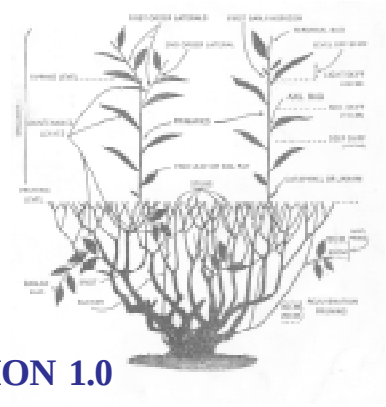
THE PLANTERS' HANDBOOK



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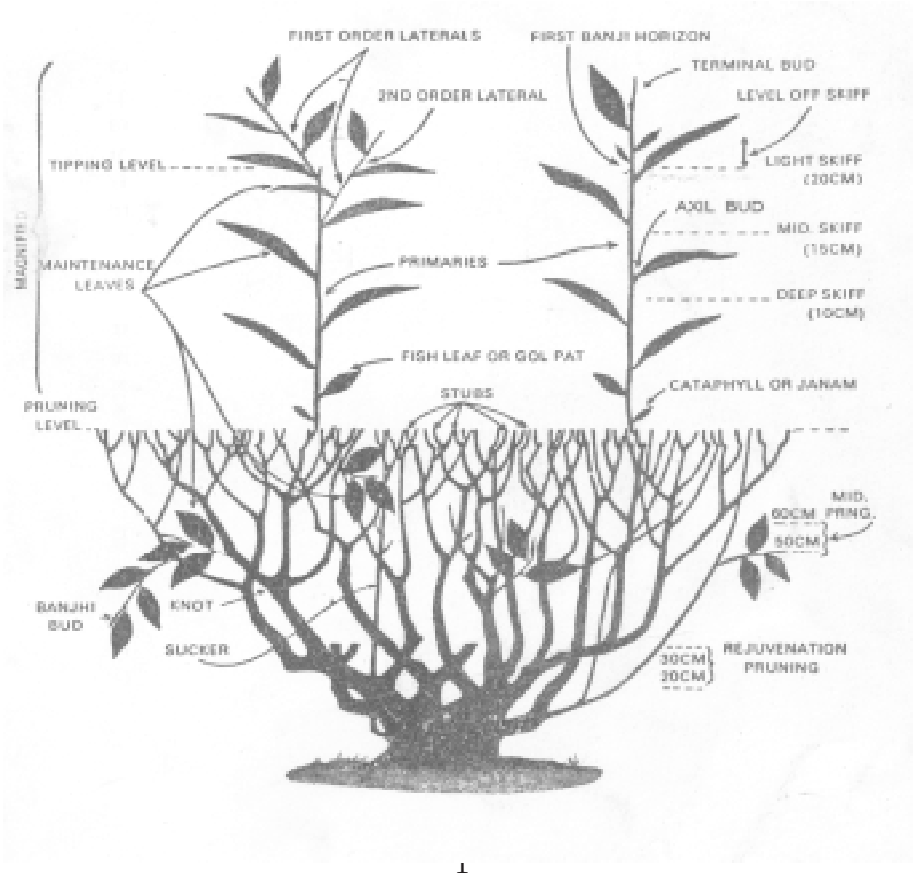

Preface to the Digital Version

TRA publications, particularly the Planters' Handbook have been in great demand over the years. During recent times due to rise in printing and associated costs, we could not fulfill the requirements of these publications. Moreover, some concepts have undergone considerable change and there has been a shift in priorities in the tea industry. All these have made us to look for an economic version of these publications which can be quickly and easily updated for the benefit of tea growers. The publication has been brought out for the first time in CDs with convenient navigation facilities. The credit of the outcome goes entirely to Dr. U. George and Mr. Manik Paul (Planning and Information Technology Department), who have critically examined the need of the users by inviting opinions from a cross-section of people who involved in these publications, both contributors and readers. Ms Shakuntala Dutta's critical proof-reading must be highly appreciated. I am sure this Version -1.0 of the publication will fulfill the requirement of those who are associated with tea industry. The process of improvement will continue after we receive feed back from the users. I am privileged to present the electronic version of the The Planter's Handbook on this special occasion of 34th Tocklai Conference .

