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DEPARTMENT OF AGRICULTURE

TANGANYIKA TERRITORY

Tea in Ceylon and South India

A Report by F. R. Sanders, District Agricultural Officer, Tanganyika Territory, on a visit to Tea Estates and Experiment Stations in Ceylon and Southern India

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The following tea districts were visited:—

CEYLON.

Kandy	Elevation	2,500-3,500 feet
Newar Eliya	,,	6,000 ,,

SOUTH INDIA.

Animallaias	,,	3,500-4,500 ,,
Kanan Devans... ...	,,	4,000-6,000 ,,
Nilgiris Wynaad ...	,,	3,500 ,,

RAINFALL.

2. The following figures give the rainfall, in inches, of various tea estates in the above districts:—

ESTATE.

	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
1	—	—	—	2·56	3·10	3·20	3·11	7·00	3·97	4·48	11·48	12·69	51·59
2	—	—	—	1·45	4·98	9·60	13·05	78·98	66·31	10·13	17·69	5·82	208·01
3	—	1·67	0·60	2·78	4·14	4·12	15·70	23·90	12·05	5·19	11·03	7·67	89·85
4	—	—	—	2·99	—	12·95	35·03	38·45	50·98	5·34	22·05	5·68	181·12
5	—	—	—	1·89	2·03	4·04	17·00	13·37	3·71	16·05	13·17	6·35	77·61
6	—	—	—	0·18	3·79	4·26	37·20	49·14	38·48	3·52	14·53	5·23	166·28
7	—	—	—	0·71	1·61	4·77	19·13	41·57	27·65	4·03	4·54	4·68	108·71
8	—	—	—	0·20	1·81	5·39	15·05	21·64	15·06	3·58	5·97	2·78	71·48
9	0·80	0·63	0·57	1·63	4·59	5·30	23·97	42·16	20·85	8·27	8·72	3·69	121·17
10	9·12	5·22	2·23	3·86	6·78	5·43	9·64	7·50	5·69	5·93	11·80	10·51	82·71
11	8·57	5·65	2·03	3·32	5·66	6·64	12·85	12·07	7·91	8·29	11·13	9·00	93·12

In each district there are considerable differences in the annual rainfall of estates; for example, estates 1 and 2 in the above list are within forty miles of one another; estate 2 experiences a heavy south-west monsoon while estate 1 is sheltered from the south-west and gets the north-east monsoon more severely. It is not the amount of rainfall that is the important factor but its distribution throughout the year. The minimum under South Indian conditions is considered to be 55 to 60 inches per annum.

SOILS.

3. The acidity of the soil is an important factor. The tea bush grows well in soils of Ph 5 and 6, the vigour of its growth is reduced under conditions of decreased acidity and fails completely under neutral or alkaline conditions; under conditions of acidity greater than Ph 5 the rate and vigour of its growth is again decreased.

4. *Drainage.*—Almost invariably steeply and fairly steeply sloping land has to be dealt with, conditions under which the loss by wash is likely to be considerable. The basis of the drainage plan is to provide sufficient drains to lead away excess water which, in the event of heavy storms, cannot be absorbed by the soil. It is usual to have the main drains running directly down the slope; if possible these are cut down a natural gully. Subsidiary drains are led into these main drains; these are usually on the contour, and have a fall of only about 1 in 40. In many cases silt pits are dug in the trench as a means of reducing loss by wash.

5. To prevent erosion as much as possible, in certain cases *Paspalum dilatatum* is planted along the edges of the main drains, and hedges of *Tephrosia candida* or *Clitoria cajanifolia* may be planted on the upper edge of the subsidiary drains; these hedges are uprooted when they become woody.

6. The subsidiary drains are cleaned out at intervals and the soil thrown above the drain; this tends to form terraces.

7. Terracing of steeply sloping land, though not a general practice, has been done in a few instances in Ceylon. The terracing was done at the time of clearing and was confined to old coffee lands which had passed out of cultivation. The following is a description of the terracing method used on a particular estate together with the results obtained: No actual draining was done. The hillsides were contour trenched, the vertical distance between the trenches being 10 feet. The trenches were level, the soil removed from them was thrown above and formed into a bund. Where stone was available a bund was made 18 inches above the line of the trench and the soil thrown above this. *Tephrosia candida* was planted on the

bund for the purpose of binding the soil and was lopped periodically. The less steep land was dealt with by contour trenches alone. The opening of land by this method cost, including cost of seed and planting seed at stake, Shs. 370/- per acre. The rainfall on this estate is 100 inches, and the maximum daily rainfall held by the terracing so far has been:—

1927			1928	
April 30	0·85 inches		July 5	1·54 inches
May 1	5·75 ,,		,, 6	3·35 ,,
,, 2	0·90 ,,		,, 7	3·49 ,,
,, 3	2·35 ,,		,, 8	3·45 ,,
,, 4	0·32 ,,		,, 9	0·35 ,,

A five-acre clearing planted under this system yielded 676 lb. per acre when four years' old.

8. Catchment pits or trenches (12 × 1 × 1½ ft.) are sometimes made between the rows of tea for prevention of soil-erosion; these besides holding up the excess water serve to aerate the soil. Where possible they are dug across the slope. The pits when filled are either cleared and the soil spread around the neighbouring tea bushes or fresh pits are dug.

CULTIVATION.

9. Where the area to be planted consists of freshly-cleared jungle, nothing other than holing is done, but a grassland clearing is usually dug over. When the clearing is to be planted with basket or stump plants, holing is done as long as possible previously to planting; when seed at stake is the method adopted, the land is deep-forked.

10. Deep cultivation is done usually after pruning, either by forking or by mamoti digging. During the period the tea is in plucking, weeding and envelope forking is done; cover crops where grown are pushed behind the fork.

