ft.
1 ,, = 424 sq. ft.	Back = 424 sq. ft.
1 end = 152 sq. ft.	1 end = 240 sq. ft.
1 ,, = 152 sq. ft.	1 end = 240 sq. ft.
1152	1280

Factory Plan I.	1152 × 1280 = 2432 sq. ft. windows complete with glass, pivot hinges, tower bolts, &c. at 45c. per ft. 1094	40	
		say 1100	00
5.	*Staircase to upper storey*	say 50	00
		R4450	00
	Erection on estate of Ironwork Factory ...	500	00
	One 25 feet iron water-wheel *complete* with spur gearing *Sterling*	£150 0	0
	Two Jackson's "*Excelsior*" rollers	277 10	0
	Two do. "*Venetian*" driers	255 10	0
	One rotary adjustable tea sifter	25 0	0
	One Tea breaking machine	25 0	0
	Gearing for the above machinery.		
	96 feet 3″ turned polished shafting		
	5 pairs turned flanged couplings for same... ...		
	2 loose turned collars for shafting with set screws		
	9 cast iron ornamental brackets for shafting ...		
	9 cast iron plumber blocks with brasses, bored to fit shafting		
	Pulleys.		
	Main driving ...1·96″ dia. × 10″ face wrought iron		
	For over head shaft...1·36″ „ × 10″ „ cast iron		
	„ rollers ... ...2·24″ „ × 12″ „ „		
	„ driers .. ...2·48″ „ × 8″ „ „	R1,000	00
	„ sifter ... ... 1·6″ „ × 6″ „ „		
	„ breaker ... ... 1·6″ „ × 6″ „ „		
	Note.—Pulleys to be turned on face, bored to fit shafting, and fitted with steel keys.		
	Belting.		
	Main driving ...60 ft. 8″ (×8 ply.)...		
	For rollers ...50 „ 6″ (×6 „)		
	„ driers ...50 „ 2″ (×4 „)...		
	„ sifter ...25 „ 2″ (×4 „)...		
	„ breaker ...30 „ 2″ (×4 „)...		
	Erection of the above machinery and gearing on estate	R500	00

Note.—The machinery is quoted as for delivery at Colombo railway station. Gearing would be for delivery at Messrs. Brown & Co.'s Works at Hatton.

This building contains slightly over 11,000 square feet of floor surface, or 14·72 pence per square foot for the building unerected in Colombo.

To summarize :—

Cost of building	£675
Machinery	733
	£1,408
or with exchange at 1/5	R19,877
Floors, windows, &c.	4,450
Erection of factory	500
Gearing, belting, &c.	2,000
Erection of machinery, &c. ...	500
	R27,327

To this has to be added transport of machinery and factory from Colombo to estate, a very heavy item which cannot be estimated for as it varies greatly; wheel-pit, watercourse and the necessary dams or anicuts for intercepting the water in the stream; about 700 rupees (4,000 square yards) for withering cloth with the carpentry work in erecting the same; clearing the site for the building and cutting foundations; fermenting tables, bins, lamps, and fittings of various kinds. In many cases the total cost of this building, erected, with all fittings complete and including incidental expenses, will amount to close on R32,000, or R2·91 per square foot of floor surface. R30,000 or R2·72 per square foot will be found a minimum cost for it. By altering the arrangement of the shafting and machinery as shown in Plan II, a saving of about R750 may be effected, owing to the saving in the items for shafting, brackets, couplings, plumber blocks, &c. Factory Plan I.

A building such as this would be sufficient for an estate of 400 to 500 acres, producing up to 200,000 lb. per annum. A third drier would be required however for this quantity, and some additional withering accommodation in a cheaply erected building close at hand would be found a convenience. It must be borne in mind that this estimate is liable to great modifications in many respects. On estates where timber is plentiful and good the flooring of upper storey will cost far less, a saving of R300 in this item being quite possible. In the case of the windows a similar saving may be effected by making them on the place from seasoned logs, in which case the value of the timber has not to be considered. There are also numerous little details in the fitting up of the factory for which it is quite impossible to estimate accurately, and we have here merely put in round figures the limits within which the cost of the building may be expected to lie. The cost of cement is put too low for many places; and again, a less substantial floor than what is here estimated for may be considered sufficient by some. Allowance is here made for 6″ of stone paving, 6″ of cement concrete (4 of metal, 2 of sand, and 1 of cement) and ½″ of cement floating (1 of cement and 1 of sand) on the top. A much less substantial flooring than this is frequently laid and lasts fairly

Factory Plan I. well, but is not of course nearly so satisfactory for a surface exposed to such rough usage as the floor of a tea factory.

Factory Plan II. Plan II., which has kindly been drafted for me by Messrs. Brown & Co. from dimensions given them, shows the ground plan and side and transverse elevations of a factory of the ordinary type as erected on upcountry estates, where timber and stone are plentiful. The upper floor is supported on 2-feet dressed stone piers, the verandah roof and main roof by wooden posts. At a very slight addition to the cost 18" stone piers may be substituted for them. Doors are not shown on the plan; they must be put where found most convenient. Four doors and 156 windows 3½' x 2½' each containing four panes, are allowed for in the estimate. That is, 33 windows and 1 door in each side of lower flat, and 36 windows each side of upper flat. At wheel-pit end 12 windows in lower flat, and 6 in upper; at the opposite end 10 windows and a door on lower flat and a door only above. This gives 2,272 sq. ft. of windows. These should be of good seasoned timber, and when this is not available, it is better to purchase jakwood for the purpose. The estimate allows for this, and the timber for doors and windows is not included in the sawing account. If the centre window of each group of three is made to revolve on pivots it would be sufficient. It would be preferable however to make them all moveable. The ground floor dimensions are 120' x 50', verandahs being 12' broad, and main building 22' in the clear. Upper floor is 120' x 24' for withering. Height of lower floor 11' and of upper floor to tie beams 8'. The upper floor is for withering, and will contain a double row of shelves of 45" withering cloth down the centre, and single rows of shelves along the sides. Leaving 10 feet clear at the end, with shelves 6" apart, this room will afford 24,600 square feet withering space, sufficient for 4,000 lb. green leaf. On an emergency more leaf can be put on the lower floor on unoccupied spaces, and it would be well to add to this building a cheap temporary withering shed for surplus leaf, to be used when required. With this addition, a store of these dimensions will be sufficient for a 400 acre estate, producing say 150,000 lb. tea per annum. By the addition

Factory Plan II.

of another drier, and the extra withering accommodation alluded to, it will be found sufficient for an estate of 400 to 500 acres, producing say 200,000 lb. tea per annum. The machinery here shown is the same as in Plan I., but differently arranged. The shafting is fixed in the centre of the building overhead, and is only 34 feet long instead of 96 feet, which is of course more economical, though probably less convenient. The most convenient arrangement will be to have a double row of steps outside to the upper floor at the end opposite to the wheel, up which the coolies can bring the leaf to be weighed in, and from whence it can be run in trolleys along the withering shelves. Shoots above the rollers conduct the withered leaf from the upper to the lower floor. Steps should lead to the upper floor from the lower at the same end. The letters on the machinery in the ground plan, and the figures on the elevation showing arrangement of belts, correspond to the same in Plan I., and are referable to the explanatory notes there given. The sifting and packing rooms E. & I. may be closed in by boarding from the rest of the building, if desired. An office can be put in one corner of the verandah, or under the weighing-in steps. These details, however, have not been allowed for. In order to make the comparison between the cost of this building and that figured in Plan I. more satisfactory, the floor is estimated at 30 cents a foot for cement concrete, &c., as previously described, and the windows are estimated to be made of purchased timber. The ordinary roof and floor timber and all weather boarding, amounting to 18,000 feet, is calculated for sawing on the estate and delivery at factory site for R7 per 100 feet. Where timber has to be purchased a sum of say R1,000 (18,000 feet at R5·50 about) will have to be added on, but this building is intended chiefly for erection where timber and stone are close at hand, and where transport of material from Colombo is difficult and costly.

ESTIMATE FOR PLAN II AS SPECIFIED.

1144	cubic feet dressed stone masonry at 37 cts.	423·28
702	„ footings (3′ × 3′ × 3′) at 25 cts. ...	175·50
6000	square feet concrete and cement flooring (6″ stone, 6″ cement concrete, ½″ cement floating,) at 30 cents per sq. ft.	1800·00

Factory Plan II.	248 sheets galvanized iron 7' × 2'3" at	R2·25	558·00
	248 ... ... 8' × 2'3'	2·50	620·00
	80 lengths guttering (6 feet) at	2·25	180·00
	Ridging, down pipes, corners, hooks, &c. ...		100·00
	4 doors (½ glass, 2 double 8' × 6', 2 single 7' × 4')		120·00
	2272 sq. ft. windows complete with glass, pivot hinges, bolts, &c. at 45 cts. per ft.		1022·40
	Door hinges and locks, nails, roofing clips, paint for doors, &c.		350·00
	Carpentry work on roof and weather boarding		500·00

TIMBER REQUIRED.

26	posts 8" × 8" × 9'	= 312	feet.
26	,, 8" × 8" × 10'	= 347	,,
½"	weather boarding	= 4500	,,
13	floor beams 14" × 7" × 26'	= 591	,,
156	joists 7" × 3½" × 12'	= 1638	,,
520	planks 7" × 1½" × 12'	= 3640	,,
192	post for frames 4" × 2½" × 9'	= 936	,,
52	,, ,, 4" × 2½" × 11'	= 309	,,
24	planks for steps 12" × 2" × 8'	= 192	,,
4	,, ,, 12" × 3" × 15'	= 75	,,
125	rafters 5" × 2½" × 15'	= 1172	,,
125	,, 5" × 2½" × 14'	= 1094	,,
13	tie beams 10" × 5" × 26'	= 422	,,
13	kingposts 5" × 5" × 6'	= 65	,,
39	struts, &c 5" × 3" × 6'	= 156	,,
12	ridgepoles 7" × 3½" × 11'	= 115	,,
150	reepers 1½" × 3" × 12'	= 450	,,
50	poleplates 6" × 5" × 11'	= 504	,,

Sawyers' measurement	16518 feet	
Say 18,000 feet to allow for wastage at R7		1260·00
Total...		R7109·18

This building contains 8,880 feet of floor surface and the cost is therefore 80 cents per square foot erected and finished. The space covered by each set of piers with the roof framing, &c. above it, is one-tenth of the whole building, or 888 square feet, costing say R710. Additions to, or deductions from, the size of the building as here planned, may be made at this rate, a small allowance being made for the cost of the ends being unaffected by the length.

The Machinery as figured in the plan costs by Messrs. Brown & Co.s' specification delivered at Colombo Station £733 or with exchange at 1/5 ... . R10,348 **Factory Plan II**

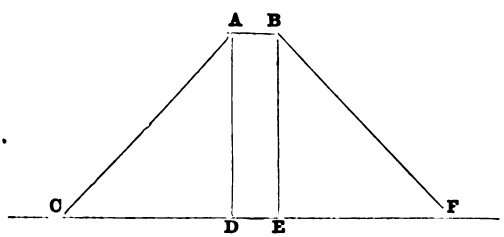
Cost of erection	500
Gearing, belting, &c. as planned ...	1,250
Cost of factory as per preceding estimate	7,109
Total...	R19,207

To this must be added transport of machinery only to estate; cost of wheelpit, watercourse, and the necessary dams or anicuts for intercepting the water in the stream; about R450 (2,700 square yards) for withering cloth with the carpentry work in erecting the same; clearing the site for the building and cutting foundations; fermenting tables, &c., &c., as enumerated before. The total cost will therefore be about R22,000, more or less, according to the cost of the details not calculated, the chief item being the wheelpit and watercourse. This gives R2·47 as the cost per square foot of flooring for the complete building, or R2,200 for each length of 12 feet. In comparing the cost of these buildings it must be borne in mind that, in the case of Plan II, the value of the sawn timber is not estimated, it is presumed that this comes from forest growing on the estate. If timber were purchased and transported from a distance the cost would be increased by about R1000. The iron factory as shewn in Plan I is well adapted for erection where transport is easy and cheap, and it has the advantages of lessened danger from fire and practical indestructibility from other causes.

Water-power. The advantages of water-power over steam-power have been previously alluded to; wherever the former can be made available for the greater portion of the year, it should certainly be taken advantage of; the saving in fuel and wear and tear of engine will pay for the extra initial expense involved, and even during the dry weather, the water-wheel may be made to assist the engine in its work. The fact that the dry season is the time when the press of work is greatest is unfortunate, and there are consequently but few estates which will be found quite independent of steam-power all the year round. Dams, though they can be made of some assistance, will not be found a very efficient help, as the water

Water-power. is required incessantly for 8 or 10 hours at a stretch, a length of time which will try the resources of the largest reservoirs we can construct. The following hints on dams from Mr. Ballardie's essay are of value :—

Bunds. In selecting a site for a bund, the most suitable ravine will be chosen, on the lowest, narrowest part of which the embankment should be made. All logs or matter which will rot must be removed. Advantage should be taken of any projecting rocks in the ravine, against which to butt the sides of the bund. After cutting down to the solid, a layer of well-puddled earth or clay, say 12 inches thick, should be well pounded in; on the top of this the embankment should be made. Great care must be taken where the junction of the natural and made banks takes place that there be no leak. The height of the bund must be regulated by the necessities of the estate, and the size of ravine; but a good rule for a section is: the distances *a b* and *d e* should be 3 ft. broad, and the heights *a d* and *b e* should equal the breadths *c d* and *e f*; the angle *a d c* and *d e f* would thus be right angles. The height of bund should



be at least 3 ft. above spill level. The first work after fixing the site is to lay the supply pipe. Cast-iron gas pipes jointed with cement will in large dams be found the most advantageous, as no external pressure can affect them; but in smaller dams common white iron spouting well riveted will be sufficient. When the point is fixed for the pipe, a square of at least 2 ft. of well-puddled clay should be made all round the pipe. To this work great attention should be paid, for if not properly done at first, it will be a continual source of trouble.* We consider bunds formed of earth preferable to those generally built on estates of stone, as they are cheaper, and, if proper care be taken in the puddling, less liable to leak. The spill is the only piece of masonry necessary; this should be built with cement. The outside of all earth work should be puddled, and either sodded or planted with grass.

In building a tank it is of primary importance to prevent unequal settlement, or any movement of the wall that would cause leakage." (Hurst). This can to a great extent be avoided by raising the bund regularly and evenly, carrying on the whole line at once. Molesworth gives the following data: Breast slopes 3 to 1; back slopes 2 to 1. The proper materials for good clay puddle are clay and as much sand and gravel as are consistent with its holding water. (Rankine). The spill must of course be propor-

*Brindley's advice is, "Puddle it, and puddle it, and puddle it again."

tionate to the size of the dam; but in all cases it should be large enough to carry off all surplus water, even during heavy rains. Bunds and Sluices.

The most suitable form of sluice door consists of a round wooden plug, about a foot broad, fitting into a hole in a wooden box out of which the supply pipe leads. A box 1½ foot square will be sufficiently large, and will be found to stand the rush of water better than any masonry construction. The plug should be broader at the top than at the bottom so as to fit tight, and should be raised and lowered by a vertical iron bar, ending in a screw. A gangway must be made from the bank to work this door.

Where the driving power is taken direct from the stream anicuts are frequently required. These should be placed on as straight a part of the river as possible, curves being objectionable at flood times. It is scarcely necessary to say that no expensive building should be erected till the majority of the fallen timber and driftwood from higher clearings have been washed down. The weir should be placed obliquely, as by this a longer line is gained, and flood waters are prevented rising to such a height as they otherwise would with a shorter crest. An angle of from 50° to 60° is generally used. If made sharper than this, the surge at upper end is apt to eat into the bank. For the section of the anicut, the upper side should be from vertical up to an angle of 45°; the lower side should slope down at an easy gradient. The sharper the angle of upper side, the greater will be the catch of water, and consequently the weaker will be the bund. The planter must satisfy himself as to what angle would best suit the stream—all calculations being based on floods. If circumstances justify a thoroughly permanent building, joints should be made of 2 of fine sand to 1 of cement, well ground (to be made in small quatities as required); but in the majority of cases,* large stones laid in without cement and faced with grass sods will be found sufficient, and can be easily placed *in situ* by estate coolies. In all cases it will be found advisable to build the weir lower in the centre than at the sides, that the overflow may escape without injuring the banks.

There has been much discussion regarding the respective merits of turbines and water-wheels. The latter are simpler, and will naturally always be preferred by planters upcountry. With an abundant flow of water a good wheel is a very simple and satisfactory machine to have. For high falls a turbine is best suited, and this machine is strongly recommended by Mr. Jackson as follows:— Water-wheels.

When water is admitted to a Turbine, it at once developes a correspoding amount of power, and it can be just as quickly stopped, and being a quick-speed motor, any variations of the pressure applied to the leat being rolled does not materially affect its speed.

* Applicable to coffee, but not to tea, the preparation of which in Ceylon will extend over the larger portion of the year.

Water-wheels.

This is not the case with the overshot water-wheel which must have time to fill or empty its buckets before the speed is increased or diminished.

Where only one Roller is driven by the overshot wheel, the attendant can, by careful watching, get along fairly well with it, particularly if the lay shaft is fitted with a fly-wheel, but where two or more intermittent feeding and discharging Rollers are to be driven by such a wheel, there will be very serious risk of accident on account of such wheel not being under prompt control, but apart from this altogether comes the question of quantity of water, fall, and first cost, all of which will be found in favour of the Turbine.

The power can be conveyed from the Turbine to the machines entirely by belting, and the planter will at once see the great value of this, in so far that any coolie could mend a belt in a few minutes, whereas in the overshot wheel a coolie can neither tell when a tooth will break out of the segment spur-wheel or pinion, nor can he put such a tooth back again when it does break out.

Yet one more point in favour of the Turbine. A "governor" could be very readily applied to it to control the speed if deemed desirable.

Mr. Lamont gives the following rule for calculating the power of a well-made water-wheel or turbine:—Multiply the cubic feet of water per minute by the height of the fall, and divide by 700: the quotient will be the horse-power of the wheel. He also gives the following interesting extract:—

If a ponderous vertical wheel be applied to a very high waterfall, its diameter will be so large, and its revolutions so very few, that it must be connected with a great deal of auxiliary machinery to impart that rapid motion which is generally required. On the contrary, the turbine being comparatively so small and its revolutions so numerous in a given time, its motive power can be at once transmitted.

Moreover, what operates as a disadvantage in the ordinary wheels, contributes to the more efficient working of the turbine; for the higher the waterfall, the smaller, and consequently the less expensive, the turbine adapted to it; and also it is applicable on falls of water so high that the ordinary wheel cannot be used. Another great property of the turbine is its constant and uniform motion, which arises from the diffusion of the impelling water over the whole of the circumference at the same instant. This perfect uniformity of motion is a peculiar feature of the turbine. The turbine is capable of working under the back water as long as the surface of the fluid in the reservoir remains the highest, during which time it will produce a moving force proportional to the difference between these two levels, without a perceptible diminution of the useful effect, thereby evidencing that it is exempt from the casualties to which the vertical wheel is so often subject.

If a turbine be connected to a steam-engine during the dry months while water is scarce, it can be made to transmit the highest obtainable power from the quantity of water by which it may be supplied, and it can be made so large as to drive all the works in the wet months, saving the expense of fuel, economising

the liquid that commonly runs to waste, and giving sufficient time for any repairs that might be required on the steam-engine, clearly showing the great advantages of the turbine over the vertical wheel, for it could not be made so large as to receive the extra water in wet weather, without lessening the effective power of the smaller quantities in dry weather. Water-wheels.

It is a fact of vast importance that turbines on the improved principal of construction, supersede in America, France, and many other parts of the Continent, every other description of water-wheels, and after long experience of their superior working power in impelling machinery, however ponderous and complex, they have been stamped with the approbation of the most eminent mill-owners and manufacturers. And I am firmly convinced that their general introduction is now a mere question of time.