M. Hazarika
Director

28 November, 2005

PREFACE TO THE 2nd EDITION

The Planters' Handbook was first published in 1979 to provide technical information and guidance in a simple and concise manner to those involved in the various aspects of tea plantation, cultivation and manufacture, The publication was found to be of immense utility by the readers and was in good demand. The entire stock of the publication was exhausted by 1994-95.

Since its publication there have been some changes and/ or improvements in the field management practices and processing technology of tea. The scientists of TRA were requested to update the respective chapters of the handbook. The scientists have made every effort to update the publication to make it more comprehensive. However, before final printing, it was critically examined by Mr. G. R. Bagai, Chairman of the Agriculture Committee, Mr. R. Chaliha, Chairman of the Engineering Committee, and Dr. S. Sarma, Secretary, TRA. The relevant suggestions put forward by them were also duly considered and incorporated. I extend my sincere thanks to all of them.

I hope that the revised edition of the Planters' Handbook will be useful as a technical guide to all concerned.

1996

B.C. Barbora
DIRECTOR
TEA RESEARCH ASSOCIATION

FOREWORD

This publication is aimed at the people who are helping to make the Indian Tea Industry one of the largest in the world.

It is not an academic treatise. But a practical, concise, detailed and handy guide book for everyone involved in tea, serving in various fields from plantation to manufacture.

It is in essence a concentration of technical information available over a very broad and very scattered spectrum of sources. The Tocklai Encyclopaedia, the various Memoranda and "Two & a Bud", are some of them. I would like to thank the Editorial Committee, the scientists at Tocklai and all others who took active interest in the publication. Particular thanks are due to Mr. J.P.F. Furst, who made this enormous research, collation and compilation possible.

We hope that the publication will be of extensive use among tea-men all over.

Sumat Prashad
CHAIRMAN
TEA RESEARCH ASSOCIATION

1979

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CHAPTER I

ESTATE INFORMATION

CHAPTER I

ESTATE INFORMATION

Section 1. LAND HOLDINGS AND SURVEYS

1.1 Forms of settlement from Govt. to tea plantations

a) Fee simple grant (rare)

b) Waste land application (obsolete)

c) Special cultivation (tea) grant (must)

The estate includes these, but areas for tea and ancillary purposes have special rates of revenue.

1.2 Grant documents (pattas) or copies thereof are kept in the estate. Govt. land records are kept by the District Settlement Officer who will issue extracts from records and revenue receipts (Jamabandis).

In Assam, village revenue staff (mandol), in W. Bengal, .Junior Land Revenue Officers and in other states B.D.O./Circle Officer or his representative will verify land matters. Land records affecting estates may also be kept by Assistant Settlement Officers at Sub-divisional Head Quarters.

1.3 The rights of a land holder

a) To renew his grant

b) To enjoy "easements", including free access to his grant and free drainage over others' land.

These rights can be

i) Obtained in writing with the land grant

ii) Implied in the land grant (when there is no public access and no other drainage means)

iii) Acquired by 20 yrs' free use.

N.B. These rights are to be exercised on fixed alignments. Where roads or drains are to be moved, consent of concerned land holders is required.

c) To utilize timber, if purchased at the time of settlement

1.4 Duties to other land holders — to give access to their grants, allow their drains to flow.

1.5 Services offered by Govt. approved Surveyors

a) To produce or up-date the grant map from the Govt. Cadastral Survey and Mark boundaries.

b) To produce estate maps showing boundaries, estate facilities and tea areas (with area statements).

c) To produce maps with a grid of spot levels and/or contour lines.

d) To produce detailed maps showing extensions, replanting, buildings, as required.