11. The system of catchment trenches is, of course, a further cultivation and is considered to be very beneficial in its effects.

12. No cultivation is done during the monsoon in order to minimise the loss by erosion; weeding during this period consists of hand-pulling.

MANURING.

13. The manuring of tea is developed to a high degree both in Ceylon and South India, although the use of the types of artificial fertilisers and the time of their application differ in the two countries. The following are general notes on the effect of nitrogen, phosphoric acid and potash on tea:—

Nitrogen.—This is the chief factor in producing and prolonging vegetative growth. Unless nitrogenous manures are used it is only rarely that manuring will increase production. In excess, however, or when not balanced with phosphoric acid or potash, they may lower quality and resistance of the bush to pests and diseases.

Phosphoric Acid.—This is seldom of much value for the tea crop when used alone. When used with nitrogen the increase is above that which nitrogen alone would give. It promotes root growth, hence its value in young and freshly pruned tea. It hastens maturity and tends to cause the plant to complete its life cycle rapidly (important when dealing with seed bearers). Excess of phosphoric acid may lead to wooding up and early flowering and may cause an increase of hard stalk.

Potash.—This seldom gives an increase of crop when used alone but as an addition to other manures it often leads to increased efficiency of the other constituents of the manure applied. It lengthens the period of vegetative growth, *i.e.*, gives a longer flushing period and helps unpruned tea to continue flushing. It may increase resistance to disease. It has a beneficial effect on carbon assimilation.

14. It is essential that nitrogen, potash and phosphoric acid should be present in the correct proportion, if the maximum benefit in growth and yield is to be obtained.

15. The application of manures takes place in relation to time of pruning, the mixture applied at pruning time is referred to as the pruning mixture; subsequent applications within the one pruning cycle are referred to as general mixtures; the latter are applied a year or 18 months after pruning.

16. *Pruning mixtures.*—These should consist of quickly available nitrogenous and phosphatic manures, to give impetus to new growth of both root and shoot. In Ceylon the pruning mixture is usually applied a month before pruning; the practice in South India is to apply the mixture at or only just previous to pruning.

Examples of pruning mixtures:—

(a) Pruning cycle three years:

Groundnut Poonac ...	50 lb.	providing	Nitrogen 30½ lb.
Sulphate of Ammonia	80 ,,		Phosphate 38 ,,
Nitrate of Soda ...	35 ,,		Potash ... 30 ,,
Steamed Bone Meal	150 ,,		per acre.
Nitrate of Potash ...	60 ,,		
	375 lb. per acre.		

(b) Pruning cycle three years:

Groundnut Poonac ...	50 lb.	providing	Nitrogen 17 lb.
Nitrate of Soda ...	30 ,,		Phosphate 23 ,,
Sulphate of Ammonia	50 ,,		Potash ... 20 ,,
Conc. Superphospate	50 ,,		per acre.
Nitrate of Potash ...	40 ,,		
	220 lb. per acre.		

(c) Pruning cycle four years:

Groundnut cake ...	100 lb.	providing	Nitrogen 48 lb.
Conc. Superphosphate	100 ,,		Phosphate 76 ,,
Blood Meal	80 ,,		Potash ... 16 ,,
Nitrate of Potash ...	50 ,,		per acre.
,, ,, Soda ...	70 ,,		
Ephos phosphate ...	100 ,,		
Fish guano	100 ,,		
	600 lb. per acre.		

(a) and (b) are examples of mixtures used in South India, (c) of a mixture used in Ceylon. From example (c) it will be seen that in Ceylon the pruning mixture consists of both quick and slow acting manures and that the application is considerably heavier. The Tea Scientific Officer in South India considers that an application of manures supplying the following is sufficient:—

Nitrogen 20 lb., phosphate 20 lb., potash 20 lb.

17. *General Mixture.*—The object of applying the general mixture is to encourage increased production of leaf throughout the period of the pruning cycle. Each

year from pruning the amount of nitrogen in the mixture should be increased and the phosphate content decreased, in order to force the flush rather than the flower. The mixture is applied at intervals of 12 to 18 months depending largely on the length of the pruning cycle.

Examples of general mixtures:—

(a) Groundnut Poonac	100 lb.	providing	Nitrogen 50 lb.
Sulphate of Ammonia	150 ,,		Phosphate 40 ,,
Steamed Bone Meal	150 ,,		Potash 35 ,,
Muriate of Potash	50 ,,		per acre.
	450 lb. per acre.		
(b) Muriate of Potash	70 lb.	providing	Nitrogen 50 lb.
Sulphate of Ammonia	100 ,,		Phosphate 40 ,,
Nitrate of Soda	125 ,,		Potash 35 ,,
Conc. Superphosphate	100 ,,		per acre.
Groundnut cake	105 ,,		
	500 lb. per acre.		
(c) Fish guano	200 lb.	providing	Nitrogen 29 lb.
Sulphate of Ammonia	40 ,,		Phosphate 38 ,,
Nitrate of Potash	30 ,,		Potash 10 ,,
Conc. Superphosphate	50 ,,		per acre.
Muriate of Potash	20 ,,		
	340 lb. per acre.		
(d) Castor cake	150 lb.	This mixture is applied at 600 lb. per acre, that is.	
Groundnut cake	230 ,,	Nitrogen 55·8	lb. per acre
Whale guano	200 ,,	Phosphate 25·2	
Blood Meal	80 ,,	Potash 19·8	
Steamed Bone Meal	100 ,,		
Sulphate of Ammonia	150 ,,		
Nitrate of Potash	90 ,,		
	1,000 lb.		