To Mr. H. W. Unwin, of Colombo, the publishers are indebted for the following useful notes:—

Water Wheels and Turbines.—The effective H.-P. of a water-wheel (overshot or breast) is calculated from the *vertical* distance through which a given weight of water acts on its periphery or rim, for it is clear that if you could put 33,000 lb. of water (=1 H.-P.) or any other weight on one side of the wheel it will exactly counterbalance or lift a similar weight on the other side. Now 1 H.-P.=33,000 lb. lifted 1 foot in 1 minute, so if you calculate the weight of water passing over your wheel in 1 minute, and multiply that weight by the height in feet, from the moment the water begins to act on the buckets to the moment it leaves them, you have the total number of lbs. of power expended in working the wheel; divide this total by 33,000 and you have the effective H.-P. less about ¼ which must be deducted for friction, etc.

Example.—Required the H.-P. of one 16-foot overshot wheel supplied by a stream 2½ feet wide × 9 inches deep with a mean velocity of 2 feet per second (=120 feet per minute) performing ¾ of its theoretical efficiency.

$$\text{H.-P.} = \frac{2{\cdot}5 \times {\cdot}75 \times 120 \times 16 \times 62{\cdot}5}{33{,}000} \times \frac{3}{4}$$

$$= 5{\cdot}1 \text{ or say } 5\ 1/10 \text{ H.-P.}$$

Turbines realize a greater percentage of useful effect than other water-wheels, the water acting simultaneously on all parts of the wheel with equal force. To compute the H.-P., multiply the weight of water passing through the supply pipe per minute into the *vertical* fall in *feet* from the top of supply pipe to bottom ditto and divide by 33,000, deduct 1/5th from the result and the actual power given off by the wheel at its periphery will be obtained. In Ceylon many of the water-wheels are so indifferently hung that they develop considerably less power than they should do.

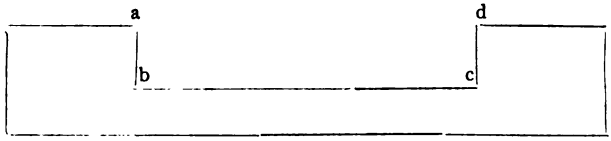
Memorandum. 1 gallon water = 10 lb.
1 c. ft. ,, = 6¼ galls. = 62½ lb.
mean velocity of a stream = about 9/10th of *surface* velocity.

It has of course to be borne in mind that the power that can be obtained from a water-wheel is limited by the capacity of the buckets and strength of the wheel, and hence it is well to obtain professional opinion before deciding on motive machinery. It must always be remembered also that it is false economy to work with too low a power; this means

Water-wheels.

undue strain on the motor, and the possibility that at a future time the power may be found insufficient for the machines required.

To gauge the amount of water in a stream, take a board, sufficiently broad to stretch across the stream, and cut a portion of it away thus:



Place the board in an upright position across the stream, the cut side uppermost, and sod up all openings round it so that all the water pours freely through the opening a b c d, without backing up from below; for it is evident that if the water is retarded in its flow through the opening, it will pour deeper through it than if permitted to flow through without obstruction, and thus the quantity of water in the stream would seem to be larger than it really is.

The opening must also be sufficiently large to allow plenty of room for the passage of the whole stream.

Given the width from b to c, and the depth of the water flowing through, its volume can be calculated from the following table:—

TABLE FOR WEIRS.

Giving the Delivery in Cubic Feet per Minute for each one inch of Width of Weir.

Inches depth on Weir.	0	1/8	1/4	3/8	1/2	5/8	3/4	7/8
1 ...	0·40	0·41	0·56	0·65	0·74	0·83	0·77	1·03
2 ...	1·14	1·25	1·36	1·47	1·59	1·71	1·84	1·96
3 ...	2·09	2·22	2·36	2·60	2·64	2·78	2·93	3·06
4 ...	3·22	3·38	3·53	3·69	3·85	4·01	4·17	4·34
5 ...	4·51	4·68	4·85	5·02	5·20	5·38	5·56	5·74
6 ...	5·92	6·10	6·30	6·49	6·68	6·87	7·07	7·27
7 ...	7·46	7·67	7·87	8·07	8·28	8·49	8·70	8·91
8 ...	9·12	9·33	9·55	9·77	9·99	10·21	10·43	10·66

Thus, if the opening from b to c be 8 feet or 96 inches, and the depth of water be 4½ inches, we have:—96 × 3·85 = 369 cubic feet per minute.

On the subject of Belting, Mr. Jackson writes as follows:— **Belting.**

I am of opinion that indiarubber bands are best suited for Ceylon.

I have lately seen several five-ply straps that were sent out with our first rollers some years ago, and they are practically as good as new, the reason in my opinion being due in a great measure to the use of Harris's patent clip for the joint.

In nearly all cases it is the jointing of the belts that gives trouble.

Coolies are often careless and punch holes in a very irregular way to form a joint, and it is this irregular cutting up of the straps that usually brings them to grief.

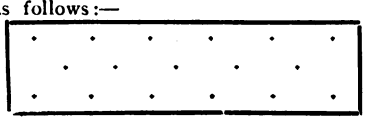
Another fruitful cause of the destruction of belts is too short centres between the pulleys over which they run.

In designing permanant factories it should be arranged that the driving pulleys of our Rollers shall be fifteen to twenty feet away from the line shaft, and for a main driving belt, twenty-five to thirty feet centres will be found about right.

The following from Mr. Dowling's "Tea Notes" is of value:—

BELTING.

A Gandy's Cotton Belt 4 inches wide is considered powerful enough for a Tea Rolling Machine and Saw Bench. The principal thing is the piecing of the belt. The longer the splice the stronger the belt will be. Wear always shows itself at the piecing, but if it be done as follows, it will be a long time before there is any appreciable wear. The holes for piecing should not be punched out of the substance of the belt, but the threads should be gently pressed apart with an awl, so that none of the fibre may be ruptured. Bolts with large flat heads on the side next the pulley, and with screws and nuts on the other, are a very easy and efficacious method of fastening the ends of the belt together, but strips of leather, technically called laces, may be used if preferred. If one end laps over the other by four feet, the piecing will be infinitely more durable than if it only laps over 18 inches or two feet. In the event of the piecing wearing out, the belt can be cut so that the two ends just meet, and a new piece of the belting, say 8 feet long placed at the back, and bolted or laced to the two ends. Take care in fitting the piece on the back not to use the old bolt holes in the original belt but to make new ones. This also must be observed if the belt should stretch and require shortening. If the belt passes through the fork of a guide to direct it on to a fast and loose pulley as desired, it is essential that a wooden cylinder working freely should be placed on each prong of the forks, otherwise the friction of the belt against the forks will rapidly wear out the salvage of the belt. Fasten as follows:—



about 4 feet in length.

BELT LACINGS.

The strain on belts is always in the direction of their length, and therefore holes cut for the reception of lacing should be oval. Eel skins, when procurable, make the best lacing belts. Raw hide

Belting.

lacings are useless, and Indents should express Dressed leather.

Mr. Unwin notes :—

Belts.—Machinery belting, if of leather, should be kept free from damp and occasionally oiled with fish oil. Where the machines are liable to constant wet in working (as pulpers) use the guttapercha composite belting. Holes for laces and rivets should be punched out with a *hollow* punch, not roughly bored.

Steam Engines.

As regards steam engines, these are machines which must be chosen and erected by a competent engineer, and their working requires skilled supervision. On no account should cheap engines be purchased; most varying sums can be paid for them, but it will be found cheaper in the end to buy a good machine from a well-known maker than to endeavour to economize. Besides this, it must be borne in mind that the amount of fuel consumed by engines of different types varies greatly, and that a saving in capital outlay may soon be lost in unnecessary working expenditure. The difference between the consumption of fuel for a tubular boiler and that required for the old upright type will be found very great, and is a matter of the greatest importance when fuel is scarce.

The following is Mr. Jackson's advice on the subject:—

With regard to the steam engine, I will only remark that I consider the horizontal fixed type, detached from the boiler, with the locomotive multitubular boiler, the best suited for Tea factories. The boiler should be two or three horse-power in excess of the engine, and have a special large fire-box for burning wood as fuel. Where a good efficient water heater is provided, compound engines effect very little saving under 16 horse-power.

These locomotive boilers can now be had in several pieces for easy transport to hilly estates.

There appears to be an erroneous impression abroad that a water-wheel and engine cannot be made to give off their power in unison with each other on to the same shaft.

Suppose that I had a Tea estate on which I would be quite certain of sufficient water for three parts of the year to do all my work, I would at once put down a turbine and an engine as well (such engines being able to do the work alone), and I would so arrange these by means of belting and pulleys, that they would be both connected to the main line shaft. Then, when water began to get short, I would light the fire in the boiler, then turn on all the available water on the turbine, and make up the balance of the power required with the steam engine.

I find a number of gardens will have to take this into consideration, and I advise, where fuel is scarce and expensive, even if there is sufficient water for half the year, that a combination of the turbine and engines to work together is desirable.

Mr. Unwin gives the following:— Steam Engines.

STEAM ENGINE AND BOILER.

Stoking Memoranda.—See that the water is about half-way up the guage-glass, and when steam is up, see that the cocks are all clear and not stopped up with dirt; see that the safety-valve is quite clean and the lever works freely. *Never* overload the valve on any pretext whatever. If the valve leaks badly, remove the lever and weight, take out the valve, fasten its shank to a wooden handle, and grind it into its seat with emery (fine) and oil. This will generally suffice. *Leaks and drip* should not be allowed to fall on the plates of the boiler and wet ashes from the furnace cause rapid corrosion. Paint or tar the shell of the boiler, but not, of course, any brass-work. Man-hole and mud-hole doors should, if they leak badly, be removed and a fresh joint made. For joints use plaited hemp with red-lead and linseed-oil about the consistency of thin putty. If by neglect, the water disappears from the guage-glass and test cocks, don't run away, but haul out the fire, open the furnace door, and cool down the boiler. *Don't* turn on the feed pump, for if the water has sunk below the crown-plates of the furnace, you will probably have an explosion. Blow off the boiler once or twice a day to clear out dirt and scale, (about an inch by the guage-glass will do) and then turn on the feed and fill up again; a boiler will, if properly cared for, work without danger for 15 or 20 years, but where doubt of its history exists, have it tested to at least 1½ times its working pressure by cold-water with an hydraulic force pump made for the purpose, and if no cracks or defects are disclosed, the boiler is safe for another year. Cracks between rivet-holes are always dangerous. The fire should be *evenly* distributed over the fire grate, or considerable loss results by cold air passing through, and neutralizing the heat of the furnace. *Priming* in a boiler may generally be cured by a wooden-grating (say of plank 1¼ inch thick) fastened inside the boiler so that it floats under the steam-chest or orifice where the steam is drawn off. Priming is very much in the nature of a water-spout inside the boiler by which the water is churned up with the steam, and may be understood in its action by watching a tub or tank of water emptying itself through a hole in the bottom. Once or twice a year open and thoroughly cleanse the boiler. Finally a careful stoker is the best of all safe guards.

Memorandum.—Ordinary High-pressure Engines consume 10 to 12 lb. coal per hour per indicated H.-P. In ordinary practice 1 lb. coal evaporates 6 to 8 lb. water at 212°. Wood has only about ¼ of the evaporative power of coal or coke.

Starting and Working Engine.—Examine and clean all oil holes and see they are well supplied with oil. Open cylinder water-cocks before starting and do not shut them till all condensed water is blown through. Use grease or tallow for lubricating cylinder, heat in a kettle and pour in while liquid.

Brasses heating.—Watch while machine or engine is working and if (through want of oil, or the caps being screwed down too tightly) they heat, stop work and cool down with cold water before commencing again. It is a good plan to cut a small groove in the top brass, parallel with the axis of the shaft (*not* crosswise running round the journal) as this means distributes the oil evenly.

Memorandum.—Friction increases directly with the pressure per square inch, so that large bearing surfaces decrease (*not increase*)

Steam Engines. friction. The velocity of the moving surface does not affect the question except indirectly as using up the lubricating agent.

Feed Pump.—If this does not act, the valves perhaps are choked and must be cleared; sometimes a few taps with a piece of wood outside may free the valve; otherwise the caps must be removed and the valve taken out. If the retention-valve near the boiler leaks badly and the pipes become very hot (from the boiler water being blown back on the pump valves), take out the former valve, and if no mere temporary obstacle has checked its action, the valve may need to be ground with fine emery to a good bearing into its seat.

H.-P., The standard (horse-power) fixed by Watt and still accepted for all calculations is 33,000 lb. lifted 1 foot in 1 minute.

Cleanliness in the management of tea machinery is insisted on by Mr. Jackson, and he suggests cleaning the rollers daily with soft soap and water. The durability of machinery is undoubtedly assisted by strict cleanliness, and every drop of waste oil, grease, &c., should be carefully cleaned off.

Mr. Unwin says:—

Tools for Tea Factory.—A supply of spanners to suit all nuts of the machinery and engines. (For small nuts up to 1½″ perhaps a screw-spanner is most useful). An oil-can with long spout, a little resin for belting, one or two files of sizes. Where it can be managed, a small portable blacksmith forge with vice and small anvil will be found most useful and will probably soon repay their cost; a few of the common blacksmiths' tools will also be necessary such as hammer, cold chisels, tongs, &c., and coolies may soon be taught the use of them. A few punches and copper rivets and washers for leather belting.

Fuel. The subject of FUEL SUPPLY is a most important one, and it is one to which sufficient attention is not always given. In cases where there is no forest reserve quick growing trees should be planted in all waste land, and for this purpose Mr. W. Ferguson suggests "Waa," (Cassia Siamea), for the lowcountry, as being the best caloric-giving wood in the island, green or dry. One of the great merits of this tree, according to Mr Vincent, is the rapidity with which it grows up when coppiced. For what Mr. Vincent says about firewood, see Appendix. At medium elevations Sapu will be found a good tree to grow, also Lunu Medilla. At high elevations, toons, cryptomeria japonica, eucalypts, grevilleas, wattles and other Australian trees can be grown.

The following valuable information has been contributed by Mr. James Irvine to the *Ceylon Advertiser*:—

Where wood can be procured at say R1 per cubic yard weighing 5 cwt. it is cheaper than any fuel which can be used in Ceylon. The tea planter's difficulty, however, will be the uncertainty of the supply and difficulty of transfer. At present th

Ceylon Government Railway pay to the Forestry Department R1·37 per cubic yard for selected wood. This wood, I believe, weighs about 600 lb. to the cubic yard. Selected low-country timber, however, is much heavier than the ordinary forest growth of the hills. An acre of ordinary hill forest will not probably turn out more than from 200 to 250, say 225, cubic yards to the acre, of wood fit for fuel, or 126,000 lb. Allowing 2 lb. of wood for every lb. of tea cured, it will take an acre of forest annually for every 63,000 lb. made tea. Given an estate of 300 acres yielding 400 lb. tea per acre, it will take practically 2 acres of forest every year to cure the tea. To supply an ordinary estate of 300 acres, yielding what is now the recognized average yield of Ceylon tea, viz., 400 lb., it will be necessary to keep replanting quick-growing trees every year. The value or heating power of the fuel will vary much, and differ much in weight, according to the timber planted or growing naturally on the land, and the cost of cutting and carriage will also vary with the conditions of each estate, but on no estate where timber is available should fuel cost more than R1 per cubic yard of say 600 lb., which should cure half its weight in tea, giving one-third of a cent of a Rupee per lb. as the cost of fuel, but to this must be added the value of the land held in reserve. Fifty acres of forest held in reserve means the loss of a crop of 20,000 lb. tea were it in cultivation. Coal is at present the only substitude for wood, and at the current price of coal in Colombo, a ton of coal will cost from R30 to R40 per ton on the estate, according to the station at which it is delivered, and the carriage to estate added, the value of coal compared to wood is as three of wood to one of coal, which will give the following results:— Fuel.

4 Yds. wood = 1 ton weight.
12 ,, ,, = 1 ton of coal as is 3 to 1.

A ton of coal will cost R35 to R40, or in other words three times as much as wood, or practically the cost of coal is one cent per lb. of tea against one-third of a cent for wood. Railway rates for transport of fuel must be lowered; for coal, and patent compressed fuel will doubtless be delivered in Colombo at greatly reduced rates; but the great difficulty still remains—how are we to get fuel to stores situated in inaccessible places*? Coal is costly and difficult of transport; coke is much more costly and the most destructive to fire bars and heating plates of the dryer of any fuel which can be used. Wood, where it can be got in abundance, is the cheapest of all fuel, and the easiest managed by an ordinary cooly but the cost of reserve forest lying idle, especially on small estates, is a very serious matter. There are few large estates, however, where quick-growing timber may not be planted in ravines, on ridges, or on broken land or poor patna. Planted timber will give at 5 or 6 years old nearly as much fuel from the thinnings as an acre of ordinary natural forest. Planted timber is regular and close, and having no trash or soft stuff or "Mousa" in it, all is available. A natural forest, when the underwood is taken out, is often little better than a scrub with hardly a dozen trees to the acre. The first thing for a tea planter to do is to plant every piece of *waste* land with quick-growing trees. The cleaning up

* Mr. Irvine, who is not an Irishman, means, of course, places difficult of access.—PUBLISHERS.

Fuel.

of old timber on the estate will probably last till the planted trees are fit to utilize.

Mr. Irvine then goes on to suggest petroleum from Upper Burmah or the Black Sea as the probable solution of the fuel difficulty where timber is scarce. He also gives the information that a 10 H.-P. engine will consume 5 cwt. coal in a working day of 8 or 9 hours, which means an annual expenditure of R3,000 for coal, or its equivalent in wood if it be got on the estate R1,000. With a tubular boiler of the most approved form, a 12 H.-P. engine can be worked for 8 hours with 2 yards of good wood only. Much, however, appears to depend on skilful stoking, especially where coal is the fuel employed.

Rollers.

ROLLERS are the first machines that must engage our attention, and of these there are now many in the market. The most generally popular machines are those by Mr. Jackson, they are:—

His *Hand Roller*, price at Colombo R500, taking at a fill 40 to 50 lb. of withered leaf, working best at the smaller fill. Requiring 4 coolies at 25 minutes up to 30 minutes to finish the roll.

Output of rolled leaf 800 lb. per day of 10 hours. This machine can be geared for power.

The Universal Roller, price at Colombo £92.15 sterling. About the same capacity as above, 2,000 lb. green leaf maximum, or 1,600 lb. per day if not pressed. Roll finished in 20 to 25 minutes.

The Ceylon Roller, price at Colombo £130 sterling, capacity about 150 lb. withered leaf at a fill, say 5,000 lb. green leaf per day of 10 hours.

The Excelsior Roller, price at Colombo £138·15 sterling, capacity 240 lb. withered leaf at a fill, or about 8,000 lb. green leaf per day of 10 hours, roll finished in 20 to 25 minutes.

The "Hand Roller" and "Universal" are both well-known and do excellent work. This is a point about which there is no question. For coarse or underwithered leaf these machines can scarcely be excelled. Regarding the larger machines Mr. Armstrong writes:—

The Ceylon Roller.—This was built at my suggestion to suit our special wants. It can be driven by a 16-feet water-wheel, and with one of the smaller rollers to back it, is equal to a 200 acre garden, or at a pinch even 250 acres if we have lots of water. Most of us who are converting our poor diseased coffee fields into everlasting fields of tea, already have valuable 16-feet or 18-feet water-wheels: without the *Ceylon Roller* these are useless lumber. Any gardens therefore of from 100 to 250 acres with water-wheels ready fixed and water to drive them, have here the very roller to suit their purpose, always beginning with one of the two smaller rollers.