1.6 Assam Land Measures

2 hath x 2 hath = 4 sq cubits = 9 sq ft =1 kani = 1 sq yd

16 kani = 1 locha = 144 ft^2 = 13.38 sq Metres (m^2)

20 locha = 1 Katha = 2880 ft^2 = 267.6 m^2

5 Katha = 1 Bigha = 14400 ft^2 = 1337.8 m^2

4 Bigha = 1 Pura = 57600 ft^2 = 5331.2 m^2 = 0.53 ha

1 acre = 3.025 Bigha (3 Bigha $2^1/_2$ locha) = 0.405 ha

8 hath = 12 ft = 1 nal length

12 ft x 12 ft = 1 nal area = 1 locha

1.7 Bengal Land Measures

45 ft^2 = 1 chhatak

16 chhataks = 1 Katha = 720 ft^2 = 66.89 m^2

20 Katha = 1 Bigha = 14400 ft^2 = 1337.8 m^2

1 acre = 3 Bighas 8 chhataks

12 ft x 12 ft = 1 tang (Darjeeling)

1.8 Standard Land Measure

1 acre = 0.40469 ha, 1 ha = 2.47105 acres

Section 2. LAND DRAINAGE

The root zone of tea requires aeration for optimum growth and production.

Poor drainage or waterlogging results in a crop loss of 15-40%, poor response to fertilisers, susceptibility to diseases, weed growth and proneness to moisture stress. Development of drainage pattern can be expected to result in 10-15% crop increase.

2.1 Objectives

a) To ventilate the root zone by lowering the water table. This can be checked with piezometers or open wells, at least 1.0 m deep installed midway between two lateral drains.

b) For safe disposal of surface runoff water for prevention of soil loss. This can be observed by looking for traces of soil wash.

2.2 Definitions

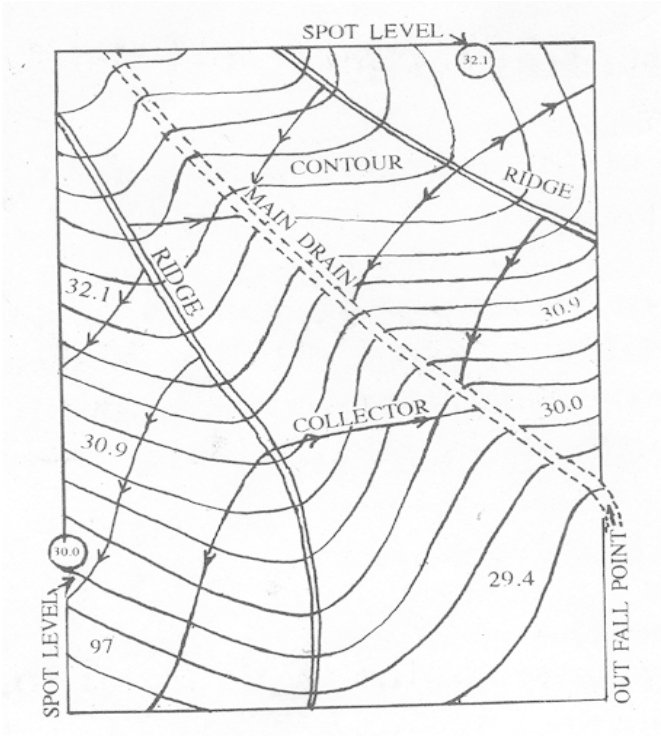
Catchment	:	The area bounded by ridges and discharging at one point.
Outfall/Outlet	:	The point to which water from a catchment discharges out.
Main drains	:	Roughly follow lines of natural drainage and are large enough to carry excess water from the catchment.
Collector drains	:	Collect water from field drains and discharge on to the main drain.
Field drains	:	Intercept seepage and collect surface water.
Contours	:	Imaginary lines drawn by joining the points of same elevation with reference to certain datum line.