Examples (a) and (b) are from South India. Examples (c) and (d) are from Ceylon. In a four-year pruning cycle, two applications of the general mixture may be made. The Tea Scientific Officer of the South Indian Planters' Association is of the opinion that a general mixture employed for the manuring of *good* tea should consist of the equivalents of 40 to 45 lb. nitrogen, 25 lb. phosphates and 25 lb. potash. It is important to note that sulphate of ammonia tends to maintain the acidity of the soil.

18. *Green manuring.*—Green manuring refers generally to the use of leguminous plants but it includes the use as manure of any vegetation. It is extensively employed in Ceylon and South India as a source of bulk nitrogenous manures. Green crops employed as manures may be divided into three groups:—

(a) Cover crops, *e.g.*, *Indigofera endocaphylla.*
Centrosema pubescens.
Oxalis spp.
Desmodium spp.

Indigofera is extensively grown in Ceylon both as a protection against wash and as a manure. Centrosema has a tendency to climb into the tea bush. The general practice in Ceylon is to fork in alternate rows.

(b) Semi-permanent shrubs, *e.g.*, *Tephrosia candida.*
Crotalaria striata.
Clitoria cajanifolia.

The two first named are in more general use. Planting is at intervals of 10 to 12 feet between the rows of tea. It is the practice to lop at a height of about 3 feet and to bury the loppings. After a period of 1 to 2 years the bushes are uprooted. *Clitoria cajanifolia* is used occasionally as a contour hedge above a drain for the purpose of binding the soil. It is lopped frequently to a height of 1½ to 2 feet and uprooted when it becomes woody. In all cases lopping is done just previous to seeding, in order to get the maximum benefit from the crop.

(c) Permanent Shade Trees: *Albizzia molucana.*
Albizzia stipulata
Grevillea robusta.
Erythrina lithosperma.
Glyricidia maculata.

The amount of green manure obtained from the first three mentioned above is confined to leaf fall. Erythrina and Glyricidia are lopped to a height of six feet and kept at that height by subsequent loppings (two to three times per year according to rate of growth). The loppings are stripped of their leaves and the latter are forked in. Erythrina and Glyricidia are in more general use in Ceylon than in South India.

NURSERIES.

19. *Seed.*—The following is a list of the seed used on the various estates visited and also those recommended by the Tea Scientific Officer of the Planters' Association:—

North Indian—	Dhonjan	Dark or medium leaf.
	Damgri	
	Mesai	
	Manipuri	
	Rajghur	
	Dhoolia Manian	
	Betjan Assam	Light leaf.
	„ Lushai	
South Indian—	Bonaccord	Medium dark leaf.
	Nellimunda	

Good seed is essential.

20. Dark and medium dark-leaved types are considered more resistant to the leaf diseases and the effect of sun than are the light-leaved types. The light-leaved types give a better quality tea and, if provided with fairly heavy shade, do well. Seed is received packed in powered charcoal. The seed is separated into "sinkers" and "floaters" and these are germinated separately. In some cases "sinkers" are put straight out into the beds without preliminary germination. The germinating beds are under a pandal of grass. The beds consist of a layer of sand (two inches thick) either on a surface of rammed soil or on a raised table of bamboo. The seed is spread on the sand and is covered with sacking or coir-matting. The seed is kept moist by night and morning watering. Germination occurs in 12 to 15 days and when the root is about one-quarter inch long it is removed and planted in the beds or in baskets.

21. The nurseries are usually situated in a sheltered hollow into which an ample and permanent supply of water may be diverted. The site on which the nursery is to be made is dug to a depth of 3 feet and the beds, consisting of jungle soil or a mixture of jungle soil and cow manure, are made. The beds are usually 30 × 3 ft. and raised about 8 inches; a bed of this size contains about 1,200 plants.

22. For shading the nurseries, high pandals (6 ft.) are preferred to low (2 to 3 ft.). Initially, of course, the former system is more expensive but when the low pandal is used almost always it has to be raised. The sides of

the pandal should be thatched lightly as a protection against the morning and evening sun. In some instances dadap (*Erythrina lithosperma*) stumps (8 feet) are used as supports for the pandal; these take root and afford a certain amount of shade in the second dry weather.

23. The germinated seeds are placed 4 to 6 inches apart in the beds or one to each basket; the seed is only half submerged in the soil.

24. The nurseries should be watered well once per day, either early in the morning or the evening. Excess water results in a considerable modification of the normal development of the root, lateral rootlets being formed in small numbers only, due to some extent to limited aeration.

25. The basket plants are put out into the clearing at the onset of the rains, *i.e.*, June, at 6 months old. The bed plants are put out as stumps or transplanters at 18 months or 2½ years old.

26. There seems no definite preference for either of the above systems, in fact one method alone is rarely used In the case of the basket plants the cost of the nursery is for 6 months only, as against 18 months in the case of stump plants or transplanters. In one or two instances basket plants are considered to be better than stumps because the latter are said to make no fresh root growth until after the monsoon, and in the event of a drought they are unable to withstand the dry conditions. Basket plants on the other hand become immediately established in the soil. With stump plants there is the advantage of seeing the root system of each before putting out and any with twisted tap roots or poorly developed roots can be discarded.

CLEARINGS.

27. Jungle is preferred to grassland in South India. In Ceylon old coffee land which has gone back to patna is often cleared and planted. In South India the clearing, whether jungle or grassland, is burnt off. In Ceylon it is considered preferable not to fire the patna land but to uproot the grass and allow it to rot; by so doing a good cover for the soil is provided and also humus is added

to the soil (the cover is an important point in a new clearing). In one area in South India a "pan" of clay exists at a depth of 3 feet in grassland and in order to break this Red Gums (*Eucalyptus robusta*) are planted quite closely, 6 to 7 years before tea is planted. These are also an important source of fuel.