The Excelsior.—This requires *at the least* a strong 20 ft. to 22 ft. wheel with *lots* of water to drive it, and may be purchased

by any garden of over 200 acres having no motive power ready fixed. If an engine is to work it, I would recommend 10 h.p. to be purchased. 6 h.p. will work an Excelsior, but the more power we have the more economical it will be in the end, and we may have to work two Excelsiors at one time, besides other machinery. Rollers.

Barber's "Blackstone" roller is a machine working on an entirely different principle from the foregoing; the action is that of two vertically placed discs revolving in a drum, and having the leaf between them; one disc being movable in a horizontal direction, pressure can be brought to bear on the leaf. Up to this point the machine is very similar in action to Kinmond's original "Centrifugal" roller and Thompson's "Challenge." The chief distinguishing feature of Barber's is a fluted "spheroid," surrounding the axis on which the discs work, but unattached to it, and hence moving round with the leaf. The arrangement of the raised battens on the discs is also peculiar. The chief advantage claimed for this machine is the small power required to drive it as compared with what Jackson's rollers take. The "Standard" machine is said to be driven by a 12 ft. × 3 ft. water-wheel, and it does 500 lb. leaf per hour. It is also adapted for hand work. It costs £75. The "Miniature" machine is only made for hand work, and is priced at R500, taking 50 to 60 lb. a fill. This machine certainly does most excellent work with fine leaf, and is said to roll coarse leaf well also. It is undoubtedly a valuable addition to the machines available for choice.

Mr. Kerr has now brought out a new roller, his previous invention having been proved an infringement on Jackson's patent. The machine is described as follows:—

This machine with or without the brush action is now being made by MESSRS. BROWN & CO. OF HATTON of good strong superior material and of best manufacture, it is capable of rolling off 100 lb. of withered leaf—one fill of box—in 30 minutes, or if by hand power in 40 to 45 minutes.

Price of machine:

Hand power	R350	net cash
Water or other power	„ 385	

on delivery from Manufactory.

The principle on which this machine works is in some respects similar to that of the original, as for instance the long lever with box without bottom for holding leaf is retained, the box does not turn back but is enclosed in a case or shroud without top or bottom, moving up and down with the table or platform outside the box, thus preventing the leaf to be rolled from escaping. The

Rollers.

table or platform is hinged at one—the far end, and the other end is raised or let fall by means of a strong spring and rapid screw, by which *great* pressure may be used to any degree required, or a light roll if wished for. No high upright frame now used.

One great advantage this machine possesses over other machines is that it has no under-trap-door to take away the roll, and thereby it *retains all the juice* when leaf is being rolled, which is absorbed by the roll.

This machine appears to be doing satisfactory work and is certainly good value for the money.

Thompson's "Challenge" roller is a machine that has been working on several estates in Ceylon and does a large quantity of work. With good leaf it does it satisfactorily. Kinmond's "Centrifugal" roller would not require mention except that several have been erected in Ceylon. It is not a very satisfactory machine to work as it breaks the leaf, heats the roll, and spills a great deal. It has the advantage of doing a great deal of work, about 4,000 lb. of leaf a day, with very little power—about 2½ horse-power suffices. The driving pulley on the machine is 20 inches in diameter, and should be driven at a speed of 150 revolutions to the minute; this gives a speed of 60 revolutions to the discs. The machine consists of two vertical discs revolving in the same direction on their axes inside a drum, one disc can be moved by means of a screw and springs towards the other, thus regulating the pressure. The centre of one disc being above the other gives a twist to the leaf. Mr. Kinmond has recently, it appears, in conjunction with a Mr. Richardson, invented a new roller which is thus described:—

This machine is described as differing from all other tea-rolling machines, in that, at each stroke or revolution of the rolling surfaces, the tea leaf is presented to the rolling surfaces at a different angle, and no two points in the rolling surface give the same rolling action to the leaf, which is subjected to a multiple action, the consequence being a harder twisted leaf and a total absence of flat leaves.

The motive power required is 3 h. p., and it is stated to be capable of rolling 960 lb. of green leaf per hour. The price in England is £100, and the makers are Messrs. Robey & Co., Globe Works, Lincoln.

Frater's "Colonial" roller is a new machine, recently placed before the public. It consists of three discs with concave surfaces bolted to centres of iron. The two outer discs revolve in one direction, and the centre disc and barrel in which they are enclosed go the opposite way. An inverted spur wheel with teeth inside the rim instead of outside

is a peculiar feature in the invention. The leaf is put into the machine through a door in the barrel, and pressure applied by means of two screws and hand wheels, placed in front of the machine. This machine will shortly be made in England. It is very well spoken of by those who have used it. The cost of a hand roller to roll 100 lb per hour is R500, and the cost of a power roller to roll 400 lb. per hour is R1,000. The latter machine is said to be driven by a 12-feet water-wheel. Rollers.

Messrs. Law & Davidson's roller is shortly to be in the market, but prices and other particulars are not yet published. It is thus described by the makers :—

The principal novel features are as follows :—

1. Direct application of manual power to the moving parts, and consequent reduction of friction to a minimum.

2. A large rolling surface, consisting of a bevelled trough or tray, with battens disposed over its area, which assist in rolling the leaf and prevent its spilling by directing it to the centre.

3. (1) An arrangement by which a draft of air is continually passing through the "roll," keeping it cool; (2) and by which leaf dropped on the table is automatically absorbed by the box, and brought at once in contact with the rolling surface.

The result of this combination is, that as the machine has a rolling surface as large as the travel of the box, a large quantity of leaf is rolled in a given time, while, as the leaf is continually turning over the battens, the cells of the leaf are all broken with a much lighter pressure than is usually required, while the appearance and twist given to the leaf is all that could be desired.

The percentage of broken leaf is very small.

There are several other rollers used in India which may be briefly alluded to. Jackson's old single action roller is preferred by some to his newer machines, but public opinion in Ceylon is not likely to be influenced by this. Most of the other rollers are bag machines, against which there is a strong feeling. The wear and tear of bags must be great, and it is doubtful if the outturn is as good from a bag machine as from one where the rolling leaf is more or less exposed to the air. It must be added though that many Indian planters think the prejudice against bags unfounded.

Haworth's is a machine that does a lot of work, and that is much used in Assam. Lyle's is said to do a lot of work and to be of simple construction. Greig's link and lever roller machine has not, that I am aware of, been tried in Ceylon. The larger size, price £75, is said to do 12 maunds an hour, a very large outturn for the price. The leaf in this

Rollers.

machine is enclosed in bags, and pressure applied by means of a lever arm. A smaller machine, price £55, is said to do from 6 to 8 maunds per hour. The Agents for Messrs. Greig's machinery are Messrs. Brown & Co.

Driers.

There are a great number of driers before the public now, and their various merits have from time to time caused much discussion. Mr. Jackson having discarded entirely his old driers which were not a success, has now some splendid machines to offer. It may be premised that there are disadvantages in trusting to one large machine for such an important work as firing, for if anything goes wrong with it in any way, work comes to a standstill; also, with short pluckings, it is better to have a small machine to work them off, and therefore a very large drier should always be supplemented by something smaller for occasional use. It is said that motive power in a drier is a disadvantage. In the case of the Victoria drier the power is partially devoted to turning the tea and hence saving labour; such power as is required for working a fan is of course a loss as against driers like the Sirocco; and where steam power is used it is a great disadvantage to have to get up steam to work the drier, say on a packing day, when no rolling is being done, and when the steam left in the boiler after rolling is finished is not available. A great advantage possessed by Mr. Jackson's driers is that the tea is not exposed to the atmosphere during the drying process. The Victoria drier, class A., is thus described:—

The Feeding Hopper is sufficiently large to hold about two or three maunds of fermented leaf.

When the leaf is carried in by the automatic feeder, it falls on to an endless travelling web of perforated plates (also of lead-coated iron), which over-lap each other somewhat like Venetian blinds when closed.

These are carried round on the chain wheels at ends by means of pitch chain of a disconnecting and interchangable form.

The web has a slow motion imparted to it by means of gearing, and it carries the tea along while the exhaust fan is drawing the hot air rapidly through it. When it reaches the end it is tipped over and falls on a second web of the same kind. It is thus returned and tipped on to a third, and so on till it passes over five travelling webs, and is then discharged.

It is thus turned four times in the course of drying, and the travelling webs can be adjusted in a few seconds to run at five different speeds, allowing the Tea from 10 to 25 minutes in the machine.

One boy is required to supply the hopper with leaf, another to carry away the dried tea, and another to attend to the fire. Driers.

The motive power to drive the machine is fractional.

The consumption of fuel varies of course with its conditions, but it will generally be found that from one-and-a-half to two maunds of fairly good timber will give a maund of tea perfectly dried.

The outturn, when a steady temperature and speed are kept up will be about three maunds per hour of dry tea.

Mr. Rutherford, who has erected one on Mariawatte, writes as follows:—

When kept constantly fed with leaf it turns out at the rate of 240 lb. made tea per hour (passing the tea through twice), the first time at an average temperature of 300° and the second time at 240°. The quality of the tea made leaves nothing to be desired, and, although I cannot give you the result of London sales, the local sale of 12,510 lb. made from this Drier averaged 85½ cents in Colombo.

It takes three coolies to work the machine—a stoker, filler and drawer. On this estate the cost of labour and firewood (exclusive of Engine power) to make 1,000 lb. of tea is R4, or say 2-5ths of a cent per lb. of tea.

One thousand lbs. are turned out in 4¼ hours, so that in a large garden, making over this quantity, the cost per lb. would be considerably reduced.

The Machine working automatically saves any breakage or handling of the tea during firing, the workmanship and material of which the Drier is composed are greatly superior to anything we have hitherto had in drying Machines, and for gardens making 1,000 lb. of tea and upwards per day, I consider it the best type of Drier in the market.

The price of this machine, £370, is very high indeed, too high as is very generally thought for the amount of work it does. Three Siroccos doing the same amount of work, cost £285 only. The second size of the Victoria costs £270, and does 160 lb. dry tea per hour. The Venetian drier costs £100 in England and does from 60 to 70 lb. per hour. A brick stove is required for it which takes 250 fire bricks. Mr. Mackie writes as follows about it:—

I know of no machine which occupies such a small space in the factory for the quantity of work it does, the drying chamber being only three feet square. It is compact, uncomplicated, strongly made, and easily worked by coolies, and appears to me to be exactly what we require as a preliminary to your larger ones. One great advantage over any others I have seen, including the choolas, is that the leaf is not handled nor removed from the drying chamber until the process is quite completed, which of course saves labour, produces a more uniform tea, and obviates the formation of dust.

The output of dry tea in average working ranges from 60 to 70 lb. per hour, with a temperature of from 240 to 260 degrees.

The consumption of fuel is comparatively small, owing to the

Driers.

large amount of tubular heating surface encased in brick-work forming the stove, any part of which can be very easily replaced.

As to the consumption of fuel in Jackson's driers we require more information and experience. The tubular principle in the case of the Clerihew was very wasteful of fuel.

Davidson's Improved T Sirocco is a very popular machine, and one which is being very generally erected. Its chief advantages are that it is comparatively cheap, and that it requires no motive power. The old form of Sirocco was a very good machine in many ways; it made excellent tea, but did very little work. The new form costs very little more and does double the work, but there is some question as to whether the resulting tea is as good. Mr. Armstrong, however, is of the contrary opinion, and states that any imperfection in the outturn is not the fault of the machine but of the manager. Complaints have also been made that the diaphragm plates burn through too quickly and require constant renewal. The new machine is thus described by the makers: –

The hot air is very equally distributed under all the trays by means of the hollow chambers, which act as deflectors, and the baffle plates on each side of them (shewn in the section of the illustration), and the current is thereby so thoroughly mixed that the temperature under each tray of the lower tier is exactly the same from end to end of the apparatus.

This equal distribution of the hot air is accomplished independently of the trays themselves or the depth of leaf upon them, and, consequently, the drying is done as effectively with very thin layers of leaf as with thick layers. When worked with thin layers, the trays come through dried in 15 to 20 minutes from the time they are put on wet. Managers can therefore work with whatever charges on the trays they find produce the best quality of tea from the particular description of leaf they have to deal with. As a general rule, however, with this improved T "Sirocco," light charges and quick changing of the trays give best quality of tea, and largest out-turn.

The upper tier of trays is entirely uncovered, and the waste heat arising from them remains in the tea house, and is available to wither the green leaf if the house be suitably arranged for the purpose.

Ten trays are the complement of this Apparatus when filled, but we supply twelve trays with it, the two extra being to facilitate loading and changing.

The fine tea which falls from the trays is all ejected by sloping shelves or hopper shoots into the two receiving pans outside the stove-casing (shown in the illustration).

The drying box portion of the Apparatus has one-fourth more drying surface, and the Stove is nearly three-fourths larger than in our previous make.

Fireclay tiles are not now employed for lining the furnace of this enlarged and improved Stove, as the dispersion of the fire heat therefrom is so managed that it causes scarcely any perceptible wear on the cast iron ribs forming the sides of the fireplace, or on the steel diaphragm plates, during a season's work. Driers.

With the exception of the trays, the improved T "Sirrocco" is entirely constructed of steel and iron, and can be readily put together even by an inexperienced person.

Price £95, complete with twelve trays, smoke chimney, thermometer, fire bars, fire irons, &c., packed and delivered free on board the outward steamer at Liverpool or Glasgow. Terms: Cash against documents.

Mr. Armstrong's opinion and experience of the Sirocco is as follows:—

For ordinary sized gardens then I would select before all others the T Sirocco; this will work off 80 lb. made tea per hour easily, and as now built they are much more lasting than formerly, and should the diaphragm plates burn through they are easily replaced. A pit 18 ft. by 8 ft. by 5 ft. 6 in. will hold two of these, and if our garden is only a small one we might have only one in each pit, a loss in stoking only, so as to spread the heat throughout the withering lofts, a pit 8 ft. by 10 ft. by 5 ft. 6 in. will then be large enough. If the factory is built according to the plan I have suggested, the smoke chimney should be led beyond the upper floor through the roof of the wing, by an elbow bend, thus not interfering with our withering shelves—a chimney running through the withering floor is an objection also in the way of drying leaf in its immediate vicinity, and causing extra labor (if space is not wasted), in moving leaf perpetually as it withers and before it gets dry.

The T Sirocco is too well-known to need description. Nor need I waste your time in explanation how it is worked, as very clear instructions are given by Mr. Davidson with each Sirocco. Suffice it to say I find 14 lb. of roll to each tray give the best results. It should be worked at 275°, 80 lb. an hour of dry tea is well within its capacity, 1 cooly will stoke 2 Siroccos if in the same pit. With 2 coolies to each Sirocco to attend to the firing, and 2 coolies carrying and preparing roll, thus 7 coolies are required to work 2 Siroccos in one pit; if 4 Siroccos are in use 1 cooly can be saved in preparing roll, or 4 Siroccos will require 13 coolies, and will turn out 320 lb. made tea per hour, at a consumption of 1½ lb. of dry wood per lb. of tea. Some small gardens of 100 to 120 acres may still with advantage work the old form of No. 1, and I hope Mr. Davidson will keep a few on hand and give them to us cheap. If the old form of No. 1 could be obtained at a *low figure*, it would pay young gardens, or gardens of small area, to purchase one or more of these, even in preference as I said above to the T Sirocco, as No. 1 will work well up to the limited rolling powder then used. Firing by charcoal should be avoided if possible, as the waste in firewood and cost is so great. That different gardens owing to some local differences in leaf give different results is quite patent. In rollers taking twice the time at the same speed and with the same pressure to give the same results, and in driers worked at the same temperature turning out far less tea, as witness the difference in Mr. Hay's experience at Blackwater and mine at Rookwood, as previously shown: my No. 1, turned out 46 and 48 lb. made tea in one hour

Driers.

whereas Mr. Hay's trial only gave 30¾ and 33 lb. in the hour. I quite lately tried my No. 1 with the result that in 6½ hours' working I got an average of 43·70 lb. per hour, and from a converted No. 1 at 6½ hours' work an average of 73 lb per hour: both were worked at 275° as near as we could keep it, and the converted No. 1 was working under the greatest disadvantage being in a temporary earth-pit with no draught. In making pits for the T Sirocco we must provide for a good draught by opening a funnel to the outer air, or having windows close-by and low down. From experiments tried I am perfectly satisfied that the T form of Sirocco will turn out an even brighter outturn than the No. 1, and complaints brought against it of stewing the roll or causing a dull outturn are the fault of the manager and not of the drier.

There is a second form of the Sirocco burning coke or charcoal only, and costing £50, which is not likely to be generally used, and need not engage our attention.

Mr. Dean's experiments regarding coal in the Sirocco shew that for first firing about 35 lb. per hour would be a safe calculation, and for final firing only about 20 lb. per hour. This, with the addition of 1½ cwt. wood a day.

Kinmond's driers have been erected in Ceylon on several estates, and they hold in India a very high reputation for quantity and quality of work. The tea is dried on trays, pulled in and out of the hot air chamber in the ordinary way. The hot air is drawn from the furnace by a fan, and the machine thus requires power. These machines do a great quantity of work, and it seems unfortunate that their sale has not been pushed in Ceylon in any way.

Mr. C. Shand has just brought out his "Flue Tea Drier," which certainly appears the cheapest in the market; it is described as follows:—

Its chief advantages are that it is peculiarly adapted for small, and young estates, for which expensive Siroccos cannot be afforded. The cost is not one-fourth of that of the cheapest Sirocco, and it can be regulated by the quantity of tea required to be dried daily. It may be constructed at a cost of R5 per superficial foot of drying plates.

It is worked on the principle of the ordinary choolas, but only one fire in which wood is burned is necessary, in place of numerous charcoal fires. A Flue Dryer 20 feet long, which for masonry work and iron plates would cost about R200, will dry as much leaf as twenty choola furnaces, thus saving enormously in cost of fuel. But the quantity of tea which can be dried may be very greatly increased by placing a series of trays over the hot plates.

The Flue Dryer may be made of any length, and width, but cast iron plates about three feet wide will be found the most convenient width. The greater the length of the Dryer put up, the greater the saving of fuel, as owing to the arrangement of

the iron plates those further from the furnace are as hot as those directly over it, whether the distance be 20 or 40 feet. Driers.

A mason and a few coolies can construct a Flue Dryer 20 to 30 feet long in a week, as all the masonry work, or nearly all, may be built of mud and stone, the only parts required from Colombo are the iron plates and fire bars and fire bricks for the furnace.

In addition to the above advantages, it can be added to existing Siroccos: the smoke-pipe instead of being placed close to the stove is removed to a distance from it, and, by means of an intervening Flue Dryer, tea may be fired or refired upon it without interfering with Sirocco work, and without any additional cost for fuel.

The furnace will heat the upper series of plates along their whole length, from 350 to 400 degrees of Fahrenheit. The firing trays a few inches above them may be worked if required up to 300 degrees.

The cast iron plates for convenience of transport are three feet wide, four feet long and half-an-inch thick, they weigh each 224 lbs.

The most efficient method of using the Flue Dryer is by placing upon it small ovens to contain six trays each as per diagram annexed. These can be made on the estate at a cost of about Rupees four each—a 30 feet dryer requires thus 7 double ovens to hold 42 trays, each tray will hold 4 or 5 lbs. of fermented leaf, which can be dried off in quarter of an hour if required.

If single trays are used on the dryer the process of drying will be expedited by covering the charged trays with empty ones.

When any part of the dryer becomes too hot, the effect may be remedied by placing an empty tray (Wire part upwards) below the charged tray, or by placing the latter on a bottomless box.

When the dryer is not fully covered with charged trays, the hot air from the plates will flow in a current underneath them, this can be counteracted by placing three loose bricks across the dryer on each side of the trays. It will be found that ovens to contain either one, two, or three rows of trays will be the best method of working the dryer, and with three rows of trays a 30 feet dryer will dry 1000 lbs. of made tea per diem.