2.3 Steps for making a drainage scheme

a) Contour map should be drawn with contour interval 30 cm for flat land and 1 m for steep topography. Scale of the map should be as follows :

Area	Scale
Upto 120 ha	1:1000
120 ha to 240 ha	1:2000
above 240 ha	1:4000

b) Obtain spot level along the grant boundary.



c) For each catchment develop main drain following natural water course starting from the outfall. Avoid sharp bends.

d) Provide collector drains, along the slope, one for each sub-catchment.

e) Mark laterals or field drains across the slope (in flat lands).

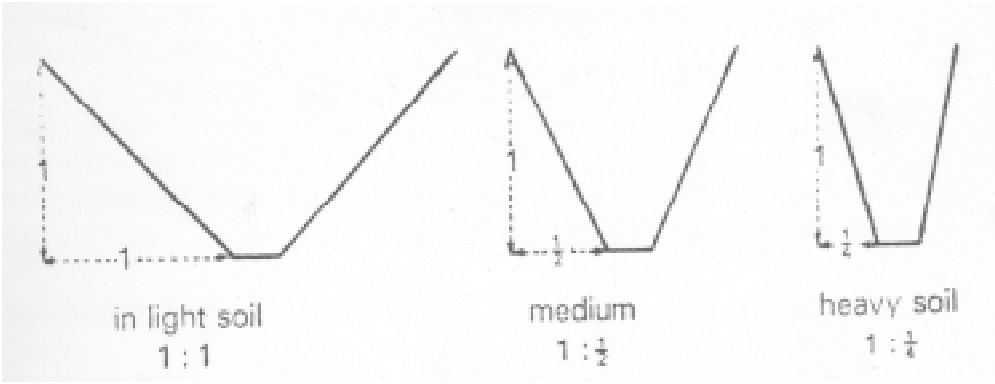
f) Provide bed gradient of the drains from highest point to the outfall point.

2.4 Drain Design

a) Dimensions of various drains are given below :

Drains	Minimum depth, cm	Minimum bottom width, cm	Minimum bed gradient
Field	105	25-30	0.25%
Collector	120	30-50	0.15%
Sub-main	150	50-150	0.10%

b) Batter the slope (upward from the drain bottom)



c) Spacing of field drains in flat land (upto 3% of slope of land)

Texture	Assam	Dooars
Clay loam	9 m	6 m
Silty loam	12 m	9 m
Loam	15 m	12 m
Sandy loam	18 m	15 m
Loamy sand	30 m	25 m

d) Spacing of field drains on slopes along contour for land slope more than 3%

Graded contour drains are provided for the purpose of conservation of soil. The spacing of the drains varies with variance of rainfall and can be calculated with the following formulas for medium texture soil:

i) Rainfall below 2500 mm :

$$\text{Vertical interval in metre (VI)} = \left(\frac{\text{Percentage slope of land}}{4} + 3\right) \times 0.3048$$

ii) Rainfall between 2500 mm and 4000 mm :

$$\text{Vertical interval in metre (VI)} = \left(\frac{\text{Percentage slope of land}}{4} + 2\right) \times 0.3048$$

iii) Rainfall above 4000 mm :

$$\text{Vertical interval in metre (VI)} = \left(\frac{\text{Percentage slope of land}}{4} + 1.75\right) \times 0.3048$$

Adjustment should be made in vertical interval for soil other than medium texture as follows :

Soil type	% Adjustment
i) Coarse texture (sand and sandy loam)	+12 to +20
ii) Moderately/coarse texture (sandy loam)	+ 4 to +12
iii) Medium texture (loam & silt loam)	+4 to -4
iv) Moderately fine texture (silt loam, silty clay loam)	-4 to -12
v) Fine texture (silty clay and clay)	-12 to -20

Bed gradient for the contour drain should not exceed 0.2%. Bed width should be 30 cm and depth should be 30-45 cm.The lower edge of the drain should be raised to collect runoff and prevent soil wash. The end of the drain should be connected to natural water course.