28. A grassland clearing is usually forked before it is holed and planted; a jungle clearing is only holed before planting. The pits are dug 2 to 3 months before the time of planting in order to allow of weathering; the pits are roughly 1 foot square by 1½ ft. deep; pits for supplies are larger, 2 × 2 × 2 ft.

29. The distances of planting vary with (a) the soil—on really good soil 4 × 4 ft. is recommended; (b) type of land—on flat land and good soil 4 × 4 ft., with similar soil conditions on steep land 4 × 3½ ft.; (c) pruning cycle —although not so important as the previous points it should be borne in mind.

PLANTING.

30. Four methods of planting are employed:—

(a) *Basket plants.*—In using this method it is necessary to ensure that the soil is packed tightly immediately under the basket and in sufficient amount to bring the surface of the basket up to the level of the surrounding soil. In some cases the basket is placed in the middle of the pit and the soil packed around. Another method is to place the basket against the lower side of the hole; by so doing the soil can be packed more efficiently around and under the basket. Basket plants are put out into the clearing at 6 months old, that is, at the commencement of the monsoon.

(b) *Stumps.*—The nursery plants at either 1½ or 2 years are cut down to 2 inches as they are removed from the nursery. If the plants are cut down several days before removal to the clearing, buds arising below the pruning cut are knocked off in transit. In many cases the stumps are dipped in a solution of cow manure.

(c) *Transplanters.*—This method is not used generally. Where the nurseries are quite close to the clearings it is considered satisfactory, but where a great deal of transport is involved the soil is liable to be shaken off.

(d) *Seed at stake.*—When this method is employed the seed is germinated and then planted in the clearing, usually two at a stake and at a depth of 2 inches. This system is used on patna lands in Ceylon. In South India, for this method the seed is not received at the correct time from the seed gardens in North India. One estate in South India favoured this method and planted out in February with success. (The rains start in late May.)

31. A certain amount of selection of plants is practised when transferring the plants from the nursery. All weak plants and those having twisted tap roots are discarded.

32. In every case some sort of temporary shade is placed round the young plants in the clearing; bracken or fern of some kind is generally used.

SHADE.

33. Usually both temporary and permanent shade are planted, at the same time as the young tea plants. In clearings on wind swept grassland at higher elevations, belts of *Acacia dealbata* are planted at an earlier date to afford protection. The temporary shade consists usually of leguminous plants such as *Tephrosia* spp. or *Crotalaria* spp. these grow quickly and give a light shade and in addition they are lopped, thus providing green manure. The amount of such shade must be regulated.

34. *Grevillea robusta* is more generally used as a permanent shade except at the higher elevations. It has the advantage of being easily raised from seed and grows quite rapidly in the clearing. In some cases Grevillea as the sole permanent shade in mature tea is not considered good mainly because of its tendency to "go up" rather than spread. This is remedied in many cases by topping at 20 to 25 feet when the tree has reached a diameter of 9 inches at that height; it then spreads well. Under such circumstances its branches can be thinned out easily if the shade subsequently becomes too dense.

35. *Albizzia moluccana* and *A. stipulata* are also used but are less easily established.

36. In Ceylon, *Erythrina lithosperma* and *Glyricidia maculata* are used as shade. These grow well up to an elevation of 4,000 feet, and Grevillea is used in addition, but more as a windbreak than as a shade tree (as in South India). It is a general experience that Erythrina does not do well in exposed positions; this also applies to Grevillea at the higher elevations (6,000 feet).

37. At elevations greater than 5,000 feet *Acacia decurrens* and *A. dealbata* are employed as shade trees; these have the disadvantage of having a large and shallow root system.

38. *Leucena glauca* and *Cassia didymobotrya*, both of the shrub type are planted at the higher elevations (5,000 to 6,000 feet). The latter forms too dense a bush and the shade is not sufficiently high.

39. The following are planting distances of Grevillea and Erythrina alternating in the rows in mature tea fields on several estates at elevations from 3,000 to 6,000 feet:—

Rows	50 feet	Individuals	20 feet.
„	36 „	„	36 „
„	45 „	„	18 „
„	50 „	„	20 „

Tephrosia spp. and *Crotalaria* spp. are also planted to give a light shade in addition to providing green manure; usually this is done where Erythrina is not planted.

40. *The advantages of shade in the proper degree are that it*—

(a) affords protection against the sun;
(b) affords protection against winds and frosts;
(c) reduces evaporation from the soil;
(d) provides soil mulch;
(e) averages the crop through the year.

The effect of shade on made tea.—Teas grown under unshaded conditions generally show more tip; the liquors are light and thin but are more pungent and brisk than those grown under shade. During periods of heavy rains, in shaded tea there is a tendency towards rank growth, and unshaded tea is then much superior.

41. Generally, *heavy shade* has an adverse effect on the quality of the tea produced.

PRUNING.

42. The first application of a knife to tea newly-established in a clearing, or as supplies in old tea, is referred to as "topping" or cutting across. It consists in the cutting back of the centre stem or stems to a low level, varying between two and ten inches, with the idea of forcing lateral growth and so obtaining a low spreading bush. The period between transplanting and "topping" varies with the rate of growth.