Gibb's & Barry's drier is another machine, used in India, which has not been introduced to Ceylon. It burns coke and not firewood, and requires power to drive it. These considerations, together with its very high price, will probably prevent its general introduction. It consists of a sloping hollow cylinder, which revolves on its axis. The hot air is drawn through a coke furnace and driven up the cylinder, into one end of which the roll is put. This machine does a very large quantity of work.

Bicknell's drier for charcoal appears to be an arrangement for improving upon the ordinary choolas. It is said to cost R125 (including R50 royalty) to erect, and to fire 200 lb. tea a day with an expenditure of 100 lb. charcoal. This drier also appears to

Driers.

have no representation in Ceylon. Messrs. Main & Co. announce a drier as follows:—

The next invention is by the same makers, and is a "Tea Firing Machine," for which they claim that it has the power to "fire" at any desired temperature at the option and under the control of the operator; and that it will fire its charge at 200° in 15 minutes. One size of drier takes 200 lb. at one charge, and the other 80 lb.—or equivalent to about 800 lb. and 320 lb. per hour respectively. We are not informed if this quantity refers to green leaf, fermented leaf, or made tea.

Messrs. Greig & Co. have two driers in the market, which have been extensively advertised. The XL ALL is for drying tea and also for withering leaf, and consists of a fan revolving in a drum, and forcing a current of hot air from a stove through the material to be dried. The "Multum in Uno" is a tray machine working by a natural draft and requiring no fan. It consists of one or more sets of four trays, ranged above a furnace, and heated by "globulous" pipes. The erection of three driers to one furnace is recommended, and the cost of this is £85 f.o.b. Glasgow. We have no data regarding the amount and quality of work of these machines as yet.

The following is the description of "Brown's Patent Desiccator":—

Hot air is generated in a furnace by being passed through passages formed by layers of pipes through which pipes the products of combustion are passing.

The heated air after leaving the furnace passes into the Desiccator, which consists of an Iron chamber 14 feet long by 3½ feet wide, fitted with one row of four trays on which the tea to be dried is placed.

By means of an exhaust fan the heated air is made to pass rapidly through these trays in succession, the air current being guided by baffle plates, so that it passes first down through the layer of tea on the first tray then up through that on the second, down again through that on the third and finally up through the tea on the fourth and last entered tray.

From this it will be seen that the leaf in passing through the Machine receives the hot air on alternate sides, thus obviating the necessity for handling the leaf in order to expose the undried parts.

The working of the Desiccator may be described as follows:—

The leaf to be dried is placed on a tray and pushed in at the end nearest the fan or the coolest end, after the lapse of a short interval a second tray filled with leaf is pushed in, pushing the first tray one division farther along, this continues until the fifth tray is introduced. When tray No. 1 which will now have reached the last space, passes out at the other and hottest end of the machine finished.

A fifth single space has been provided, however, placed above the last space, on which any tray that has passed through the

usual course and leaves the Machine not quite dried may be placed and finished off so as not to interfere with the progress of the other trays. Driers.

From a short experience the proper interval between the introduction of the trays, and the proper quantity of leaf to be placed on the tray is soon learned, so that the leaf leaves the chamber in a proper state of dryness.

The low temperature at which the Machine is worked renders burning almost impossible, the drying being effected rather by volume of air than by intense heat.

It will be noticed that the furnace is quite separate from the Desiccating chamber, and it will generally be found most convenient to have the furnace erected outside the tea-factory so as to avoid the necessity of bringing fuel into the factory, besides insuring the absence of all smoke in the tea room.

The only Desiccator at present erected in the Island is on Hunasgeria Estate. It has now been working some three months and with very satisfactory results. Mr. Davidson, the Manager of the Hunasgeria Tea Company's Estates, puts down the outturn of made Tea at fully 100 lbs. per hour.

Witherers machines have engaged the attention of inventors for a long time, and if a machine to hasten this process without damage to the tea and independently of the weather could be invented, it would be a great boon. There are, however, many difficulties in the way, and it seems doubtful if they will be overcome. Messrs. Greig & Co.'s green leaf witherer has been already alluded to; Messrs. Main & Co. appear to have invented one also which is thus described:— Witherers.

Messrs. A. & J. Main & Co., after having made careful and elaborate experiments for the last two years, seem to be confident they have at last solved the problem, and state they can effectually wither green leaf in from 1½ to 2 hours, while all "stewing," scorching," or other deleterious effects are avoided. The fundamenal principle of their patented appliances is to desiccate or dry the air before it is allowed to operate on the leaf. This is done by an absorbent, perfectly innocuous, cheap at first cost, and which does not require renewal beyond the evaporation of the moisture absorbed. The desiccated air is then applied to the leaf in a simple, but effective, manner at the *normal temperature* of the atmosphere, or about 85° to 90°, while light is freely admitted.*

Gore's sifter is very highly recommended by Mr. Armstrong; it costs R350, and its out-turn is about 100 lb. tea per hour, in four classes. It is Sifters.

* Mr. Gow, of the firm of Gow, Stanton & Co., has patented a withering machine which will soon be tested in Ceylon. It is avowedly founded on Chinese experience, the main principles being withering by means of hot air, while the cells of the leaves are broken by flappers. Apparently the function of the roller will be merely to give twist to the withered and broken-celled leaves.—PUBLISHERS.

Sifters.

made for hand work, and one man can easily turn it whilst another feeds it. A larger and stronger sifter can be made to order, for power, costing R475. The chief peculiarity of this machine is the patent mesh with narrow elongated openings for separating flat leaf. It is very highly spoken of by Messrs. Armstrong, Deane and others, and is thus described by the inventor:—

This entirely novel Machine has been designed to meet the widely-felt want of an efficient Tea Sifter the cost of which shall be within the means of small Factories and which shall supersede not only hand-sifting but *hand-winnowing as well.*

The Machine consists of a Single Tray (surmounted by a Box) which is slung between the standards of a strong frame.

The Tray is divided into three chambers into each of which fits a sieve while the Box contains another sieve. The bottoms of the chambers are concave surfaces of Sheet Iron into each of which a spout is fitted. The Tray is made to vibrate at great speed by means of an Eccentric working in a frame beneath it.

The Tea is fed into the Box, in which, during its passage thence down the Tray, it is sorted into the different kinds by means of the different sieves, each kind being received into its respective chamber and thence conveyed by its respective spout to a Chest underneath.

The whole design being it is believed the most simple and compact ever offered to planters.

The principal advantages claimed for this Machine are:—

FIRST AND SPECIALLY: the introduction of the new "Patent Broken Tea Sieves" which extract the Broken Flat Teas during the passage of the Bulk through the machine in as simple a manner as ordinary wire sieves extract ordinary Teas. These seives are made of a new Wire Mesh with narrow elongated openings. Through these openings the broken flat pieces pass while the solid and wiry pieces run over the surface. The great advantage of employing them is manifest since it will be seen that they are designed on the one hand to obviate the need of an expensive Blast Fan in the machine and on the other to save having recourse to the disagreeable alternative of hand-winnowing. Each Machine has one Patent Sieve.

The sieves are arranged to permit of the easy extraction of the Finer Teas and with the least possible amount of friction thereto.

The sieves are all removeable at a moments notice whereby others of different mesh can be substituted thus suiting all tastes and methods.

They are open to inspection and can be readily cleaned while the Tray is in motion.

The Tea when fed into the Box-Sieve is under control of the hand.

The Machine is available for purposes of equalizing.

Ansell's sifting machine is a very useful one. It is suited for power only. A fan at the top acts on the tea as it is fed into a hopper and blows out all flat leaf; the tea then descends through a series of trays which separate it into the various grades. It is an expensive machine.

Jackson's "Eureka," costing £81 5s. in Colombo is a very good machine also. Mr. Armstrong thinks the tea travels over too much ground and thus gives a grey make. Mr. Jackson on the other hand points out that this may be obviated by altering the inclination of the sieves. Mr. Armstrong thus describes a sifting machine that can be made on the estate by any one:— Sifters.

A very good and cheap sifter can be made at the factory, necessitating the cleaning by hand of the broken pekoe only—thus:—sling three trays one above the other, strongly joined together and about 18 in. apart. Each tray is 8 ft. by 3 ft. inside measurement. These are slung inside a strong framework or on to strong cross beams and worked with an ordinary crank with 6 in stroke fixed on to the bottom tray, all must be good work and strong. The top tray is No. 8 mesh and receives the bulk, souchong passing out in front. The second tray is No. 10—the tea falling through No. 8, drops on to a sheet of galvanized iron leading from the mouth-end of the top tray to the feeding end of the second at a good slope thus delivering all teas that have passed through No. 8 to one end of No. 10: this passes out pekoe souchong to the right end (of No. 10) by a little iron spout. Teas passing through No. 10 are delivered by another sloping sheet of galvanized iron to the head of the bottom tray, which as was explained in sifting by hand should be a No. 12 or 14 mesh according to circumstances; this delivers pekoe to the left end of the tray, by an iron spout sloping in the opposite direction to that delivering pekoe souchong above. Under No. 12 or 14 and at a good slope forward should be fixed No. 26 mesh,—on light reepers only. The broken pekoe and broken tea falling on to this are dusted and fed into a box in front of the sifter to be then separated by shologoo as in hand sifting. A sifter like this I made for myself, sorting 600 lb. per hour as above, and it cost about R300—this cannot be driven by hand, but is a very efficient and cheap machine. If wood has to be purchased teak will be the best, but it will bring up the price to R350 to R375 about.

The "Rotary Adjustable Tea Sifter," costing R250, is a machine which works on the principle implied by its name, and hence is noiseless. Noise is one of the drawbacks of the sifters previously described.

Greig's sifting machine, costing £28, is an arrangement of the ordinary circular sieves one above another, and is said to do well.

Jackson's "Invincible" tea cutter, costing £23 10s in Colombo, is a very useful machine for breaking up souchong and congou. Reid's machine is better suited for congou and fannings. Jonas' breaking machine is also in the market; a man is said to be able to break up 30 maunds of tea a day with it. Cutters.

Messrs. Greig & Co. advertise a green leaf cutter costing £37 in Glasgow, and the object of this machine is to cut up coarse leaf and equalize it into squares

Cutters.

and triangular pieces before or during rolling. It is claimed for it also that the Pekoe tips may be separated from the bulk by means of it. If this can be done there is no doubt the machine is a valuable one, as the necessity for rolling fine and coarse leaf together is a very unfortunate one. To make perfect tea they should be separated before rolling. Green leaf sieves, consisting of a frame fitted with No. 3 or 4 mesh, is often employed to separate the leaf before rolling when the plucking is fine.

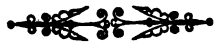
Packers.

Of packing machines the latest invention is Mr. Gilruth's, and it is thus described:—

By the courtesy of Mr. H. D. Deane, Mr. Gilruth's Tea Packer underwent a trial at Kintyre Factory. The machine is very ingenious and compact, and, worked by hand on this occasion, packed four chests (3/8ths No. 2 Japan boxes) of broken pekoe 90 lb. each, in 22 minutes, a second trial of coarser tea resulted in two chests of 85 lb. each being packed in 6 minutes each chest, but a screw giving way further trial had to be suspended. The tea packed compared favorably with that packed by coolies in the ordinary way and showed no signs of being broken. With the few alterations which Mr. Gilruth will now carry out, the packer will prove of great value, in that it will pack tea in the *state it leaves the sieves* unbroken and free of foreign matter. The machine operated with was constructed for power, but was worked by hand for this occasion, and under these conditions proved itself capable of packing 1,000 lb. per hour.

The machine is in the hands of Messrs. Maitland & Co., and is expected to cost R300.

"Dick's patent mechanical tea packer" is said to compress into 800 boxes a quantity of tea which, by the usual method of packing, requires 1,000. The cost of this machine is £147 10s. at Glasgow.



CHAPTER X.

YIELD AND COST OF PRODUCTION.

Yield of Estates.

Regarding the yield of Ceylon estates much information has been given by proprietors, and the following data were collected by Mr. Armstrong three years ago:—

In my own experience, at 4,700 to 5,600 feet elevation, with fair soil, ordinarily featured land, as our hill country goes, fairly steep, I find the yield has been as follows, and I do not consider I am yet in full bearing:—

At 2½ to 3½ years old 165 lb. tea per acre.
3½ to 4½ „ 292 „ „ „
4½ to 5½ „ 262 ... } Pruned heavily in July last season,—season ends in Sept.—to shape bushes, which explains shortness of yield.
5½ to 6½ „ 450
6½ to 7½ „ year finishes end of Sept., 700 lb. per acre will be exceeded all around.

Bushes from the first have been under plucked.

Again I have yield given me at an elevation of 1,800 to 2,500 feet.

Average age 3 years 224 lb. per acre.
4 „ 380 lb. „
5 „ 315 lb. „

And please note on this garden of over 200 acres in extent, there was a considerable loss of leaf, from allowing large areas to grow up during these three seasons, for seed, from which little, if any, leaf was plucked; had the full acreage been plucked, the average would have reached 100 lb. more per acre.

Again, I have given me figures of an estate, at an average of 2,500 feet elevation, 400 lb. per acre at 3½ to 4½ years old.

Another estate, at an average of 500 feet, gives for the first *six months* of this year, January to June, being in June 4 years old, 400 lb. per acre; the estimate to December is 600 lb. per acre; and will probably be exceeded. Again, an estate from 100 to 400 feet, showing an average age all round of 4 years, gives 430 lb. per acre. This estate is widely planted 5×6 and 5×5, and had it been 4×4 would have given a larger yield, as bushes do *not* cover the ground, but 430 lb. at 4 years is good enough, you will allow

Yield of Estates.

I have again many instances of estates, up to 3000 feet, giving 400 to 600 per acre up to 5 years of age; and at 4,000 to 5,000 feet, from 360 to 420 lb. per acre.

More recent experience has proved that in the case of unexhausted coffee land, or virgin soil, the yields here mentioned are easily obtained or exceeded. 400 lb. per acre on the hills and 600 lb. per acre in the low country, is the estimate which has been ruling for several years, and on which future probable yields have been based, and these estimates have not been falsified by results so far. To obtain any data on a large scale from which results can be deduced is impossible as yet owing to the enormous area of young tea not yet in full or partial bearing. It is generally admitted that some unsuitable and exhausted land has been planted, and no one expects that such land will yield more than 300 lb. per acre, if that. This apart, the yield in question may be confidently looked for on all good land, and it will very probably be exceeded in many cases. The phenomenal yield of 1,200 lb. per acre on Mariawatte has often been quoted, and this shows what can be done with high cultivation on suitable land.

The following information as to cost of manufacture has been published by Mr. Rutherford: to it have been added results on Strathellie by Mr. Scovell, which agree with the former in a striking way.

Cost of Production.

Cost of Rolling and Firing Teas by Various Methods.

Process.	No. of lb. made tea.	Labour on withering, rolling and firing.	Charcoal and firewood.	Total.	Saving over hand-work.	
		c.	c.	c.		
Hand-rolling and firing over chulas	201,964	4·11	0·87	4·98	...	*
Hand-rolling, firing with chulas and Siroccos of old type ...	103,042	3·82	0·38	4·20	0·78	†
Rolling: hand-power Challenge; firing with chulas and Siroccos of old type ...	44,070	2·32	0·38	2·70	2·28	†

* Average of 4 gardens. † 2 gardens.

Process.	No. of lb. made tea.	Labour on withering, rolling & firing.	Charcoal and firewood.	Total.	Saving over hand-work.	Cost of Production.
		c.	c.	c.		
Rolling No. 2 Kinmond roller, and drying with No. 2 driers & chulas: *water power very imperfect* ...	95,652	1·45	0·31	1·76	3·22 *	
Rolling No. 1 Kinmond roller, and drying with No. 2 drier: steam power	118,362	1·45	0·28	1·73	3·25 †	
Total ...	563,000 lb.					

The other items of cost in manufacturing this quantity of 563,000 lb. of tea were as under:—

Average of Four Gardens.

	Cents.
Plucking, including baskets and transport to factory	10·31
Sorting and packing	0·53
Boxes, lead, solder and hoopiron	2·80
Transport to Colombo, charges f. o. b.	1·75
Tea-house sundries	0·48
	15·87
One Garden.	
Cost of rolling and firing, if done by machinery ...	1·73
Total cost of manufacture f. o. b. Colombo ...	17·60

The following are the actual figures of cost on the past season's working at Strathellie with Jackson's Excelsior Roller, Ansell's Sifter, and Davidson's No. 1 Sirocco. Facilities of transport give Mr. Rutherford's estates a slight advantage, but practically the cost of plucking, manufacture and placing f. o. b. in Colombo are the same:—

	Cents.		Cents.
Plucking, including, baskets and transport of leaf ...	10·36	against Mr. R.'s average of	10·31
Rolling, firing, sifting, and packing including boxes, and tea-house sundries	5·47	,, ,, ,,	5·54
Transport to Colombo and charges	1·86	,, ,, ,,	1·75
Total cost of manufacture f. o. b. Colombo	17·72	,, ,, ,,	17·60

* 1 garden—the saving shown would have been greater, had water-power been sufficient.

† 1 garden.

Cost of Production.

The cost of plucking is here higher than that given by Mr. Armstrong as the result of several years' working, which is 7 cents per lb. only: it will be perfectly safe, therefore, to take the cost of gathering, manufacturing and placing tea f. o. b. in Colombo at 17 cents on all gardens where there are no difficulties of transport, and where machinery is used. The actual cost of manufacture by machinery is 5·47 per lb., and 5·54 per lb. is the cases of Mr. Scovell and Mr. Rutherford respectively, and where hand manufacture is carried on another 4 or 5 cents would have to be added to the cost for young gardens starting work, though in the case in question the extra cost was only 3·25 on an outturn of 201,964 lb. tea.

The other works on an estate will not of course vary in proportion to the yield, and the greater the yield becomes, the less per lb. is the charge for "field work." The proportion which these bear will therefore be different on the hills and in the low-country, if the comparatively larger yield generally allowed for the latter is considered. Let us now take the working expenses of a 200-acre garden in full bearing.

Superintendence and Tea House Conductor	R4,000
Weeding at R1 per acre: 200 acres at R12 ...	2,400
Pruning at R6 ,, ,, ...	1,200
Nurseries and Supplying	500
Upkeep of Roads and Drains	500
Tools	200
Contingences and General Transport ...	750
Buildings and Machinery, Upkeep & Repairs	1,000
Total...	R10,550

400 lb. per acre on 200 acres = 80,000 lb. tea, or slightly over 13 cents per lb. with 17 cents for manufacture &c., and putting tea f. o. b. in Colombo; this amounts to 30 cents per lb. for gardens producing 400 lb. per acre. If the yield is 600 lb. per acre the field works become under 9 cents per lb. and the cost per lb. 26 cents. The necessity for manuring must not be lost sight of, however, and an extra 5 cents per lb. of tea may well be allowed for the expenditure under this head which will inevitably become necessary as time goes on. On 80,000 lb. tea, 5 cents is R4,000, a liberal annual amount for manuring on a 200-acre garden, allowing as it would for the application of bulk to fifth of the acreage annually, or of artificial

manure to a large portion of the estate every year. From 30 to 35 cents per lb. may therefore be safely reckoned on as the cost of putting tea f. o. b. in Colombo, allowance being made for manuring. To the information just given, which has been published before, Mr. Rutherford has added the following more recent figures for lowcountry estates:— Cost of Production.

Plucking	ct. 9·00
Firewood	0·23
Rolling and Drying	1·30
Sorting and Packing	0·40
Boxes, Lead and Solder... ...	2·60
Transport to Boat	0·12
Boat, River and f.o.b. charges...	1·00
Sundries and Watchman ...	0·35
Total for manufacture ...	ct. 15·00

To this add:—

Salaries, Allowances & Contingencies	7·50
Cultivation	5·00
Repairs to Factory, &c. ...	0·50
Cost in Ceylon	28·00
Freight and Selling Charges ...	10·00
Total...	ct. 38·00

at 1/6 per rupee=7d sterling.