2.5 Lack of gravity or natural outfall can be overcome by developing artificial outfall by pumping.

2.6 Special purpose drains

a) Boundary drains — prevent entry of outside water into the tea area.

b) Interceptor or isolating drains - develop 1.5 m deep cutoff drain to intercept seepage where a slope meets the flat land.

c) Pipe drain - install 10 cm diameter sub-surface or pipe drain when it is difficult to maintain open drain in loose texture soil with 6-12 mm size pea gravels used as filter around the pipe to a thickness of 7.5 cm. Installation depth should be about 1.5 m below ground level with a bed gradient of 0.2%.

d) Sump - sump or reservoir be created to facilitate operation of the pump.

2.7 Drain construction

Digging of drain should be taken up during winter when soil moisture content is low.

Digging should be started from outfall end and upward. Excavated materials should not be left on the banks of the drains.

Deepen the culvert beds at least 15 cm below the drain beds.

At junction points, drains should meet gradually along the direction of flow.

Section 3. SOIL

3.1 Classification by particle size

Soil type	Clay less than 0.002 mm	Silt 0.002 to 0.02 mm	Sand greater than 0.02 mm	
Loamy Sand	10-15%	0-30%	70-85%	LIGHT
Sandy Loam	15-20%	0-50%	50-70%	---
Loam	5-25%	25-50%	30-50%	MEDIUM
Silty Loam	0-25%	50-80%	20-50%	---
Clay Loam	25-40%	15-55%	20-45%	HEAVY

A crude test: Fill a straight sided clear drinking glass half full with soil plus water to the top. Thoroughly shake and allow to settle for one hour. Sand will be at the bottom, clay will remain in suspension. The fine layer over sand is silt.

3.2 Classification by structure

Free running from edge of hoe when dry : crumbs

A crude test to check on the desirable crumb structure :

Roll moist (not wet) soil into a 3 cm ball, drop onto a hard surface from a height of one metre. With well structured soil the ball will break.

3.3 Classification by profile

A vertical section is made at a drain edge or with a special pit. Top soil and sub-soil are distinguished by colour and depth recorded Pans, if any, are identified and depth recorded.

3.4 Soil samples for analysis by TRA

a) Method

Collect with a 2.5 cm. auger, top soil 0-15 cm. depth and sub-soil from 16-30 cm. depth in the same boring. Take 10 random borings per hectare to represent the area.Top soil samples to be bulked together, mixed thoroughly and reduced to $^1/_2$ kg. Also bulk and mix subsoil samples separately, $^1/_2$ kg top soil and $^1/_2$ kg sub-soil represent one ha. Collect sufficient samples to represent the whole area.

b) Despatch in tins, wooden boxes or strong doubled polythene bags, individual containers to be labelled both inside and outside, giving the estate name, section number and whether top or sub-soil. Covering letter

(of which a copy should be in the package) must give the purpose of the test — (for nurseries, only pH and eelworm tests are done; for planting, pH, organic matter and available potash; for problem areas, requirement of amendments and available nutrients), the land use history and recent field practices.

c) Time for taking samples

For pH value and eelworm, any time of the year but not within 2 months of fertilizer application to ground.

N.B. If soil samples are taken to prepare a fertilizer programme these must be taken during cold period before the intended time of fertiliser application.

d) Interpretation of results

Eelworms	—	No more than 6 for 10 g of soil is suitablefor nursery. Soil with 7 eelworms for 10 g or more requires treatment (**See Chapter II, 4.3**).
pH value	—	Tea grows well at 4.5 to 5.5, above and below this range, the value should be adjusted (**See 3.5 d**).
Organic matter	—	Expressed in % of organic carbon. A rich soil has 2% Org. C. Soils below 1% need attention (**See 3.5 b**).
Available P_2O_5	—	On a scale of 5-50 parts per million, 35 plus is adequate. Below this, remedial application of phosphatic fertilizer can be done in agreement with TRA recommendations.
Available K_2O.	—	On a scale of 10-100 ppm, 100 and plus is adequate; below this, remedial doses of potash fertilizers should be applied.