43. The following are the varying methods employed in dealing with young tea on estates in Ceylon and South India:—

Estate No.	Alt. in ft.	Method
1 Lat. 7°N.	3,000	At 11 to 18 months from planting, depending on the vigour of the bush, the bush is topped to 4 inches. One year later it is topped again at 9 inches. Then it comes into the normal pruning cycle which in this case is 2 years.
2 Lat. 7°N.	6,000	Two-and-a-half year old stumps are planted out. After a further 3 years they are topped to 8 inches, and then tipped to 5 inches above this cut. The first normal pruning cut is made 3 inches above the topping cut. The pruning cycle in this case is 4 years.
3 Lat. 10°N.	3,500	Stumps or basket plants are planted out and 24 to 27 months later they are topped to 4 inches; 9 months later tipped to a height of 30 inches. After a further 9 months they are pruned to 5 inches above the topping cut and brought into tipping 3 months later.
4 Lat. 10°N.	4,000	Seed at stake. At 18 months topped to 18 inches (if a good spread is obtained at this level the centre is taken lower). It is then tipped 4 inches above this and brought into plucking. If no branching has occurred topping is done at 12 inches.
5 Lat. 10°N.	4,500	Stumps. Topped back to 10 inches 2 years from putting into the clearing. One year later cut across at 15 inches if any advantage in spread of bush obtained by so doing, otherwise at 12 inches. Tipped and brought into plucking.
6 Lat. 10.N.	4,000	Stumps. 18 months from planting in the clearing single stems topped to 2 inches but advantage is taken of any spread that may be obtained up to a height of 12 inches.

Estate No.	Alt. in ft.	Method
7 Lat. 10°N.	5,000	Stumps. Two years after planting in the clearing they are topped to 2 inches, after a further 18 months they are tipped to 18 inches and then brought into plucking.
8 Lat. 10°N.	4,500	Stumps. Two years after planting in the clearing (a) single stems are cut back to 3 inches: (b) double stems are cut back to 6 inches; (c) others are cut back to 12 inches. The bushes are cut across at 15 inches the following year, tipped and brought into plucking.

44. The type of pruning does not vary with altitude; the altitude is given in the above table in order to explain to some extent the wide divergences in the time lapsing between planting, topping and the first regular pruning. These instances are given to illustrate the methods employed to obtain bushes with good spread. All whippy shoots and wood of less than "pencil" thickness are removed, in some instances the centres are cleared with the idea of forcing side growth. Small and undersized bushes are left to develop. The bush generally shows need of pruning by the shoots going "banjhi," that is, the bush is passing into a resting phase in which the bud of the young is ill-developed.

45. The first real pruning consists in cutting back to 4 to 6 inches above the topping cut. This gives a good length of wood from which new shoots may arise and also into which a down pruning may be made. Whippy shoots are cut away, but branches of more than a pencil thickness not interfering with other branches are left. It is usual to remove all branches arising below the height of the original spread except when an older branch is to be replaced at the next pruning. The bushes are pruned to an exact level, the height being taken from a branch in the centre of the bush.

46. Subsequent prunings are done on similar lines at definite regular intervals of time, the interval being determined by climatic conditions, elevation and "jat" of tea. Heavy manuring (especially phosphatic) and light plucking tend to decrease the length of the cycle not so much because of its going "banjhi" as the fact that the bushes

get unwieldly for plucking. In Ceylon the mid-country tea (2,000 to 3,000 feet) is pruned on a 2½- to 3-year cycle and the up-country (6,000 feet) on a 4- to 5-year cycle.

47. It does not appear to be a general practice to undertake down-pruning, that is, cutting back into the wood immediately above the topping cut. The more general practice seems to be that of gradual replacement of the main frame by the encouragement of lower branches.

48. The period in relation to climatic conditions at which pruning should be done is an important factor. It is considered inadvisable to prune immediately before or during a drought period (January, February and March in South India) or immediately before or during the heavy monsoon (June and July); in both cases the rate of recovery is slow and there is the probability of damage to the young shoots by heavy rain if it is done immediately before or during the monsoon.

49. Instances occurred in which pruning was done in the drought period (December, January); in a particular case the following reasons were given:—

(a) the whole estate would be in plucking in April at a time when there is a shortage of labour;

(b) January, February and March is the period during which the best teas are made, so that if pruning is done in September and October the tipping leaf would be brought in in January and February; as tipping leaf is of poor quality the standard of the made teas would be reduced. In this case a 2-year pruning cycle existed.

50. On another estate on which a 4-year cycle is employed, pruning is done in August and September, that is immediately after the heavy monsoon, for the following reasons:—

(a) the advent of the regular plucking season after pruning coincides with the production of the best teas, and

(b) the possibilities of branch canker are avoided.

51. In the case mentioned in paragraph 49, pruning could have been done in August and September, but in

doing so the October-November flush would have been lost over half the estate. In the case mentioned in paragraph 50 the flush over the corresponding period in the instance of the 4-year cycle would be practically negligible.

52. In parts of Ceylon where the rainfall is well distributed and a heavy monsoon is not experienced, pruning may be done at any period of the year.

53. Pruning cuts should slope towards the centre of the bush. The prunings are usually placed between alternate rows of bushes and when the leaves drop off the prunings, these are forked in or left as a mulch. The sticks are usually removed. Occasionally the entire prunings are buried in trenches between the rows, but this is not done if stem diseases are present.

TIPPING.

54. Tipping consists in the breaking back of the first new shoots after pruning to a definite level. The tipping height is fixed by taking 4 to 6 inches above the pruning cut on a central branch; the remainder of the bush is then tipped to this level.

55. It is usual to tip with the best gang of pluckers in order to get a good shaped bush. In many cases the tipping is done parallel to the slope of the hill; in a few cases the tipping level is horizontal, but the latter method makes plucking difficult from the lower side of the bush.

56. The time elapsing between pruning and tipping varies. Generally speaking, at between 2,000 and 4,000 feet altitude, the bushes are ready for tipping approximately 3 months after pruning, and at 5,000 to 6,000 feet, 5 months after pruning. The tipping gang is put into the field when about 60 per cent. of the bushes are ready. Tipping should be done before the shoots become woody or else breaking back is difficult and knives have to be used.