As to prices, the result of Messrs. Gow, Wilson and Stanton's carefully compiled statistics show an average price for Ceylon teas of 1/3¼ for the year 1885. Commencing at 1/2¼ at the beginning of the year, prices rose to 1/3¾ for the last quarter; 1/3¼ gross price would mean a net price of 1/1 or with exchange at 1/7=68 cents. At the maximum cost of putting tea on board ship, 35 cents. This leaves a profit per lb. of 33 cents or R132 per acre, and such profits as these are now being obtained. No one of course would be so sanguine as to expect that such profits are likely to be maintained for long, with the enormous increase in production that Ceylon will show in a few years, a fall in price is inevitable, but it will be seen that with exchange as it is at present, a fall in price to 1s. gross, or say 10d. net, will still leave

Cost of Production.

a fair margin of profit. The course of prices during the present year 1886 points to a lower average price than last year, sales during April averaging 1/0¾ and 1/0½ instead of 1/2¼ in the previous corresponding period. During May and June the prices have again run lower, and the average price this year will be far below that of last. Estimates such as these of course depend largely on the conditions of each particular garden. It is obvious that where steam-power is required for the factory the expenditure will be greater in fuel, and through the wear and tear inseparably from its use. Where fuel has to be purchased and brought from a distance another element of expenditure is introduced, and this expense will be very great where the three conditions, lack of water-power, absence of fuel, and distance from roads and railways, are combined. In such cases extra fertility of soil may be hoped to make up for the disadvantages in question. With abundant water-power and fuel reserve, there is no doubt that tea can be produced for considerably less than the figure quoted, other conditions being favourable.

Estimates.

Let us now consider the cost of bringing into bearing an estate of 200 acres cultivated land with 100 acres forest reserve.

Cost of 300 acres land at R50 per acre...		... R15,000
1st Season.—1st July 1886 *to 30th June* 1887.		
Felling and clearing 100 acres at R15...	R1,500	
Pegs, lining, holing and filling 4 × 3½ (say 3,000 plants per acre) at R20 ...	2,000	
Planting and Supplying at R5... ...	500	
Nurseries and cost of 25 maunds seed which should have been laid down previously	2,000	
Roads and Drains at R15 per acre ...	1,500	
Lines, temporary	300	
Contingencies (tools, surveying, medicines, &c., &c.)	500	
Superintendence...	1,500	
Weeding 15 months at R1	1,500	11,300
Total...		... R26,300

Estimates.

2nd Season.—1st July 1887 *to 30th June* 1888, *plants now 1 year old.*

Cost of felling, planting, nurseries, roads and drains and weeding 100 acres as before	R9,000	
Permanent lines	1,000	
Contingencies (tools, surveys, &c,) ...	1,000	
Superintendence	2,500	
Weeding previous clearing ...	1,200	
Supplying ,, ...	250	
Roads and Drains upkeep ,, ...	250	
Topping ,, at R2 per acre	200	
Superintendent's Bungalow & Furniture	2,000	R17,400
Total... ...		R43,700

3rd Season.—1st July 1888 *to 30th June* 1889, *plants now 2 years old.*

Any leaf plucked after topping to be sold to a neighbouring estate until factory is erected.

Superintendence and tea house conductor	R3,500	
Weeding 200 acres at R12 ...	2,400	
Supplying and Nurseries	500	
Pruning 100 acres at R6, Topping 100 acres at R2	800	
Roads and Drains...	500	
Contingencies	750	
Tools	200	
Tea house, permanent with fittings, 72' × 48', 1 "Excelsior" roller, 1 "Venetian" drier, 1 sifter and breaker, shafting, pulleys and belting, 1 water-wheel and pit with water-course, &c., including erection of machinery, &c. &c.	13,000	
Plucking, manufacturing and putting f.o.b 20,000 lb. tea at 17 cents (200 lb. per acre off 100 acres)	3,400	
	25,050	
By 20,000 lb. of tea netting 50 cents per lb.	10,000	15,050
Total...		R58,750

Capital account is now R58,750, or R293·75 per acre.

Estimates.

4th Season.—1st July 1889 *to* 30*th June* 1890, *tea* 3 *years old.*

Expenditure on 200 acres as per former estimate	R10,550	
Additional expenditure on buildings, Lines, Bungalow and Factory (R1000 is included in the preceding figure)	2,000	
Plucking, manufacturing, and putting f.o.b. 55,000 lb. tea (350 lb. per acre from 100 acres and 200 lb. from 100 acres) at 17 cents	9,350	
	R21,900	
By 55,000 lb. tea netting 50 c. per lb.	27,500	
Profit ...	R5,600	5,600
Outstanding capital		53,150

5th Season—1st July 1890 *to* 30*th June* 1891, *tea* 4 *years old.*

Expenditure on 200 acres as before ...	10,550	
Plucking, &c., 70,000 lb. tea at 17 cents	11,900	
	R22,450	
By 70,000 lb. tea netting 50 cents per lb.	35,000	
Profit	R12,550	
Outstanding capital		R40,600

An amount which will be recovered in three years' working. It is of course utterly impossible to tell what the course of the tea market will be in the future, and how results may be affected by the course of exchange, such estimates as these are always liable to be falsified by what cannot be foreseen, but at present the above estimate is what may reasonably be counted on. A capital account of R290 or so, *without interest*, which is a separate calculation varying with circumstances, giving a profit when in bearing as follows:—Cost of production 35 cents, nett price 50 cents, profit per lb. 15 cents, which at 400 lb. per acre is R60 per acre profit, or over 20 per cent on the capital account. Exception may be taken to the yield of 400 lb. per acre, as being too high an amount to look for. It is obvious of course that yields of estates will vary largely, some will give much more than others, hence whilst some will give less than this yield, others will give more, and the amount in question is what may reasonably be hoped for from all good land, properly cultivated.

CHAPTER XI.

ENEMIES AND BLIGHT.

To the young plants in the nursery and in the field the most destructive enemies are the *crickets* and *grubs* which eat down the young shoots as soon as they appear. So destructive are these pests in some localities, that stake planting is impossible, the young plants in the field never having a chance. On mature bushes the most commonly observed enemy is the *red spider*, it also attacks nurseries and young plants. This is one of the worst enemies of tea in India, but as it never remains during wet weather, it is not likely to prove such a serious pest in Ceylon as it does there. *Mosquito blight*, or *Helopeltis Antonii*, is known in Ceylon as the worst enemy of the cocoa tree, but as yet it has not attacked tea seriously. In India, I have seen acres covered with a luxuriant flush one day which the next are brown and withered through the sudden attack of this pest. It attacks the young shoots chiefly, puncturing them and sucking out the juices, so that they wither and die. The red and large black ants appear to be determined enemies of this insect, and it has been suggested that they should be employed to destroy them. A *caddis worm*, or insect closely resembling one, has proved destructive to the bark of the tea bushes in some places, but these can easily be picked off and destroyed. *White ants* appear likely to prove annoying in some of the lower elevations, as it is evident now that they do not confine their ravages to dead matter but attack living vegetable tissues as well. The destruction they cause is not generally discovered till it is too late, the plant withering and dying in consequence of their underground attacks. It is not likely that this will prove a very serious pest, for there is no apparent reason why tea should be singled out from other vegetable growths for

destruction. Some discussion has been raised on the subject of the dying out of tea in small patches, and this has been traced to the presence of the stumps of a jungle tree, known botanically as *symplocos obtusa*. (See Appendix). It would appear that the mischief is due to fungi developed during the decomposition of the roots of the tree in the ground. The effect of cutting out these stumps has been tried with good effect.

Such matters as these have been more closely studied in India, and the following extracts from the *Tea Planter's Vade Mecum* will be of interest:—

The red spider is a very diminutive insect, reddish colour on the back, and white on the under part of the body. It lives and feeds on the sap of the leaf. Its eggs resemble white dust or very fine *soojee*. The eggs have a very slight adhesive coating, by which they adhere to the leaf; the numbers that are to be found on the leaves are sufficient to extract all sap, after which they wither, showing in bad cases a resemblance as if the leaf had been scorched by fire, leaving white stains. The red spider, as I have generally seen it, is worse on tea without shade on flat land, but bushes along the slopes of hollows where jungle is growing, are rarely bad with it.

The Tea-Bug or Mosquito Blight attacks the young shoots, which then curl and dry up, while the Red Spider more particularly confines its ravages to the full grown succulent leaves. A curious circumstance in connection with both these forms of Blight is that neither of the two has yet been met with on any other plant,—at least so says Mr. Wood-Mason; but some planters dispute this, and we should be inclined to think, also, that the Tea-bush is not the only plant patronised by these gentry. The difficult matter, in applying any remedy for Red Spider, is, that the eggs are laid in *hollows* close to the ribs of the leaves, and are not scattered over the whole surface, so as to be at once perceptible and get-at-able. Although heavy rain is one of the best antidotes, still the eggs are so firmly attached to the leaves, that it requires a good deal of continuous downpour to wash them away, and even then the spider itself takes shelter underneath the leaves, and is thus on the spot ready to commence anew. When at Darjeeling some years ago, we visited a garden there heavily afflicted with Red Spider; and, going out after a heavy downpour of rain, we picked several leaves, and placed them under the microscope, when it was seen that though many eggs had been washed off, a good many still remained; the Spider itself was in such cases seen on the underneath portion of the leaf, almost as free from wet as if it had been under an umbrella, as it were, which Nature had kindly provided.

There appears absolutely to be no remedy for Spider-blight. In fact, if there were, it must necessarily be most difficult of application over anything like a large area. Syringing with muddy water has been recommended, and for the time it has seemed to be efficacious, but as the eggs revive under the influence of the sun, the relief is only partial; besides which, it is difficult to apply such a remedy over a large area. Some have propounded

the theory that the Red Spider only attacks weakly plants, and therefore that nutritious or well-manured soil is all that is needed. No doubt to a certain extent this is correct, in-so-far that a strong and healthy plant will better be able to recover from a partial attack than one growing on impoverished soil; but it is hardly likely that the Spider should prefer old and exhausted to young and vigorous plants. We believe that, on one estate, "burning" was tried on a bad patch, and with some success; but as a matter of fact, any *real* remedy remains to be found.

* * * * * *

About the end of May numerous caterpillars, about an inch long, and of a dullish brown color, were noticed; but they did not at first attack the tea plants. However, they shortly began to do so, eating the bark of one and two-year old shoots, and causing the plants to die back; in some cases nearly to the ground level.

Small low *jat* plants suffered most. At first only a patch separated from the rest of the garden by a road was attacked, but latterly they spread over the rest of the garden.

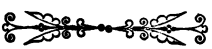
I have only just finally got rid of the caterpillars.

I had millions gathered and destroyed, and in this operation I found that laying down pieces of mango, which attracted large numbers of caterpillars, was of some assistance. In gathering the insects it was necessary to use a small piece of bamboo as a pair of tongs, as the caterpillars induced an itching sensation if touched with the skin.

This pest has hitherto been unknown in Lower Assam, as far as I can ascertain.

Regarding the "Tea Stick Insect":—

"This insect is found in different parts of a garden, but mostly in secluded spots, and cool flat corners, where I have generally found them. The damage they do appears mostly to take place at night. In the day you will observe them making for the base of the bush, or hiding under the foliage, should any be left at this stage of their attack; but that is what generally goes first. Afterwards, they attack the bark, and tea being a hard wooded plant, is very likely to be killed should the pest remain long enough—as you will be able to judge from the specimen of shoots sent you along with the insects."



APPENDIX.

MACHINES IN TEA FACTORIES.

The following brief extracts are taken from a most valuable paper on Steam Engines in the *Tea Planter's Vade Mecum.* Those interested in the subject would do well to procure and study the original paper:—

THE BOILER AND HOW TO CARE FOR IT.

The principal cause of decay in a steam-boiler is corrosion: this takes place internally and externally. By internal corrosion is meant that which occurs in the inside of the steam or water space, where the boiler is exposed to the action of steam and water at a pressure above that of the atmosphere. External corrosion means the decay by oxidation of any part of the boiler not in contact with steam and water inside: so, a leaky joint or rivet in a flue, or the end of a tube leaking, and causing corrosion in the fire-box, will come under this heading. These leaks often take place and cause corrosion at the openings into the boiler where the steam or water valves are fastened to it. There are several of these openings,—one at the communication-valve by which the steam is allowed to pass to the engine; one at the feed-water check-valve through which the water is allowed to pass into the boiler to replace that which is evaporated and goes into the engine as steam. This valve is called the check-valve, because it prevents or checks the back-flow of water from the boiler. There is an opening at the safety-valve, the valve which allows the steam to escape before it rises to a dangerous pressure, at each of the water-gauge glasses, by which the steam and water are admitted to the glass which shows the water in the boiler, and at the test-cocks, by which the height of water is ascertained independently of the gauge-glass, thus being a check on it. The manhole and mudhole doors are large openings for the purpose of getting at the inside of the boiler to clean it, and there is another opening at the blow-off cock, which is used for emptying the boiler, and for another purpose to be alluded to further on. All these valves, cocks, and other "mountings," as they are called, are liable to leak where they are joined to the boiler, and the water lodging about the boiler, especially in places where it is not easily seen, as beneath the wood and felt, or other non-conducting substances with which most boilers are covered, often causes serious corrosion,—the more serious because it is not seen or thought of till the boiler has become badly injured. Besides the above sources of leakage, we often find the joints of the plates or some of the rivets leaking. Sometimes through original weakness in the iron, but more generally through over-

heating, we find a plate cracked, and leaking from the crack. The fireman, in cooling his ashes, often throws water into or about the flue or ashpit, and wet ashes are often carelessly allowed to lodge there; this is a common cause of most destructive corrosion, and should be prevented. The stuffing-boxes of cylinders, &c., in those classes of engines which have the engine placed upon the boiler, are frequently leaky, and the water from them falls on and lodges about the boiler. Tubes and stay-bolts are often found leaky, with the usual corrosion of neighbouring parts; rain or other water is often carelessly allowed to fall on the boiler; the drip or drain-cocks from the valves and cylinders often leak, and contribute their quota to the general destruction. All leakages enumerated above are preventible and curable, and, when seen, means should be at once taken to stop them. The boiler should be examined from time to time to detect leakage in the more obscure places where it is liable to be passed over unobserved.

Stuffing-boxes are a fertile source of leakage: when they are allowed to go any length of time without the packing being renewed, no amount of screwing-up will make them tight. When they are observed to leak, the gland should be lightened, care being taken not to tighten it so much that the friction of the packing on the rod will cause the latter to heat, and also that the nuts of the bolts be tightened evenly all round. Should the leakage not cease when the gland is moderately tightened, the packing must be taken out and replaced by fresh packing. Care should be taken that the whole of the packing be removed from time to time. Any pieces that are not much worn may be put in again, but the new pieces should be put in first, so as to be at the bottom of the stuffing-box. Gauge-glasses have a small stuffing-box somewhat differently constructed, and made tight by the gland compressing an India-rubber ring. If the latter rings are not obtainable, a little lamp-cotton soaked in oil may be used. No red-lead or any such substance as putty should be used in packing a gauge-glass, as some native firemen are apt to do.

The materials with which the stuffing-boxes are packed are many. In a large marine engine, or in the large class of stationary engines used in spinning-mills, &c., many elaborate and expensive kinds of packing are used; India-rubber, canvas, wire-gauze, asbestos, and other substances, entering into their composition. One of the best of these is Tuck's patent packing, which consists of strong linen cloth soaked in India-rubber solution, and rolled spirally round an interior square core of India-rubber into the form of a rope. Packing is also made of hemp or jute, soft rope plaited into a gasket, or lamp-cotton done in the same way. When being put in, all packing should be cut a little shorter than will go round the rod, so as to allow it to expand lengthways when screwed up. If cut with a bevelled end so that the ends overlap, so much the better. When being placed in the stuffing-box, the cut end should be at opposite sides alternately, so that the steam cannot pass. Rope or cotton packing should be well soaked in, and Tuck's packing well rubbed with tallow or oil.

All valves, cocks, &c., which are attached to a boiler are known by the general term of boiler mountings. With the exception of the smaller cocks, they are attached to the boiler by means of a flange, which is bolted to the shell of the boiler, the heads of the bolts being in the inside of the boiler. As it

would be difficult and expensive to make such an accurate fit as to be steam-tight between the flange and the shell of the boiler, it is usual to introduce some substance which, while compressible, while soft and newly introduced, and thus capable of being screwed up so as to fill every crevice, will afterwards harden sufficiently to prevent escape of steam or water, even under very high pressures. One of the most useful substances for this purpose is a putty made with two parts of red to one of white lead, moistened with linseed oil. This is mixed with hemp cut in lengths of about an inch, and teased. The putty is then well beaten with a hammer, and worked by hand as a baker kneads dough, for two or three hours,—the longer the better. It is then spread evenly and thinly on the flange, a little is put round the neck of the bolt, and a little on the ring or washer which goes under the nut. The whole is then screwed up as tightly as possible. Sometimes a piece of canvas or wire-gauze is cut the size of the flange, with the centre-hole and bolt-holes accurately cut in it. This, if canvas, is first soaked in linseed oil and then smeared with the above putty, without the cut hemp, and thinned considerably with linseed oil so as to be semi-fluid. If wire gauze, the putty can be spread on it as above; with canvas or wire gauze it is necessary to wrap hemp, steeped in the semi-fluid putty, round the neck of the bolt, and also to put a small hemp ring or grummet round the point, under the washer; the grummet also soaked as above. There is a very useful patent cement for the above purpose, superior to red and white-lead putty, called Scott's cement. It is used moistened with linseed oil, &c., as above.

Care should be taken, in tightening up a joint, to screw the bolts evenly up all round. This is best done by tightening them in pairs, taking opposite bolts as pairs.

India-rubber in thin sheets, from one-sixteenth to one-eighth of an inch thick, and also a kind of cloth prepared with solution of India-rubber, are now more generally used than anything else in making joints. They require no red-lead or other putty, and should be cut like the canvas or wire-cloth with the centre and bolt-holes accurately in their places. They should then be rubbed on one side with black-lead to prevent the joint adhering when re-opened, and screwed up as above. Instead of hemp round the heads and points of the bolts, in this case small rings, cut out of the waste parts of the sheet, should be used. The above prepared cloth is called "insertion sheet," and any hardware merchant can supply it. I recommend it as being the best material for making joints, as well as the cheapest, where the flanges are fairly fitted; but if the flange is very rough, or the part of the boiler to which it is to be attached be very uneven through corrosion, some substance must be used which will squeeze into and fill up the inequalities. In such a case the aforementioned putties, or a piece of thick India-rubber, may be used.

Care should be taken to empty the boiler when it is to be out of work for any time: no water should be left in it. The little that remains in the bottom should be carefully dried out, a gentle fire kindled,—not in the furnace but the ashpit, to evaporate any remaining moisture; and when the boiler is thoroughly dried inside, the man and mud-hole doors should be put on, and all other openings carefully closed to exclude damp air.

The inside of the fire-box and tubes is usually found covered with a hard black scale. This is composed of carbon, with a small admixture of silica, and is deposited from the smoke. A scraping-tool is usually supplied by the makers for the tubes, and for the inside of fire-box, &c., scrapers may be made of old files. This scale should be frequently removed, as it is a very bad conductor of heat.

To prevent as much as possible the accumulation of mud and scale, the fireman should be instructed to do as follows:—When the day's work is finished, he ought to pump the water in the boiler up to nearly the top of the gauge-glass, and leave it thus all night. Next morning, when getting up steam, as soon as his pressure gauge indicates five or six pounds, he ought to open the blow-off cock, and blow the water out until it reaches the ordinary working level. By this means a portion of the mud which has settled at the bottom of the boiler during the night will be blown out.