3.5 Soil improvements

a) Physical : by ground cover (tea or special crops), mulch, pruning litter

b) Organic matter : mulch, pruning litter retention, well rotted cattle manure and oil cakes (in cold weather)

c) Nutrients : fertilizer programme

d) pH value

Tonnes of fine (80-100) mesh limestone or dolomite required per hectare to raise pH value by one unit :

Sandy Loam	Loam	Silty Loam
1.25	2	3

Kg of fine mesh sulphur required per ha to lower pH by one unit

Sandy Loam	Loam	Silty Loam
500	700	900

Say 75 g per square metre sulphur to be forked in. In place of sulphur, 6 x the quantity of aluminium sulphate can be used.

3.6 Soil Rehabilitation (also see Chapter V, 3.5)

Dense (60 x 40 cm) cover of deep rooting grasses (Guatemala or Pusa Giant Hybrid Napier) is ideal, giving :

a) Ground cover

b) Soil restructuring by root penetration (1 m or more) “the green plough”

c) Green matter (say 100 tonnes/ha/year) from lopping — the ideal mulch

d) An indication when soil is ready to receive new tea plants — soil is not ready until grass crop is 2 m tall and heavy at the collar

3.7 Soil Conservation

a) Prevention of soil wash : ground cover and contour drains, contour planting, mulch

b) Prevention of drying out : ground cover, shade, mulch

c) Bare soil protection by cover crops : Guatemala grass, Pusa hybrid napier, *Mimosa invisa,* Citronella grass, any legume

d) Stop soil stirring/hoeing : use chemical weed control.

e) Edges of water courses (holas, jhoras) and unstable soil are lined with deep rooted trees or rested tea.

f) Spurs for bank erosion by streams/rivers

3. 8 Special conservation measures on steep slopes

a) Ridge tops should carry forest.

b) When clearing forest for extension or old tea for replanting, the clearing should

be in strips along the contour, maximum width 50 cm on steep slopes and 100 cm on moderate slopes. Forest or good tea should be present above the cleared strip.

c) Contour bunds can be added to contour drains.

d) Contour planting and heavy mulching.

Section 4. CLIMATE

4.1 Useful records

a) Rainfall : Rain gauge with diameter matched to measuring glass, level rim, 30 cm from ground, unobstructed, emptied and measured in millimetres at 8.30 a.m. I.S.T. every day. Recorded daily, weekly, annually and 20 yr. average.

b) Maximum/minimum temperatures are read from special thermometers.

c) Dry bulb and wet bulb temperatures are read from a special thermometer. The bottle on the wet bulb to be kept full of rain (distilled) water and the cloth to be clean. These thermometers are best kept in a louvred box (Stevenson screen).

d) Approximate number of hours sunshine, variable and overcast recorded every evening.

(also see T.E. Serial 17/6 and 29/1 under A6).

4.2 Drought

When there is more water transpiration from leaves than roots can draw from the soil, defence measures :

a) Use relatively resistant materials :

In plains : TS 449, TS 464, TS 397, TS 463, TS 462, TS 506 TV 14, TV 16, TV 17, TV 20, TV 22, TV 23, TV 24, TV 25, TV 26, Teen Ali 17/1/54

In hills: TS 378, TS 379, AV 2, BB 157, T 78, P 1258, P 312, RR 4/5, TTV 1, Th2, Th9, T145, T383, Sundaram

b) Build good roots with deep drains and balanced fertilizers (check on available potash — areas with less than 100 ppm K_2O cannot resist drought damage and recover very slowly).

c) Use mulch to preserve soil moisture. Priority should be given to young tea and infills.

d) Improve permanent shade.

e) Irrigation :

25 mm rain equals 250 tonnes water/ha, say 110 tankers, or a 10000 1/hr pump running for 25 hours.