57. The effect of tipping is to force into growth the buds immediately below the point of breaking back.

58. The second tipping, a month or six weeks later, brings the "secondaries" to the level.

PLUCKING.

59. *Fine* plucking consists in taking two leaves and a bud. *Medium* plucking consists in taking two leaves and a bud together with half the third leaf. *Coarse* plucking consists in taking three leaves and a bud. With fine plucking a low yield only, but a good quality tea, is obtained. Coarse plucking gives a high yield of poor quality.

60. It is usual to pluck to one leaf above the "fish" leaf and to keep the bush free of "banjhi"; if the latter is not done the flush fails as a result of "choking" with coarse leaves. ("Banjhi" is a leaf together with a stunted bud; this usually gives no further growth).

61. The period elapsing between plucking rounds varies with elevation, rainfall, "jat" of tea and soil conditions.

62. The quality of the leaf depends on the rate of growth and on the type of plucking. The best quality of leaf is plucked in the period of slow growth (that is, January, February and March).

63. The plucked leaf is picked over before withering and all coarse leaves and stalks are removed.

64. The leaf is sent to the factory at noon and again in the evening. In some cases three times daily. It is essential for the leaf to arrive at the factory in an unbruised and unheated condition.

65. Baskets are used as receptacles for the plucked leaf, cloths are not allowed as the leaf becomes heated and bruised when these are used.

66. The quality of leaf falls off the further from the bud. The stalk, particularly below the second leaf, is of poor quality, so that the inclusion of the third leaf with the accompanying stalk considerably reduces the average quality.

67. Close plucking towards the end of the pruning cycle gives the thickest and most pungent liquors.

MANUFACTURE.

68. *The factory.*—The position of the factory should be such that it receives the maximum advantage from the prevailing air movements, so that a good natural wither

may be obtained. Other important factors are those of transport and water supply.

General plan.

69. The ground floor is divided into—
(1) Rolling and fermenting room;
(2) Firing room;
(3) Sifting and packing room.

The withering lofts are above. On a number of estates in South India outside withering sheds are used when a good natural wither is obtainable.

70. The withering lofts are constructed on either side of a central mixing chamber which is immediately above the driers, so that, when the atmospheric conditions are such that a good natural wither cannot be obtained, a system of artificial withering may be employed. The hot air is drawn through the lofts from the central chamber by fans.

71. Any system of artificial withering must allow of perfect control.

72. *Withering.*—A natural wither is preferred to that obtained artificially. The extent of the use of the hot air varies with the time within which it is considered necessary to obtain a wither and, in addition, with the amount of withering space available.

73. The leaf is spread evenly on racks in the withering loft or shed, at the rate of 1lb. green leaf to 12 to 15 square feet; in a few instances 9 square feet is considered sufficient. The racks consist of open meshed jute hessian or wire netting stretched over a wooden frame. The wire netting is used a great deal on account of the upkeep being far less than that of hessian; the general opinion, however, is that the hessian gives the more even wither; when wire mesh is used the leaf tip hangs through and is withered more rapidly than the rest of the leaf finally becoming dry and powdery, and lost in rolling. A very fine wire mesh would get over this difficulty.

74. There are two processes involved during withering, the loss of water from the leaf (physical wither) and the breakdown of the tannin complex to astringent tannins (chemical wither). The chemical action only occurs when

the turgor of the cells has been reduced to a certain point (roughly corresponding with a 70 per cent. wither).

75. The ideal wither is obtained when the times of completion of the physical and chemical withers coincide.

76. The extent of the wither aimed at varies from *50 to 55 per cent. in Ceylon, and in South India 53 to 62 per cent. The lower figures in each case represent a "hard" wither, a 65 per cent. wither is considered a "soft" wither, 60 per cent. being "light." The figures given for the "hard," "soft" and "light" withers are somewhat relative; conceptions of these terms in respect of percentage of wither vary.

77. The speed of the chemical action depends on temperature and is almost entirely independent of the degree of humidity, so that under natural conditions the chemical wither takes longer at the higher elevations.

78. On neighbouring estates at the same altitude which were visited, the time considered necessary for a good wither varied. The minimum time at 3,000 to 4,000 feet was 18 hours, this being obtained in dry weather; other estates at the same elevation kept the wither back to 30 hours by closing windows in the loft or by spraying with water. Thirty-six hours seemed to be the maximum and this only in bad weather; even at 36 hours there is a possibility of sourness.

79. If hot air is used to obtain a wither the temperature in the loft should not be above 90° Fahr.; temperatures of 100° to 110° Fahr. are detrimental to good teas, there being a loss of flavour. The midday loft temperature for withering under natural conditions is usually 72° to 75° Fahr. at 3,000 to 5,000 feet.

80. The following are sound indications of a good physical wither:—
(1) The withered leaf when squeezed in the hand feels like a kid glove, and on releasing the pressure opens only slightly.

*These figures are obtained in the following manner, if 100 lb. fresh leaf dries to 55 lb. this is referred to as a "55 per cent." wither.

(2) The stalk when bent completely back is sufficiently flaccid not to break.

(3) A brown colour is developed in the veins.

(4) "Nose"—a smell similar to that of ripe apples—is developed.

81. *Rolling and fermenting room.*—The rolling room should be situated in the cool part of the factory. It should be well ventilated and insulated from the heat of the drying room. The humidity of the atmosphere in the rolling room is maintained at 90 to 95 per cent., or as near as possible to that range. The difference between the wet and dry bulb thermometer should be as near 2° Fahr. as possible in the area in which fermentation is carried out. It is usual to protect the rolling room from the direct rays of the sun by darkening the windows.

82. The floor of the room in every case is of cement, in some cases white tiles are fitted under the roll-breakers.

83. It is generally recognised that one roller is required for every 100,000 lb. of made tea per year, and that one roll-breaker is necessary to every 3 or 4 rollers.