It is consequently necessary from time to time to remove the man-hole and mud-hole doors and the mud plug, and, by means of long iron scrapers, straight or curved as may be necessary, to break up and detach the mud and scale. When loosened, it should be washed down to the bottom of the boiler by copious douches of water, and then raked out through the mud-holes and plugs by long rakes. The frequency of this operation will depend on the cleanness or otherwise of the water supplied to the boiler. Rain-water is the cleanest and freest from impurities, either suspended or in solution. With dirty well or river water, the cleaning-out process should take place every week on the usual off-day.

A boiler should never be exposed to sudden changes of temperature or pressure, as these are apt to loosen the joints, rivets, and tubes. For this reason steam should be got up slowly, and when the day's work is done, should not be blown off, but allowed to cool and condense in the boiler. When necessary to empty the boiler, it should be allowed to cool for a night before the water is run off by the blow-off cock.

When no lagging or non-conducting material is supplied by the makers, the boiler may be covered with a mixture of cowdung and clay, mixed with hair or chopped tow. This may be laid on layer after layer while the boiler is kept at a gentle heat. Felt may be tied on to the boiler with ropes. I have found cooly-blankets a cheap and good substitute for felt.

Great care should be exercised in seeing that the safety-valves do not become choked up with dirt, or rendered stiff and immovable from any cause.

Should the steam at any time become too high, through excessive firing or a sudden stoppage of the machinery, the pressure may be lessened by opening the furnace door, and also the smoke-box door if any. This lessens the heat, by stopping the draft in the furnace, and thus deadening the fire, and also by admitting a current of cold air through the fire-box and flues or tubes. This method of counteracting excess pressure causes the sudden contraction of the boiler by admitting a current of cold air, and is therefore injurious, often causing leaks, especially at the ends of tubes and stays; it is therefore to be avoided as much as possible. Some boilers are provided with means of closing the ashpit, or with a damper in the chimney, which, when closed, prevents the draft from passing through the burning fuel, and thus, lessening the heat, checks the formation of steam without suddenly cooling the

boiler. In urgent cases, as where the machinery is suddenly thrown off the engine, with a heavy fire on, and the steam still rising notwithstanding the above means being taken to prevent it, the safety valve may be cautiously opened, and the engine started to pump cold water into the boiler, which should it become too high, may be blown off by the blow-off cock.

By far the most usual cause of accident is, however, insufficiency of water. Inattention to the condition of the gauge-glass, so as to allow the passages leading to the interior of the boiler to become choked up, and thus cause a false level of water to be shown, is by far the commonest cause of this. The guage-glass is fastened into two brass stands or brackets, which are fixed to the boiler in such a position that the upper one is some few inches above the working level of the water in the boiler. Through each of these brackets there is a passage leading from the interior of the boiler to the parts of the brackets just below and above the ends of the gauge-glass. These passages can be closed by cocks, and when these cocks, are open, as they should always be, the inside of the gauge-glass is in free communication, top and bottom, with the inside of the boiler; and it is therefore evident that the height of water in the boiler will stand at the same level in and be apparent in the gauge-glass as long as the water level is not above the top or below the bottom of the visible part of the glass. Opposite each of these passages, on the front of each bracket, there is a small brass screw-plug which can be removed in order to allow a piece of stout wire being introduced to the passage, to clear it of mud or any other obstruction. This can be done even when there is steam in the boiler, provided the wire be sent into an L shape, one part of which can be held in such a way that the escaping steam or water will not touch the hand. A third cock is found on the bottom of the lower bracket, and a screw-cap through which the gauge is put in on the top of the upper one. This lowest cock is called the drain-cock.

Now, to test if the gauge-glass is in good order, and clear of mud or other obstruction, first open the cock last alluded to. If both the passages of the other two cocks are clear, a mixture of steam and water will come out,—that is, steam from the top cock mixed with water from the bottom one. Now shut the top cock; water alone should come out. Now open the top cock, and shut the bottom one: steam alone come out. The top and bottom cocks are then to be left open, and the lowest or drain-cock closed. The water should stand then at about half the height of the glass. If more, the feed should be lessened; if less, increased. Delay in removing the fire, should the water get too low through the feed-apparatus not working, through leakage in the boiler or through inattention, is another frequent cause of accident. Should the feed-apparatus go wrong, and you are unable to get it to work by the time the water gets down to half an inch from the bottom of the glass, you must remove the fire from the boiler at once. On no account omit this, or run any risk by waiting a little longer to see if the feed will work; and remember that if at any time your water gets suddenly low through a leaky tube or other leakage, or from any other cause, to draw fires at once without a moment's delay, as lots of accidents and explosions have occurred through shortness of water.

Some feed-apparatus have, and all should have, a cock between the discharge feed-valve and the boiler, and also a cock

on the suction-pipe, to shut off the water supply. With these, should the valves cease working, you can shut the supply of water off, and thus stop the pump from working; and by closing the cock next the boiler, you can prevent any hot water from getting back. The supply of water should be stopped from the pump before the latter cock is closed, or the pipe may burst. This can be done by shutting the cock on the supply-pipe, or if there is none, by slacking back the cover of the lowest feed-valve. The valves can then be taken out and examined. If there is a check-valve on the boiler, and in good order, one of these cocks is not needed, as the check-valve will prevent any back-flow of water; but people frequently allow the check-valves to become leaky. Sometimes the feed-valves cease to work, through vapour forming in the valve-chest above them, and this is often the case when a feed-heating-apparatus is used. In this case cold water thrown on the pump and valve-chest will condense the vapour inside, and the valves will start again. Sometimes the valves jam inside. A few taps with a hammer on the side of the feed-chest will often start them. Sometimes chips of wood get in with the feed-water, or cinders or other rubbish find their way in, and jam the valve. The best remedy for this is prevention, by passing all the feed-water through a wire strainer.

The boiler is sometimes said to prime. This is said to occur when the water boils over, as it were, and comes into the engine with the steam. This is not as a rule very dangerous to the boiler, but it is to the engine, as the water getting into the cylinder often causes a break-down.

Priming is caused either by using dirty water, by allowing it to get too high in the boiler, or by irregular firing. The cure is indicated by the causes. Fuel should be supplied a little at a time, and often; but as this is troublesome to a native fireman, he will, if not watched, pile on a heavy fire so as to have a long spell of rest; then often go away, and leave the boiler to take care of itself till he thinks it is time to put on another big fire. This is wasteful of fuel, causes the boiler to prime; and, while the man is away, his water may get low, or some accident take place.

Should a gauge-glass break while steam is on the boiler, it can be replaced in a few minutes by closing the top and bottom cocks, taking off the cap, on the top of the upper bracket, taking out the broken glass, and sliding a new one down through the hole in the top. The nuts and ferules which squeeze the packing can be put on the glass in their proper positions as it is being slid on. During the time that the glass is being replaced, the height of water in the boiler may be approximately known by the test-cocks. These are two, or sometimes three small cocks, fastened in the boiler near the gauge-glass. They should be slightly opened, and the height of water in the boiler should stand somewhere between them, in which case steam should come from the upper, and water from the lower one. Should water begin to come from the upper one, the feed should be lessened. If steam make its appearance at the lower one, the FIRE SHOULD AT ONCE BE REMOVED.

LASTLY, REMEMBER, THAT AS LONG AS YOU KEEP THE WATER IN THE BOILER, AT A PROPER LEVEL, AND THE STEAM AT A SAFE PRESSURE, THERE CAN BE NO EXPLOSION.

At the close of the season the planter ought to remove his cylinder cover and valve-casing cover. The latter is the plate which screws on to the back of the slide-valve casing, except in the Robey and one or two other engines, where it is very improperly placed at the end of the casing,—a cheap and nasty method which is to be condemned for several important reasons. On removing them he ought to disconnect his piston and piston-rod. He ought also to disconnect the slide-valve from the eccentric rod and from its spindle, and remove the valve and spindle. If the engine is to be laid up merely from the end of the season till the beginning of the next, he should make a mixture of half tallow and half white-lead and apply it to all parts liable to rust; the inside of cylinder, the valve-face, the cylinder cover if polished, the piston-rod, connecting-rod, crank, shaft, and every other part liable to rust. The mixture should be applied hot.

If the machinery is to be laid up for an unknown time, as when it is replaced by newer or more powerful machinery, and put aside to be sold, all the above bright parts should be painted with two or three coats of thin red lead paint laid on *hot*, instead of the white lead and tallow mixture.

After a good number of years' experience in machinery, the writer has come to the conclusion that there is no oil equal to castor oil for heavy machinery. It is used for all parts of the heaviest marine and stationary engines except the cylinders and slide-valves, where mineral oil is used, as it does not so readily carbonise as castor or other vegetable or animal oils. But for oiling the bearings of a steam-engine, or even for use in the cylinder of a small engine, castor oil is far superior to any other; and since the opening of the Suez Canal its use is spreading very much even in Great Britain. But the ordinary bazaar castor oil is often full of grit and other impurities which tend to wear down the working parts of the machinery; and when one considers the millions of times that an engine revolves during the tea season, the importance will at once be seen of keeping the lubricants as free as possible from grit or dust or any foreign substance which can have a grinding effect. Therefore all oil or other substance, such as tallow or melted suet, used for lubricating machinery, should be strained before use through the finest wire gauze procurable.

Dust flying about the engine-room is a still worse cause of destruction. Therefore, the engine room ought to be separated from other parts of the building by a wall, or wooden partition carefully put together, so as to be dust proof. And in doing this it ought to be carefully separated from the boiler. When the boiler fire is being cleaned or removed, clouds of very gritty dust fly about, and portions of this settling on the engine, and finding their way into the corners and crevices about it, into the oil-cups and bearings and small oil-holes in the smaller parts of the machinery, form a deposit ready to begin its destructive grinding work when the engine starts in the morning. A good deal of dust is brought in with the tea leaf,—dust blown on to the bushes on a dry day; and lots of this also finds its way into the engine-room. Just prove this for yourself in a very simple manner. Go into your engine-house and pick up the tin oil-feeder used for oiling your engine. Unless you have an exceptionally clean engine-man, you will find it pretty well covered with a mixture of coal-dust, ashes, sand, &c., and every object in the

neighbourhood of the boiler will be just the same. Lay a small clean piece of plank anywhere in the engine-room in the morning, and examine it at knocking-off time. Just see how much dust and grit has collected on it. Surround your engine with a dust-proof wall or partition, reaching right up to the roof, leaving only an aperture for the driving-belt to pass through, and leading your steam, exhaust, and feed pipes through the partition, so as that the whole arrangement will be as nearly as possible dust proof, and repeat the experiment with the plank. You will see scarcely any dust on it after a day's work, and you will find a remarkable difference in your bills for repairs to machinery at the end of the season, as your bearings will not have worn down much, and the engineer may perhaps not need to touch them. Your engine will run a much longer time before having the very disagreeable knocking or thumping noise caused by slack bearings.

First, when a bearing is becoming or has become hot, stop the engine if it has not stopped itself, cool the parts first with hot and then with cold water, slack off the brass, and start again, using a mixture of oil and sulphur.

At the earliest opportunity take out the shaft, or whatever may have been hot, and file the journal smooth with a smooth file; also file the inside of the brass with a half-round smooth file. The journal and brass must be filed so that the file-marks will be round the shaft, that is, in the direction in which it revolves. If the shaft is very deeply scored, it should be sent to a workshop at the end of the season to be turned smooth.

TEA WITHERING.

By Percy Swinburne, late of Sylhet, Cachar, and Assam.

The old method of withering was to spread the leaf 2 to 3 inches thick on a mychan, and to turn it over several times during the night to prevent its heating too much. In wet and cold weather it was placed in small quantities at one time, on a mychan, over the firing-dhools, where the heat quickly softens and prepares it for rolling. But now great improvements have been made in the factory buildings and accommodation. It is generally recognised that the leaf must be thinly spread out, and the withering-process most carefully conducted, to turn out good tea. Withering sheds admitting air and light freely, and fitted with tier upon tier of bamboo trays, are made. Large pucka iron-roofed tea-houses are fitted with lofts for withering, and arrangements are made for regulating the heat and admitting or shutting out the air.

Natural withering, as generally understood, means that the leaf is placed in open or closed houses in which the draught of air may be regulated; while artificial withering includes the use of heated air, or of machinery.

A large proportion of the best tea which is sent to the market is now made from artificially-withered leaf, that is to say, from leaf which has been withered by heated air. The lofts of the pucka tea-houses are heated by the sun, to a temperature of over 100 degrees, and are often intolerably and suffocatingly warm. In dull and wet weather, also, the temperature in these places is still considerably higher than that of the surrounding atmosphere, as they are heated by Siroccos or other firing-machines, the chimneys of which pass through them.

There has for a long time been a strong prejudice against artificial withering. Closed hot-houses were used because the weather so often proved unfavourable, but nutural withering, under favourable circumstances, is always supposed to give the best results.

In natural withering, the faster the process the better the result, so we may conclude that perfect withering would consist in removing all superfluous water from the leaf instantaneously, without disturbing the oils, juice, &c., while sufficient heat was applied to reduce the fibre to the soft condition required for rolling.

The finest tea was made from leaf withered in 3 hours, at a temperature of 140 degrees. The tea was on several occasions carefully assorted, and true samples of the bulk were sent down to Calcutta to be valued, and the quality of the liquor, as well as the appearance, were pronounced excellent. The average valuations were about 14 annas, and the leaf was good, but not finer than that plucked on most estates in Darjeeling, or Sylhet, or Cachar, being two leaves and a bud. The market at the time was depressed, and the average price of the teas of the districts named was, at that time, between 9 and 10 annas.

In 1883 the entire crop of the Kainagar Estate, Sylhet, just under 900 mds., was withered in hot-houses' heated by smoke-flues, and realized 11 annas per lb. average. The houses were "kutcha" ones, built of bamboo and plastered ekur. They were 14 feet high in the roof, 7 feet high walls—breadth 20 feet. Two four-feet wide passages, and four rows of chalnies 3 feet wide.

The pipes were 9 inches in diameter, and $\frac{1}{8}$ inch thick, and ran along both sides of the house underneath the outer row of chalnies. The heat was much greater near the furnaces than at a distance from them, and the house gets thoroughly heated for a distance of about 15 to 20 feet only from the furnace.

The heat is also uneven; and the greater it is, the more difficult it becomes to equalize the withering. The leaf must be thinly spread and carefully watched. One part of the house withers much more quickly than another, and if the leaf is left for an hour only, after it has reached the right stage, much quality is lost.

These houses, defective as they are, are preferred to those of the old style.

When the men have learnt how to arrange the leaf, and work the fires, the rolling can be commenced at 5 A. M. every day in all weathers.

The leaf does not turn red unless it is bruised in some way during the withering process. and its juices become exposed to the air. This may happen from the leaf being gathered up a second time, and removed from one place to another.

If it is once established beyond dispute that the best tea can be made from artificially-withered leaf, there should be no difficulty in making a hot chamber in which the leaf could be very thinly spread out, and the heat equalized and regulated, and the moisture removed.

One of the great disadvantages of open houses is, that the damp cold air which checks the withering is admitted, as well as the warm air which favours it. Withered leaf absorbs moisture, and is refreshed by it—as a bouquet of faded flowers is revived by sprinkled water. But when the leaf has withered a second time, it loses its freshness, and when the flowers have again faded, they begin to give out an offensive smell; the first stages of decomposition having set in, in both cases. Leaf which

has once lost its volatile freshness and delicacy, never recovers it, and can never be converted into fine tea.

The fine qualities in the leaf may be chemically altered in the hot withering process, but they not are lost altogether, as is proved by the quality of the tea produced by it.

In the same way, however, as the flavour of the tea is affected by different firing processes, so it is probably also affected by the degree of heat applied in the withering as well as by the manner in which it is applied.

Good tea can be made of leaf which is carefully withered, rolled, fermented, and finally baked; but although strong, it is peculiar, and has not the delicate flavour and smell of tea which is roasted over charcoal in the usual way, and this again is not so aromatic in flavour as that which is dried by the rapid hot-air draught of the "Sirocco."

It would appear that the best withering would be accomplished by a strong draught of moderately warm and quite dry air passing over the whole surface of the leaf.

If the juices can be kept uninjured, the more the leaf is withered the better the quality of the tea. The presence of water in the rolled leaf appears to affect the fermentation injuriously.

It is not accurately known at present what chemical changes take place in the various systems of manufacture, but we know that we are more or less dependent on the weather, and that the changes which take place satisfactorily one day, will not do so on another, under apparently exactly the same condition. Lightly-withered leaf makes tea without strength or body, and this is probably due presence of too much water in the rolled leaf, which causes an injurious fermentation. On the other hand over withering, or bad withering, by which the juices have been injured or destroyed, have the same effect, and produce weak pale-liquored tea.

A NEW TEA WITHERING MACHINE.

(*From the Home and Colonial Mail.*)

Our representative paid a visit to Gillwell Park a few days since, and saw the new machine invented by Mr. Gibbs for withering tea. Until the blocks illustrating the machine are ready, we purpose holding our notice of the invention over. Suffice it to say that Mr. Gibbs, with his usual enterprise and skill, has made a clever attempt to solve the problem of withering tea in all weathers. The London *Times* gives the following account of the invention:—

"One of the most important of the various operations connected with the preparation of tea for the market is that of withering. For this purpose the freshly plucked leaves are placed on trays on tiers in a building known as the withering house, where, by the aid of the dry, warm temperature, they are withered. This withering process has for its object the bringing out of part of the moisture contained in the leaf, so that every leaf is rendered soft and pliable, becoming to the touch like a thin piece of glove kid. In this condition the leaf is readily curled or twisted in the rolling mill, which is the next operation it has to undergo, withering being the necessary preparation for this treatment It, however, sometimes happens that a damp atmosphere or a low temperature prevails, in which case the withering cannot be properly effected, and a considerable portion of the crop may be spoiled, thus entailing a heavy loss on the tea grower. Such cases are by no means of

rare occurrence, as some of our Indian tea growers to their sorrow can testify. In these circumstances it is of course of the first importance to have some means of remedying this evil and of preventing this serious loss. Heat has been employed to dry the air, but we believe with indifferent success, for if the temperature cannot be perfectly controlled and regulated, the leaves will become dried at the edges, and in other ways rendered unfit for the subsequent process of rolling. To overcome this difficulty, Mr. William A. Gibbs, of Gillwell Park, Chingford, has devised a machine which, in the opinion of those who are qualified to express one, is capable of effecting all that is desired whether the temperature be low or the atmosphere moist, or whether both conditions obtain simultaneously. Mr. Gibbs' experience in desiccating machinery has enabled him to thoroughly grasp the difficulty and to provide the precise remedy, but this only after several months of careful study and practical investigation into the subject.

"The machine in question, which we were recently afforded an opportunity of examining in operation, is as simple in construction and operation as can well be conceived thereby adapting itself to the degree of intelligence possessed by the class of operatives who will be intrusted with its working. It consists of one of Mr. Gibbs's fans fitted in an iron casing mounted on a pair of wheels, and having a small coke fire in a box in front of it. If we add a handwheel for driving the fan and a couple of handles for moving the machine about, barrow fashion we shall practically have completed its description. There is, of course, an air inlet to the rear of the fan, and there are two outlets in front of the firebox. Into each of these latter is fixed a light flexible hose, about 4 in. in diameter, for the distribution of the air from the fan. The work of turning the fan is very slight and here Mr. Gibbs has met the requirements of Eastern labour, for after the fan has been once started, the slightest touch of the handle at each revolution will keep it going, as the friction is reduced to a minimum. The turning of the handle draws the air into the fan, and it is expelled on the other side; but on its way to the delivery outlet, it is made to pass through a chamber which is placed over the fire, and by which means the air is raised to the desired temperature. It will thus be seen that two streams of warm dry air, one on either side, can be delivered through the hose into the tea which is laid out for withering. With regard to the range of temperature, we may observe that on the occasion of our inspection the thermometer stood at 63 degrees Fahr. at the intlet, of the fan, and at 87 degrees at the outlet, thus giving a range of 24 degrees.

"So far, the question of temperature only has been dealt with. We have now to show how the machine acts in the case of a hygrometric atmosphere. To meet this case there is a small cage fixed in the front of the air inlet to the fan. In this cage are placed roughly broken fragments of chloride of calcium, and through this mass the air has to pass on its way to the fan. The chloride of calcium abstracts the moisture from the air, which enters the fan perfectly dry and is expelled from it in the same condition, the fire not being used if the temperature of the atmosphere be sufficiently high. The machine is perfectly portable, weighing only 1½ cwt., and measuring only about 7 ft. in length by 4 ft. in height and about 2 ft. in width over all.

"The principle of this machine has been applied, or rather added, by Mr. Gibbs to the tea-drying cylinder which he devised for drying the tea as it comes from the rolling mill, and which was described by us towards the close of last year. This machine consists of a revolving cylinder through which the tea is gradually passed: being exposed during its passage to the desiccating influence of a stream of heated air. In this case the air may have a temperature of some 450 degrees on entering the cylinder, and on leaving it will still be sufficiently warm to be serviceable in withering tea. The air, however, leaves the cylinder laden with the moisture which it has absorbed from the tea, and in this respect is of course quite unsuited for withering. But by placing a cage of chloride of calcium at the exit end of the drying cylinder and a small fan beyond it, the air is drawn through the chloride, in which it leaves all its moisture, and is delivered by the fan perfectly dry and of a temperature suitable for withering, as was demonstrated on our visit. Of course chloride of calcium, being a deliquescent salt, becomes dissolved as it absorbs moisture. In the case of the drier as well as in that of the witherer, however, it is caught in a pan placed beneath the cage, and is afterwards restored to its normal condition by evaporation. It is thus used over and over again, none being wasted, and, therefore involving no expense in this respect beyond the first cost. This simple method of obtaining dry air at moderate temperatures is applicable to many products where heat alone would be injurious, and Mr. Gibbs is now in treaty with a large importer of timber to construct a building and provide large power-driven fans with calcium chambers for the rapid seasoning of damp timber. He considers that this more powerful arrangement will ultimately be adopted for tea-withering houses when the planters have satisfied themselves as to the value of the process by the use of the portable witherer we have described.

"We thus have a further extension of Mr. Gibbs' ingenious application of physical laws and mechanical principles to the saving of crops, an extension which appears destined to reflect on its inventor as much credit as those by which it has been preceded, and on which he has expended so much thought, time and money. Before concluding, we may refer to an improved apparatus, which we saw in model at Mr. Gibbs's for desiccating fibrous substances. In this instance Mr. Gibbs has taken his hay-drying machine as the basis. Here he uses a series of forks or tines fixed on two horizontal bars to which motion is imparted by a crank shaft. The material to be desiccated is fed into a perforated floor through which hot air is forced, and the form and action of the times is such as to lift and separate the material under treatment as well as to gradually carry it forward over the floor from one end to the other of the machine, at any desired rate speed. We thus have another useful appliance for the treatment of such fibrous substances as require separating during the process of desiccation, and which is specially applicable to certain new substances used in paper making, for which purpose, in fact, Mr. Gibbs has designed this model. A large machine. 35 ft. long by 12 ft. wide, is now being constructed, the cost of which as compared with the old-fashioned endless hand machine is less than one-half, while its greater efficiency in opening up the material is obvious to all practical men."

GENERALLY ADMITTED FACTS WITH REGARD TO THE MANUFACTURE OF TEA.

[The following paper has been kindly placed at our disposal for publication. It was found amongst the late Mr. Cameron's papers and appears to have been the maxims which he had acquired during his lengthened experience of tea-making in India. They are of peculiar interest to all planters in Ceylon, as the framework on which Mr. Cameron based the teaching that had so powerful an effect for good throughout the island. It will be seen that they refer *only to hand manufacture*].

1. Leaf is best withered when there is free supply of light and cool air.

2. Wet leaf is better withered in the sun or in the wind than by artificial heat.

3. Dried leaf is not necessarily withered leaf.

4. Under-withered leaf breaks in the roll.

5. Over-withered leaf gives most Pekoe tips.

6. Leaf withered in the sun gives red tea.

7. Under-withered leaf gives a green and over-withered leaf a dark outturn.

8. A bright coppery-outturn can only be obtained from well-withered leaf.

9. Under-withered leaf will take longer to fire than well-withered leaf.

10. Low rolling tables cause the leaf to get broken. Anything under 3 feet high is objectionable.

11. If sap comes too quickly in the roll, it shows that the leaf required more withering.

12. Too much sap makes a knobby tea from the leaf getting into lumps.

13. Small leaf cannot be successfully separated from the large before rolling.

14. Heavy rolling destroys the flavor of the small leaf, but improves the strength of the large leaf.

15. Heavy rolling discolors the Pekoe tips.

16. Coarse leaf requires all the rolling it can get.

17. Contact with iron blackens the roll.

18. The roll will color in any temperature, be it higher than, equal to, or lower than, that of the tea house.

19. In a higher temperature than that of the tea house the color comes quickly; in a lower temperature much slower.

20. At some period of so-called "fermentation" the roll gets warm. In the present state of our knowledge there is no certainty whether to check or encourage that warmth.

21. The roll gets blackened by contact with the air and colors more evenly covered up.

22. Coloring in balls is uneven. Roll spread out over three inches to color gets mawkish.

23. The fermentation proper cannot be brought about without heat. Teas coloured in a temperature below that of the tea-house are not "fermented" in the real sense of the word. "Oxidation" or "coloring" expresses the process more correctly.

24. There is no fixed time for coloring; the proper point is determined by the eye.

25. There is no chemical or other test in use to determine the point at which to stop the coloring.

26. The color of the roll immediately before brisk-firing is about the color of the outturn which will be found in the cup.

27. Pungency or rasp and a light liquor accompany a green outturn.

28. Thickness and a dull liquor attend a dark outturn.

29. Over-colouring produces a soft tea.

30. Care given to the withering ensures good color; care given to the roll ensures strength, but care will not ensure flavor.

31. In the present state of our knowledge there is no method by which flavor can be fixed.

32. Leaf opens out during the coloring, and requires re-rolling.

33. Heavy re-rolling before firing softens the tea. A light pressure to excite a little moisture gives the twist and the polish required.

34. Drying in the sun gives a black and tippy tea.

35. Tea dried in the sun, cups out with a metallic taste.

36. Coloring and softening go on rapidly over slow fires, and are checked by all aglow fires.

37. Quick firing gives a brisker tea than slow firing.

38. The roll spread thick on firing trays gets stewed and dull.

39. The roll has been spread too thickly when the fire cannot be seen through the contents of tray.

40. When three-quarter fired, about half an hour, trays can be safely filled up four deep, and the curing finished over slow fires.

41. Choolas can be constructed to consume one maund of charcoal, or less to one maund of tea.

42. Pucka battying developes nose or aroma.

43. Drying in the sun before packing completely desiccates the tea, but gives it a peculiar flavor.

44. Bulking is better before than after pucka battying to ensure the teas being packed hot.

45. Iron-wire, brass-wire, or bamboo trays are all good for firing, but the two former are better conductors of heat than the bamboo ones, and not liable to get out of mesh.—Local "Times."

(*From another planter.*)

I return proof of "Fact *re* manufacture." So far as firing is concerned, the "facts" refer to choola fires, but 36 and 37 are equally true of machine-firing and so far as 38 is concerned you will remember that the roll was after Kinmond's visit spread thinner on the trays with better results. So far as No. 40 is concerned, I think the tendency is now to have final firing done *slowly*, either on choolas, or in self-acting machines. For the first or three-quarter firing the Kinmond dryer suits those who believe in brisk firing and I think most of our tea-makers do; but it can be done too briskly and it probably is when the fan is run at 700 revolutions per minute, apart from the belief that many have in the superiority of Sirocco and choola fired teas. The saving of steam power alone will very likely cause self-acting dryers to be generally used, particularly when the capacity, as in the No. 3 Sirocco, is doubled at such a moderate increase of price.

It has yet to be seen how the new power worked Jackson's dryer is to answer as regards quality. That it will do quantity there is no doubt, but, should it answer well in all respects, it

will be more suitable for the larger factories, and the smaller will probably still find their best and most suitable machine in the Sirocco. Of course, there is a strong temptation where a lot of tea is being made to use the machine that does the most work in the shortest time, but, so far as our experience in Ceylon is concerned the teas fired by the latter class have not given the best results. There seems to be a unanimity of opinion among brokers and dealers at home that our teas are too rapidly fired or too hastily finished, and the sooner we acknowledge that the better, so that we may keep up our good name instead of having to recover from a bad one. It seems to me very likely indeed that the important process of firing will in Ceylon be done generally by self-acting machines and finished off on choolas, as mentioned in No. 40.

So far as the most of the "facts" are concerned there is not much that is new to those who have for years now been manufacturing tea, but the facts are so clearly and concisely put that they may be of service even to the experienced. To the latter the "facts" point out how far we are from more than a superficial knowledge of the art or science of tea-making. No. 20 shews this very clearly as also does No. 25. We know nothing more than what the eye, the touch, and the nose has told and is telling us. It would no doubt be a great step if "fermentation" was scientifically studied and we had an explanation of the change that takes place and its progress up and down the scale; and it would be as great a step if we had the tests to know when the "coloring" should be stopped.—*Ibid.*

FACTS *re* TEA MANUFACTURE.—Mr. Scovell of Strathellie, to whom we sent a proof of the late Mr. Cameron's memorandum published yesterday by us, writes:—

I have only noticed two points on which my experience does not tally with the "admitted facts," though, for the most part, you will see that I can speak in support of them.

Mr. Scovell's comments are drawn up as follows:—

1. Leaf is best withered when there is a free supply of light and a circulation of *warm* air.

5. I have not found this. An over-wither results in the breaking of leaf, increasing the Pekoe tips.

14. Heavy rolling destroys the *appearance* of small leaf but increases the strength without taking from the flavor of the tea.

18. Excessive temperature is against good fermentation.

20. The aim should be to keep the temperature as even as possible during fermentation.

30. Care given to the withering is a step towards good color, but will not ensure it. Great strength cannot be obtained from a poor jât of plant, notwithstanding heavy rolling.

44. Bulking is better carried out after final-firing, as that operation may of itself be uneven. Tea final-fired just before bulking retains sufficient heat for packing purposes. It is not desirable to pack tea with too much heat in it.

Strathellie, 30th March, 1885. ARTHUR E. SCOVELL.

In yesterday's article we find we spoke of Mr. Cameron as having been 30 years in India. In reality he had only been 18, and we ought to have said that the Memorandum left by him was the accumulated and concentrated experience of 30 years' manufacturing on Indian estates by Mr. Cameron and others before him.—*Ibid.*

HOW TO MANUFACTURE GREEN TEA.—The leaves, when plucked, are placed on open-work bamboo *chalnies* or trays, and placed in the sun until they become sufficiently flaccid or withered to allow of them being manipulated or rolled without breaking. After manipulation of about 2 to 3 minutes, the leaf is again put in the sun in the open trays as formerly for about 2 or 3 minutes, after which, when the leaves have become sufficiently heated, it is again rolled. The leaves are again placed in the sun, and rolled as formerly. This process is continued until the leaves are thoroughly rolled. When ready, they are placed in bags made of fine canvas or stout American drill of two feet in length and one foot in breadth, the mouths of which are firmly tied with cord. On each of these bags a cooly stands, supported by a pole or stick, and rolls them with his feet backwards or forwards, as the case may be. As the leaves become compressed in a smaller space and the bags become slack, they are refastened and again rolled by the feet, until they become more compressed, when they are again fastened. This process is continued until the leaves cannot be compressed any more, and the bags become quite hard. The bags are then put by with the leaf in them (they must not be opened) on *changs* until the following morning, when they are opened and the leaf taken out and well separated to prevent its being in lumps. It is next put into an iron tea-pan (in small quantities) moderately heated by a charcoal fire underneath, and kept as near the same temperature as possible, and pressed and rubbed slowly against the pan by the hand; this is continued until the leaves get quite crisp, as if they had been fired over the dholes or drums, when it is finally finished and ready for packing. Wood could be used in the place of charcoal for burning under the pan, but as it cannot be regulated so well as charcoal, the latter is used in preference, so as to keep an even temperature in the pan. The notion that a copper pan is requisite to give the tea a bright-green color is absurd, and has long since been condemned. The tea, after having been rubbed in the pan, will turn a very good pale green-color, and quite equal in strength and quantity, if properly rolled and manufactured, to any China variety; and will possess one great advantage over China tea, in that it is not adulterated.

TEA PREPARATION IN CEYLON.

RESULT OF ENQUIRY BY SUB-COMMITTEE OF MASKELIYA PLANTERS' ASSOCIATION.
ANSWERS TO QUESTIONS BY SOME 16 PRACTICAL PLANTERS.
PAPER BY MR. BARBER.

Report of Sub-Committee of Maskeliya Planters' Association on Tea Manufacture.

The Sub-Committee have drawn up this Report from the replies of Messrs. Jas. Taylor, T. J. Grigg, W. Turing Mackenzie, J. Roydon Hughes, H. Deane. J. N. Campbell, T. Dickson, F. L. Clements, W. Cameron, W. Raffin, Giles F. Walker, W. B. Hope, A. Cantlay, T. W. B. Crowther, S. G. Tench, R. Webster and R. Maclure, and some which were unfortunately not signed. The Committee thank these gentlemen for replying to the questions and also Messrs. Blacklaw, Cantlay, J. Ferguson and Rutherford for

assistance rendered. The Sub-Committee regret that delay in the publication of their Report has in some respects lessened its value.

Questions 1-2. The definition of fine plucking given was not universally accepted. The Committee consider the majority of the replies sent in, advise that the method of fine plucking, as defined, should be adopted four or five months after pruning in order to get the higest return per acre combined with a good average price. The replies lead them to think fine plucking as defined by Mr. Taylor (an extract from whose reply is annexed) is decidedly more trying to the bush than medium plucking, as the shoots are removed before the bush benefits by them; the difference per acre in return is put at about 150 lb. per acre in favor of medium plucking the first year, later on perhaps more; the difference of price from 2d to 3d per lb. in favor of fine plucking, the cost of the latter system of plucking being much more expensive, perhaps double. All replies agree that before fine plucking can be safely adopted the bushes must have a good plucking surface and that on no account should it be commenced until the fourth or fifth month after pruning.

(*Extract referred to.*)

Question not intelligible—If the bushes be allowed to get a good start after the pruning by leaving three or more leaves on all primary shoots, there is no apparent harm from finer plucking, that is, plucking the same leaves and leaving a leaf, the same as in coarser plucking, but doing it at an earlier stage of growth. Nevertheless it is reasonable to suppose that the finer plucking must be more exhausting to both tree and soil, yield being the same. There is practically no difference in quantity and the difference in value is fully ninepence per lb. in favour of the finer plucking which costs about twice as much for plucking or nearly so.

3. Bangy leaf below pruning level at the sides of young bushes should not be plucked, but where the bushes are old and cover the ground, this is not so important. It is not generally considered necessary to search for bangy in the centre of the tree below plucking level; a few replies however state that if bangy in the centre is plucked close during drought the yield when rain comes on will be greatly increased; to pull off seed and flower though beneficial is practically impossible.

4. After pruning it is advised that for three rounds 5 to 6 inches of primary shoots above pruning level should be left, or 3 full leaves, perhaps more after a heavy pruning; after third round all primary shoots may be p ucked. On secondary shoots it is at first well to leave 2½ leaves including the bud leaf. Inferior jâts should be kept lower, some however say prune lower and pluck the same; the general opinion is that if thus carefully plucked after pruning the bush will better stand hard plucking later on.

5. Baskets are unanimously recommended. For steep faces or when plucking new flush after pruning cutty-sacks may be used with advantage if the leaf is continually turned out.

6. In a few cases leaf is sifted through ¾ inch mesh. The sieve can easily be attached to the waterwheel, and we are surprised it is not oftener done as it certainly improves the wither and fermentation and takes off some water from the leaf and bruises it very little.

7. By spreading wet leaf thick in the sun and turning it frequently or by continual turning without sun, water can be partially taken off.

8. Hard withering is almost unanimously advised. Mr. Taylor's remarks are :—" As hard as possible to allow the rolling to be properly done, so that no yellowish or unsquashed patches of leaf may be found in outturn from the tea-pot, and so that the depth of color in the liquor be not reduced. With under-withering, rolling will also be imperfect as the mass of leaf is too soft and slushy and slips about without the tissue being perfectly squashed; and depths of color of liquor will also in that way be reduced. Besides a lot of water must be evaporated from the leaf in withering or else juice will drop from the machine during rolling."

9. Natural withering is undoubtedly the best, but rather than keep leaf over till the second day it is advisable to utilize sun or artificial heat in moderation (*i.e.* Chula or Sirocco heat). At high elevations this is often absolutely necessary. Sun withering is preferable to artificial. The result of much heat in artificial withering is bad fermentation. It is advised by some that after sun or artificial withering, leaf should be allowed to cool before rolling. Artificial withering is apt to dry the leaf.

10. Plenty of air and light are necessary for withering purposes but whether the air should be damp or dry is disputed. The direct rays of the sun should always be excluded. The cold at high elevations retards withering, Mr. Taylor considers it a question whether light except for the heat connected with it, is not a disadvantage.

11. Messrs. Fairweather's or Megginson's system of Tats is recommended: one pound of green leaf thin spread covers 6 sq. ft. Leaf withers best on boards.

12. For small gardens Jackson's hand-roller worked by power is highly recommended. It takes 45 to 50 lb withered leaf at a fill, rolls it in 40 minutes, requires 1 to 1½ horse-power; costs R550 without power fittings. This refers to the old hand roller. In the new one there is no movement of the bottom tray and it is similar in action to Kerr's old roller which is also recommended in some papers. Jackson's Universal rolls 120 lb. withered leaf in 1 hour, in two fills; cost £85 stg. f. o. b. in England; requires 2 horse-power. For a large garden where there is plenty of power, Jackson's Excelsior is unanimously recommended. It takes 300 lb. withered leaf at a fill, rolls it in 40 minutes, requires 4 horse-power; price £138 stg. in Colombo. Barber's Blackstone rollers have the advantage of doing much work in a short time and require little power; there are two of them, the "Standard" takes 100 lb. withered leaf at a fill, requires 20 minutes to complete the roll, which equals 300 lb. withered leaf per hour; cost R900 in Colombo. Opinions on this subject expressed now will probably be obsolete in a few months as improvements and new inventions are announced, among which may be mentioned Kerr's new roller and Frater's. In none of the papers is the Challenge referred to, but we have heard it well spoken of. The price of all rolling machines is still exorbitant, but we hope competition will before long lead to considerable reduction.

14. Hard rolling and plenty of it, is generally recommended for giving strength and body to the tea, but not for appearance, which, however, is not so much considered at home at present. Hard-rolled tea will show little tip: for a hard roll a hard wither is necessary, and for a hard wither a hard roll is necessary. As the object of rolling is to break the sap cells of the leaf, the length and hardness of the roll depends to a certain extent upon

the weather and the quality of the leaf. It is advisable not to put great pressure on at the commencement of the roll as it prevents an even twist, but weight should be added later on. For fancy teas light or hand rolling is preferable.

15. Task for handrolling is 35 to 40 lb. green leaf; a plain table is generally recommended.

16. Roll is generally sifted during fermentation through a No. 4; some prefer to sift immediately rolling is completed: some about one hour after; some at the end of the fermentation.

17. A second rolling of about 10 minutes or more, and a hard one is generally recommended; the time when this rolling is done varies as the above-mentioned siftng is always done first. Second rolling is said to improve the twist.