84. It seems a general practice to put the green leaf over the roll-breaker before rolling in order to remove any stones, etc., which may be in the bulk.

85. By rolling the leaf is bruised, the cells ruptured and the sap in the leaf is spread over the leaf surface; consequent upon this oxidation of the tannin commences (yielding brown products) and fermentation is started. Flavour, which is considered to be dependent on the essential oil content, is also developed.

86. The upper limit of temperature during rolling is 82° Fahr. If the temperature rises above this, there is a loss of pungency and body in the liquors; the heat causes the oxidation of the tannins to proceed too rapidly, involving loss of quality.

87. Forty-five revolutions of the rollers per minute is the usual rate, in one or two instances this was increased to 55 at the second or third roll.

88. The amount of rolling depends on several factors, the wither, climatic conditions and the particular tea required. When rolling to obtain the maximum flavour during the "flavour" period, light rolling is done, *e.g.*, four rolls of 30 minutes with no pressure on the first two rolls, light pressure on the third and increased pressure on the fourth. For strength, longer rolling is necessary and more pressure is applied, *e.g.*, eight rolls of 30 minutes with no pressure on the first roll increasing gradually to heavy pressure on the last roll.

89. Light rolling does not stain the tip; this type of rolling is suitable for soft withers. Hard rolling is necessary on hard-withered leaf in order to express the juice for oxidation. For a medium wither a common type of roll is as follows:—

1st, 30	minutes,	no pressure.
2nd, 30	,,	slight or no pressure.
3rd, 30	,,	half pressure.
4th, 30	,,	full pressure.

The pressure is not maintained throughout the period given but released at intervals to allow of cooling.

90. After each roll the leaf is put over the roll breaker. This is done to separate the "fines," to cool the bulk and to break up the small masses. The mesh employed in the roll breaker is usually six, but it is quite usual for a piece of four mesh to extend over the latter quarter of the breaker.

91. The "fines" (that going through the mesh) from each roll are fermented separately. The "big bulk" is rolled again in each case until the number of rolls is completed, the last big bulk is then fermented for a short time only.

92. *Fermentation.*—Fermentation refers to the conversion of the tea tannin to red and brown tannins and to the development of aroma. The process is considered to be mainly oxidation, but a secondary fermentation occurs.

93. The fermenting room should be well ventilated and the air as still as possible with no direct air currents on the leaf. The humidity should be as near saturation point as possible without actual deposition, that is, 95 per cent.

corresponding to a difference of 2° Fahr. between the wet and dry bulb thermometers. This degree of saturation is usually maintained by humidifiers or by placing hessian round the walls and keeping it moist, and keeping the floor wet. In cases where the leaf is fermented in trays these may be covered with wet hessian, but the hessian must not touch the leaf.

94. In a humid atmosphere "red" tannin is produced which gives the bright colour to the fermented leaf; under insufficiently humid conditions brown tannin is produced.

95. The process is considered to be most efficient between the temperatures of 75° to 80° Fahr., but this is rarely, if ever, attained under ordinary conditions at altitudes of 3,500 to 4,000 feet or over. Above 80° Fahr. taints appear due to bacterial action; in addition, oxidation is in advance of the development of aroma. Below 75° Fahr. the development of aroma is slow.

96. At elevations of 3,500 to 4,000 feet, the morning temperatures of the fermenting room are about 60° Fahr., at midday 70° to 75° Fahr., and fermentation proceeds slowly. In one case a method of introducing steam into the fermenting room was tried but met with no success.

97. In the majority of cases the leaf is fermented on the cement floor; tiers of tables of glass or asbestos are also used; glass, however, has not proved successful in some instances. The leaf is spread at thicknesses varying from 2½ to 6 inches, 3 inches being the more general. Thick spreading (6 inches), although raising the temperature, in no way hastens the process, owing to lack of oxygen. The leaf is usually turned every 30 to 40 minutes.

98. The leaf is considered to be ready for firing when in the main it is of a bright copper colour but with a slight indication of the green colour remaining. The "nose" is difficult to describe; it resembles the odour of a strong solution of salt in water. The colour obtained in fermenting is a very good indication of the colour of the infused tea.

99. In stating below the time taken for fermentation, it refers to the time taken from commencement of rolling to the commencement of firing of the big bulk. The

necessary colour is obtained in less time in the "fines" than in the big bulk. The period of fermentation should be short if briskness and pungency are to be maintained, for strength and colour a longer fermentation is necessary, *e.g.*, in mid-country Ceylon, 3 to 4 hours. For flavour during the flavour period of the year (that is, January to February in South India when slow growth occurs), 3 to 3¼ hours is the usual period. The following are approximate times taken at the given temperatures (Fahr.):—

	75°	—	3 hours
	70-75°	—	3¼ „
	65-70°	—	3½ „
	60-65°	—	3¾ „
under	60°	—	4¼-4½ „

100. It is recommended not to ferment for longer than 4½ hours; overfermenting results in dull liquors coloury but flat, and lacking in briskness and pungency. The fermentation may be tested by firing at intervals and liquoring.

101. In some instances during the flavour period of the year, a very short roll is done after fermenting, this being considered to give twist to the leaf and to maintain quality and flavour.

102.—*Firing.*—The firing room should be easy of access from the rolling and fermenting rooms. The object in firing is to arrest fermentation and to drive off excess moisture (the moisture content of the leaf is reduced from 50 to 60 per cent. to 3 to 5 per cent. during firing). The lowest temperature in the leaf mass at which the process of fermentation is stopped is considered to be 120° Fahr.