18. Fermentation is generally done by spreading the roll about 3 inches deep on a table, turning it every ½ hour, temperature 75 to 90. 1½ to 4½ hours seem to be the minimum and maximum time for leaving the ferment. In some cases baskets are used, and the roll is kept in a cool place. Turning the roll prevents it heating and gives an even ferment. The process is supposed by some to be oxidization: only a few replied to this question. In answer to No. 18, Mr. Taylor says:—"I do not think that temperature at least within range of climate here, has very much to do with it, though I think it has a little. My time is usually two-and-a-half hours, and three hours for first roll of the day, I spread loosely to ferment in flat trays about two or three inches deep for two hours, turning it at the end of one hour at the end of two hours I put it into a deep basket, still loosely, to ferment the rest of the time. It gets a little warm during the process, but my turning of it is to let air get more evenly at it and to break small lumps."

20. It is considered advisable to avoid great heat during fermentation as it dries the roll, also cold draughts which blacken it. Roll should not be pressed down; free access to the atmosphere should be allowed and all balls very carefully broken up. Fermentation of fine leaf is quicker than that of coarse. A hard even wither followed by hard and long rolling of good leaf give a good fermentation. A damp cloth spread over the roll in dry weather is said to hasten the fermentation.

21. A few say that light rolling improves flavor at the expense of strength. Strength is obtained by fine plucking, hard withering and rolling. It is mentioned that tea from a new clearing gives stronger liquor than that from bushes on old land. Strength and flavour depend much on soil, the jât and the altitude, and brisk firing and as little exposure to the air as possible is recommended. Mr. Taylor deprecates long fermentation as he considers it a sign of deficient rolling, and states that for tea fermented for only one hour, he has obtained a 2s. average, but he considers his present ferment better.

22-3. Average task for charcoal is 80 lb. or by contract 75 lb. From coffee stumps 60 lb. per cooly has been obtained. To one pound of tea, one to three lb. charcoal is used, according as rolls can be fired consecutively or not.

24. Chulas 2 ft. 5 in. wide at top, 13 in. at bottom., 2 ft. 6 in. or 3 ft. high are usual. Replenishing from oven optional: without gratings preferred. Brick is better than stone for building them.

25. To each tray 3 to 4 lb. of roll is put which is fired in from 35 to 45 minutes; the former preferable. Roll is generally fired quite crisp, some take it a little sooner, or some take it off when ¾ dry, empty contents of three trays into one, fire over milder fires or leave over the embers at night. Unless carefully watched coolies are inclined to leave too much to the drying embers to perform. Properly carried out this system tends however to ensure the drying being perfect and is said to develop aroma. The trays should be covered to keep out rats or anything falling on the tea. If roll is taken off before it is quite crisp, thorough final firing is required if not put over the embers as aforesaid.

28. Final firing by Sirocco or Victoria is done at 150° to 200° putting 5 to 6 lb. per tray. Final firing over chulas is done over slow fires, taking ¼ to ½ hour to each tray, 5 to 6 lb. per tray; firing before bulking is perhaps preferable to bulking before firing, as the latter is apt to falsify the bulking; but in the majority of instances the former system is adopted. A piece of cloth spread over the tray and under the tea is a safeguard against burning when chulas are used.

29. The Sirocco is certainly the firing machine generally preferred. Jackson's Venetian and Victoria are well spoken of. No. 3 Sirocco fires at 240 to 280° F., 11 to 14 lb. roll, 20 to 25 min. per tray, 55 to 65 tea per hour. By using coffee stumps carried when knocking off work, cost of fuel has been reduced to less than 1-6th cent per lb. tea made. Jackson's Victoria at 280° F. has fired 240 lb. tea per hour, and cost of fuel for rolling, firing, and sorting was about ½ cent per lb. tea. No. 1 Sirocco at temperature 300° F. 4½ lb. per tray, has fired 35 lb. tea per hour, 18 min. per tray, cost of fuel 1-5th cent per lb. tea. Since this information was received, great improvements have been made to the Sirocco.

31. Sifting by hand Nos. 14 or 12, 10 and 8 are used for 3 grades; 12 and 7 for 2 grades are recommended; dust being taken out through No. 30. Gore's Sifter with patent mesh for taking out flat leaf. No. 8 and 12 sieves have sifted over 200 lb. bulk per hour. Bailey and Thomson's Sifters and Jackson's Eureka are well spoken of.

33. Machinery required for 200-acre garden yielding 400 lb. tea per acre.—The following machinery advised:—

Jackson's Excelsior with hand Jackson in case of accidents; or

Barber's Big Roller with a Venetian Drier and improved T Sirocco; or

Two Improved T Siroccos, price each £95 f.o.b. Liverpool; or

A Victoria and No. 1 Sirocco, a Tea Sifter, a Jonas' or Jackson's Cutter.

It is recommended to use the old pulper-sifter for a roll-sifter and attach green leaf sifter for the water wheel.

300 coolies will be required for an estate as above described.

34. Cost of manufacture per lb. made tea including superintendence 5c; plucking 12c; manufacture 3c; packing 3c; transport 1c=24 cents per lb. in Colombo.

35. Approximate cost of machinery and factory for estate as above described is from R12,000 to R5,000.

36. Water-power is best where possible. Turbine is advised; a water-wheel being a less steady power and requiring more water;

the former is, however, most likely to get out of order. Cost of fuel for engine per lb. tea is ¼ cent.

38. Digging is highly recommended. The effect of castor-cake manure in one case was good; in another it did not improve the quality or price of tea. Cattle manure has undoubtedly shown good results; also burying green prunings and applying other bulky manure. In very day weather it is advised not to manure; about a month or two before or during pruning are the times preferred. Manure increases strength.

39. Two papers advise pruning all the year round to keep the labour occupied and never to have a large lot of inferior tea all at once. A few recommend pruning half from June to Sept. and half from November to January. The majority advise from June to September and get over it as quick as possible. Indigenous and hybrid can be pruned the same; bad jât hybrid is pruned after the style of China or at any rate lower and more severely than good jât. Pruning at two seasons keeps labour employed. To prune or dig in very dry weather is not advisable.

40. To be careful in every detail is the only way to make good tea. Good soil and jât help greatly, and good leaf and hard withering and rolling are advised by all. In time the whole process may be done mechanically, and at any rate great improvements in machinery may be effected.

41. When a supply has been put in and has well started near a bad jât, plant in young tea, take out the bad jât, but not before: as it is difficult to grow supplies. In old tea do the best possible with the bad jât.

42. An oblong wooden building of jungle timber, boarded floor, thatched or wooden roof with plenty of light and air make the best withering shed.

43-4. One paper says in a very wet climate a medium jât will flush better than a high jât, but the mjority prefer the latter. The highest class hybrid and indigenous will not yield so well, and bad jât teas will yield 100 to 200 lb. per acre less, and value per lb. will be 2d to 3d less. The appearance of the bush alters with soil. In bad soil no jât will appear good.

The Sub-Committee are of opinion the falling-off in the quality of tea complained of is not owing to any weakness or disease of the tea bush and must be sought for from other causes, perhaps the recent fall in price has caused this complaint to be exaggerated.

C. E. WELLDON, Honorary Secretary.

———o———

BLACKSTONE, 4th January, 1886.

1, 2, 4.—There is but one mode of plucking that can be safely recommended for the good of the bush, as for the quality of the tea to be manufactured: an entire leaf with the bud and stem attached to it, with the best part of the leaf below it, but without the stem attached—all taken at one nip. This can be done with safety at all times of the year; except soon after pruning, when the newly-grown shoots are being nipped. Calling these shoots primaries or primary shoots here for the sake of distinction, I will recommend that for the first four rounds or so, while still plucking the primaries, that they be nipped still more sparingly, a leaf with the bud and stem attached to it being all that should be taken; an entire leaf being thus left to develop at the end of the shoot, the next flush will be retarded somewhat, and the bush

in the meantime will mature, a condition to be observed if we aim at securing quality. At this early season of the year, instead of displaying an eagerness to fall with unsparing hands on the green stalks and leaves just shooting, and glutting our withering racks and machinery with vast quantities of insipid vegetable matter, which no art or skill can convert into good tea, as turned out later in the season,—if we exercise a little forbearance, and permit the bush to grow and gradually mature, taking meanwhile just enough to keep it in shape and form, we shall be speedily compensated for the apparent loss, with an ample yield of more matured leaf, without any very appreciable reduction of quantity in yield at the end, and we shall be the better enabled to maintain unimpaired the prestige we have won for quality in Ceylon.

3. Bangy leaves below pruning level should not be plucked, I think. A vigorous shoot is not commonly found ending in a bangy terminal, where the field is duly attended to, at the regular intervals. Twigs with insufficient supply of sap are generally not worth attention. Flowers may with advantage be pulled off when flowering, and seeding are due to a change of season or inferiority of jât. Where however the cause is to be found in poverty of soil, something more than taking away the flowers will be found necessary to be done at once, viz., manuring. When due to age of bush a treatment more heroic will have to be prescribed, viz., the knife. In some instances trees badly planted with the tap-root bent or injured also speedily run into seed.

5. Cutty-sacks for plucking should not be tolerated for a moment: their use would lead to the bruising, crushing, and heating of the leaf in the field.

6. I do not sift green leaf; as I sift the green "roll." I am inclined to think that the pekoes would be less liable to be broken if rolled along with the souchong.

7. I do not remove water from wet leaves before spreading to wither. I do not say it should not be done.

8. I do not advocate either under-withering or hard-withering, though it may be safer to incline towards the latter than to the former; 30 to 35 per cent for wither is a sufficient average.

9. Natural withering is better than sun or artificial withering especially for flavour. Sunning is preferable to artificial withering.

10. Light and air are among the acknowledged agents in natural withering; a draught is no disadvantage if it does not blow away the leaf.

11. The withering tats I use are similiar to Mr. Fairweather's, only a little more primitive in the details and perhaps a trifle less expensive. I believe his arrangement with wire to guide the web a better plan than mine, but in principle they are much the same. For both serving and discharging they afford greater facilities than any other withering arrangements I know of, while they have the merit of being the least expensive at the same time.

12, 13. The "Blackstone" roller, of course; as for its merits —well! are they not chronicled in the columns of local papers? I should wish to be spared discussing rollers in this paper under the circumstances.

14. When the souchong leaf has acquired the necessary twist for a marketable tea, and the juice is readily expressed on the roll being grasped by the hand, it is time to stop rolling. Hard and light rolling being relative terms may be differently under-

stood according to the apprehension of different individuals, but if we go by the above tests anything under it would not ferment properly, while rolling beyond it would, to my mind, be barren of profitable results. The disadvantages would be the following:—Discoloration of tip, breaking of tip, risk of getting the coarse and unwithered leaf broken up and mixed with the broken pekoe; waste of time and energy; fuel where an engine is used, and water in the case of a water-wheel being used; extra wear and tear of machinery. Where, however, early plucking is resorted to, that is to say, within the week, the mixing up of the grades would not matter much, as the souchong itself will command an extreme price; so that we should not be in a hurry to jump to conclusions and generalize from the success of one or two estates. Among the believers in hard-rolling there are some, I am aware, whose opinions are entitled to great weight. It is nevertheless, a creed that cannot be followed by one and all, indiscriminately.

15. Forty lb. is a good task for hand-rolling; a plain table is preferable to a grooved table. Rolling being a process of gradual compression and bruising combined, there should be no endeavour to hasten the progress of work by corrugating or flirting the table; as it may result in the tea getting broken up, before getting flaccid enough to be rolled, especially when found under-withered, during the wet season. The table should be not only flat but sufficiently high to prevent too much weight being put on the leaf during the process at the start.

16. I sift about 40 to 45 per cent of pekoe out of "roll" after fermentation by means of a simple sifter with No. 3. Sieve, designed by me and manufactured by Messrs. McIlwraith, Walker & Sons, at a cost of R80. It takes two minutes, driven by power, to work off a 100 lb. roll. It is not patented and may be had from Messrs. W. H. Davies & Co., Colombo.

17. I re-roll for about three or four minutes, the souchong only just before firing.

18. Fermentation should be carried out in a cool room not exposed to the wind; especially the dry N.-E. wind. It is a good plan to turn the "roll" over occasionally. I do not encourage heating during fermentation; on the contrary I check it. The roll is spread about two inches thick on tables for about three hours. If leaf be found to be overfermented, and cannot be fired off speedily for want of chulas or *firing* machinery, adequate to the demand at the moment, the leaf should be thinned out at once.

19. Whether oxidation or fermentation be the correct word to be used for the purpose of expressing the chemical change the roll has to undergo before firing, can hardly be said to be of any practical use to us without being prepared to carry the investigation further with the assistance of scientific men. As fermentation includes oxidation I see no reason why we should change this now familiar word into one less comprehensive and probably less applicable. The first chemical change that the bruised leaf undergoes when exposed to the action of the air at a certain temperature is oxidation. We cannot say we stop at this, before the leaf undergoes fermentation. Fermentation, according to M. Pasteur, is said to be essentially the life history of certain microbes, the germs of which are to be found in the air everywhere and always. According to the suitability of any organic matter for the development of any particular variety of these microbes, a particular kind

of fermentation will result. There are, it is said, innumerable species of microbes each of which starts its characteristic fermentation. It exists for a while, during which it produces a certain chemical change, by which the organic matter is rendered fit for the growth and development of another species, which in turn gives place to a succeeding variety, and so on, till all fermentation ceases. What we have now to ascertain with the aid of science, is what that particular stage or kind of fermentation is which conduces most to the development of the qualities we desiderate in tea. It is possible, I believe, for a competent chemist both to define this particular stage and to help the planter with simple means by which to ascertain the right fermentation since every kind of fermentation (every stage according to advocates of this theory) can be ascertained by means of chemical tests and the microscope.

20. Heaping up leaf.—Putting roll thickly in baskets, appears to help fermentation. But the safest mode, I think, is to spread on tables.

21. Flavour to begin with, is due distinctly to altitude; care in the details of manufacture, a good wither and full fermentation will secure flavour, as far as it can go on any given estate. But strength is a matter outside the factory. I have said before, the art of good tea making begins in the field. I do not believe that we can obtain more strength from tea leaves, by passing them through "rollers" and firing machines than there is to be found chemically in the leaf itself; briefly we cannot get more out of a roller than we put into it. But we can get far less, by neglecting the cardinal rules of tea-making. It is by careful selection of our jât of tea, attention to the soil, a rational mode pruning, maturing our bushes, and regular plucking, instead of waiting till the leaves get bangy, that we should hope to secure strength. The student who pursues his investigations exclusively in the factory is apt to gradually nurse himself into the pleasant delusion that good tea like good wine needs no bush.

I pass over questions intended for those who use "chulas."

28. Before packing I first bulk and then re-fire at a thermal heat, not exceeding 180 for Broken Pekoe, 200 for Pekoe and 240° for Souchong.

29. I have no fault to find with the Sirocco. I think it can hold its own a good while yet.

30. In firing I keep to the instructions.

31. The sieves I use are 14 and 10 for Broken Pekoe, that is 10 for Broken Pekoe out of "dhoolghoorie" (the 40 per cent sifted out from "roll") and 14 for Broken Pekoe left in the bulk. No. 9 for Pekoe, and Nos. 7 and 6 for breaking and sifting Souchong.

38. Manuring has a marvellous effect on tea.

39. I prune at both monsoons to find work for the coolies all the year round.

40. I have answered this already partly.

41. I cannot recommend the eradication of bad jât plants and bushes now; as if followed, it may lead to the denuding of much of the present planted area of Ceylon. The result may prove disastrous to the prosperity of the colony.

42. For external withering sheds I would recommend the use of round timber "jungle sticks" and shingled roof with jute nailed on the sides to keep off the wind. I have two such here. Hundred feet by twelve or fourteeen is a good size, with jute

stretched on either side on rollers and laths. Ten lengths of jute on sach side giving 4,500 square feet of withering area or a total of 9,000 square feet for the room. Such a building should cost no more than R150. Boarding the floor of same R112: rollers and laths for the jute R30. The total, exclusive of jute, within R300. J. H. BARBER.

THE "SYMPLOCOS OBTUSA" OR "ANTI-TEA-PLANT TREE."

(*See page 134*).

The notorious tree whose decaying roots no doubt kill all the tea plants within their range is the following, and is a native of South Malabar, Neilgherries and Anamallays, and Ceylon from 5 to 8,000 feet. The large form var. β. Major of Thwaites is a very common small tree in the forests near Abbotsford and all the ranges in that direction; and this is no doubt a typical one, whose decaying roots are so fatal to the tea plants within their influence.

Symplocos obtusa, Wallich's Cat. 4424.. A. DC. Pro. 8 p. 255 (1844) Wight Ic. t. 1233. C. P. 626 (673). A small form.

Var. β. major; foliis majoribus, brevissime acuminatus, rotundatis vel retusis; floribus parum minoribus C. P. 1820. Var. γ. obovata; foliis minoribus, obovatis vel suborbicularibus, basi acutis; racemis pauci—sœpi 1-floris.—S. obovata, Wight and Gard. MSS. C. P. 1819, var. δ cucullata; foliis majoribus, valde coriaceis, oblongis vel obovatis, utrinque obtusis, ad marginem cucullata revolutis, superne prominentim, subtus inconspicue venosus; petiole brevi, crasso; racemis ut in var. a ——C. P. 2835.

Hab. Central Province, at an elevation of 5,000 to 8,000 feet

A very variable plant, and perhaps var. β., in which the leaves frequently reach to seven inches in length and three inches in width, is to be considered the most typical form of the species. In var. *a.* the racemes sometimes become branch-like, the bracts being converted into leaves, and thus it approaches var. γ, in which the leaves of a branch often bear each a single-stalked flower in its axil. The leaves in var. γ show not uncommonly a disposition to a verticellate arrangement. Var. δ has, at first sight, a very distinct appearance, but the peculiar form of its leaves proves it to be in an abnormal state, arising probably from certain conditions of moisture and exposure.

Thw. En. Plant. Zeyl. p. 185.

(*From the "Forester's Manual of Botany," by Col. Beddome.*)

SYMPLOCOS OBTUSA, *Wall.*—A small or middling sized tree, all the parts perfectly glabrous except the margin of the calyx which is ciliated, leaves coriaceous oblong or obovate to suborbicular quite rounded at the apex or very shortly acuminate, attenuated or quite rounded at the base, inconspicuously toothed, 3-7 inches long by 1-3 inches broad, veins prominent beneath, petiole ½ to 1 inch long, bracts very early caducous, racemes axillary about 2 inches long simple, flowers few very shortly pedicelled, calyx obconical, lobes rounded, fruit oblong. *Wall. DC. Prod.* viii, *p.* 255;—*Wight Icones tab.* 1233.

A common tree on the Nilgiris and Anamallays 5-7,000 feet elevation; also on the Ceylon mountains; very variable in the size and shape of its leaves.

(*From the "Flora of British India," by Sir J. D. Hooker, C.B., K.C.S.I.,*)

S. OBTUSA, *Wall. Cat.* 4424; glabrous, leaves obovate-elliptic obtuse subentire coriaceous, spikes 1-4 in., flowers large. *A. DC. Prodr.* viii. 255; *Wight Ic.* t. 1233, and *Ill.* t. 151 b.; *Thwaites Enum.* 185; *Bedd. For. Man.* 149.

SOUTH MALABAR; Nilgherries and Anamallays, alt. 5-8,000 feet, common. CEYLON; alt. 5-8000 feet, frequent.

A tree. *Leaves* 1½ by ¾ in., or larger (attaining 7 by 3½ in. in some Ceylon varieties), base attenuated, margin often reflexed; nerves distant, irregular, distinct beneath; petiole long, often ⅛ in. in the small-leaved varieties. *Bracts* caducous; pedicels, 0 or (rarely) 1-10th inch. *Calyx tube* 1-10th in., teeth 1-12th in., round, prominent. *Petals* 1-5th in. *Stamens* 50-60. *Disc* glabrous. *Fruit* ½ by ¼ in., ovoid-cylindric, smooth; calyx-rim 1-5th in. broad, teeth prominent.—The varieties enumerated by Thwaites do not differ much from the type, but vary greatly as to the size of the leaves.

I do not believe in any native name for this plant.—W. F