103. The temperature at which firing is done varies between 160° Fahr. and 240° Fahr.; 180° Fahr. is the most common. The temperature should be high enough to avoid stewing and yet not sufficiently high merely to case-harden the leaf. If stewing occurs there is a loss of essential oil. The leaf may be completely fired by passing through the drier once or the leaf may be three-quarters fired first and then fired a second time at a lower temperature. The latter method is considered to preserve flavour.

104. The leaf when fired should "needle well," the big leaf should go to dust when pressed between the fingers but should not possess a "burnt" smell. Overfiring as

indicated by the burnt smell results in low quality and soft liquor, together with a loss of aroma.

105. It is essential to spread the leaf thinly in the driers. The fired leaf should be allowed to dry quickly. During sorting there is an absorption of moisture and in many cases a final firing is done immediately before packing; this is done at a lower temperature.

106. *Sifting and grading.*—The sifting room should be fairly large; the floor should be of cement. The systems of sifting vary and in addition there is no definite standard for any particular grade.

107. In order to facilitate grading the "fines" from the first, second and sometimes the third roll are fired separately—these give the Broken Orange Pekoe and Broken Pekoe. The following are the chief grades:—

Broken Orange Pekoe Broken Pekoe ... Fannings	Broken grades.
Orange Pekoe ... Pekoe ... ... Pekoe Souchong ... Dust...	Leaf grades.

Evenness and freedom from dust in all grades is essential. Too much handling causes greying of the leaf. The Broken Orange Pekoe and Broken Pekoe are obtained from the fine bulk; more Broken Pekoe is obtained after the coarse bulk has been cut. These two grades are separated by a 10 or 12 mesh, the Broken Orange Pekoe going through. Tannings and dust are removed from each grade by a 14 or 16 mesh.

108. Broken grades:—

Broken Orange Pekoe should be of good colour (no greying) and show "tip." It consists of the bud and the small and medium sized leaf.

Broken Pekoe consists of a slightly larger leaf than the Broken Orange Pekoe. There should be no "tip" or indication of stalk.

Fannings.—In some cases two grades are made, that from the fine bulk being kept separate from that obtained from the coarse bulk. This grade goes through a 14 or 16 mesh.

109. Leaf grades:—

Orange Pekoe the actual constituent depends on the rolling. If the leaf has been subjected to hard rolling it consists of leaf stalks and mid-ribs; if the rolling has been light it contains rolled leaves in addition. It should be free from brokens. This grade is obtained from the coarse bulk by putting over 10 or 12 mesh, the Orange Pekoe going through with some Broken Pekoe. The coarse bulk is cut after the Orange Pekoe has been separated. The grades required determine the size of the cutter to be used. ($\frac{1}{4}$, $\frac{1}{2}$ or $\frac{3}{4}$ inch are the sizes of the cutters employed). Additional Broken Pekoe is obtained from the cut leaf by separating with a 14 or 16 mesh.

Pekoe this grade is separated by an 8 mesh.

Pekoe Souchong this grade passes over an 8 mesh. The various grades are cleaned by putting—

Orange Pekoe over a	10	mesh.		
Pekoe	,, ,,	10	,,	
Broken Pekoe	,, ,,	16	,,	
Fannings	,, ,,	30	,,	dust going through.

DISEASES AND PESTS.

110. The following is a list of the more important diseases and pests of tea in Ceylon and South India. (The diseases are fully dealt with in "Diseases of the Tea Bush" by Petch (MacMillan & Co.).

CEYLON

Root Diseases.

(1) Red Root Disease. *Poria hypolaterita.*—Serious. It spreads through the soil being present originally on jungle stumps.

(2) Brown Root Distase. *Tomes lamoensis.*—Distinguished by the adherence of soil to the infected root, and patches of light brown mycelium.

(3) *Ustalina zonata.*—Distinguished by fan-shaped masses of mycelium under the exodermis of the root.

(4) Black Root Rot. *Rosellinia arcuata.*—Distinguished by patches of black mycelium on the exterior of the infected root.

Leaf Diseases.

(5) Brown Blight. *Glomerella cingulata.*—Rarely on the "flush."

Stem Diseases.

(6) Red Rust. *Cephaleuros mycoidea.*—This is caused by an alga. It occurs on nursery plants in areas insufficiently shaded.

(7) "Bitten-off" disease of seedlings. *Rhizoctonia* spp. The young rootlet is attacked and the growing point destroyed—the young rootlet assumes a stunted appearance.

Pests.

(1) *Calotermes militaris; Calotermes greenii; Calotermes dilatatus.*—These three species make their galleries in the main stem of the tea bush. They can be controlled by introducing Paris green into the galleries.

(2) Shoot-hole borer. *Xyleborus formicatus.*—This is present on *Erythrina lithosperma* and *Glyricidia maculata* as well as Tea, so that its direct control is impossible. The pest is limited in its incidence on tea by improving the standard of cultivation and so increasing the vigour of the tea bush to withstand attacks. The borer attacks chiefly the younger branches finally causing their death by hollowing out the internal tissues.

(3) Tortrix. *Homona coffeana.*—This in the grub stage attacks the young "flush."

(4) Nettle Grubs. (a) *Spalulicraspida castaniceps;* (b) *Parasa lepida;* (c) *Thosea necta.*

South India.

The root and leaf diseases together with the "Bitten-off" disease of seedlings are present in South India.

The pests mentioned as being present in Ceylon were not encountered in South India but in certain districts the Mosquito Blight (*Helopeltis*) is prevalent. The eelworm is a serious pest in the nurseries, biting off the lateral roots of the young seedlings.

(In dealing with the root diseases of tea, the more general view as to the causative fungi has been taken, as it has not been possible to obtain details of the most recent work on the theory that *Rhizoctonia* sp. is the original fungus in each case of root rot).