4.3 Waterlogging

When water fills the pore space of the soil in the root zone

Diagnosis : 1 m deep inspection pits in suspect areas

Remedy : better drainage, starting from outfall point

4.4 Flooding

When water lies on the surface for more than 3 or 4 days

Remedy :

Raise level of soil in the collar region by filling saucers and bringing in soil, protect vulnerable areas with bunds, check on drainage out fall.

Flood damage repairs :

Silt deposits are fork hoed, poor growth or dieback treated with rest, very light plucking and additional NPK fertilizer.

4.5 Intensive rainfall

Prevent damage with soil conservation measures (**see 3.7**)

4.6 Water conservation

Blocking of drains as soon as water table has fallen below the root zone and dry weather is foreseen.

CHAPTER II

PRODUCTION OF PLANTS

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PRODUCTION OF PLANTS

Section 1. CHOICE OF PLANTING MATERIALS

1.I Tocklai released TV (Tocklal Vegetative) clones for plains

a) Standard clones (above average yield and quality)

Most preferred : TV1. TV14, TV16, TV17,TV20, TV24.TV27, TV28

b) Quality clones (high quality but average yield)
Most preferred : TV21

c) Yield clones (high yield but average quality)
Most preferred : TV22, TV23, TV25, TV26, TV29, TV30

1.2 TRA certified garden clones for plains Assam : South Bank (49 clones)

TRA/Amluckie 84*
TRA/Amluckie 10J*
TRA/Borahi 21*
TRA/Borahi 33**
TRA/Borahi 38*
TRA/Borsillah 24*
TRA/Borsillah 3A*
TRA/Bukhial 21*
TRA/Bukhial 46
TRA/Cherideo Purbat 23*
TRA/Dahingeapar 24/18*
TRA/Digulturrung 2/14*
TRA/Dilli 11*
TRA/Dilli 36*
TRA/Dilli 62*
TRA/Dilli 72*
TRA/Dinjoye 16*
TRA/Dooria 4*
TRA/Dooria 15*
TRA/Gabroo Parbat 19*
TRA/Gatoonga 20*
TRA/Gatoonga 30*
TRA/Gopalkrishna 18*
TRA/Gopalkrishna 31*
TRA/Heeleakah 22/14*
TRA/Heeleakah 23/14*
TRA/Heeleakah 23/15*
TRA/Heeleakah 23/19*
TRA/Heeleakah 23/36*
TRA/Hulwating 12*
TRA/Hulwating 15*
TRA/Kaliapani 1*
TRA/Kaliapani 20*
TRA/Kaliapani 37*
TRA/Kaliapani 25***
TRA/Koomsong 23*
TRA/Koomsong 29**
TRA/Manohari 4/16*
TRA/Manohari 6/5*
TRA/Mokrung 76*
TRA/Numbernadi 10*
TRA/Numbernadi 42*
TRA/Sangsua 28*
TRA/Sangsua 40A**
TRA/Sangsua 42*
TRA/Sangsua 6*
TRA/Teloijan 22*
TRA/Thowra 2/11*
TRA/Tingalibam 3/38*

Assam : North Bank (29 clones)

TRA/Baghmari 10*	TRA/Dhulapadang 10*	TRA/Nagrijuli 5/70*
TRA/Baghmari 20***	TRA/Dhulapadang 36*	TRA/Nagrijuli 6/24***
TRA/Baghmari 35**	TRA/Gohpur 33**	TRA/Nagrijuli 7/38*
TRA/Bormajan 2**	TRA/Kacharigaon 5*	TRA/Nagrijuli 14/75*
TRA/Bormajan 5*	TRA/Kolony 26*	TRA/Seajuli 8***
TRA/Bormajan 19*	TRA/Mazbat 107*	TRA/Seajuli 16***
TRA/Choibari 27*	TRA/Mazbat 110	TRA/Seajuli 19***
TRA/Choibari 38*	TRA/Mornai 30*	TRA/Seajuli 25*
TRA/Choibari 43*	TRA/Mornai 33*	TRA/Tarajulie 34*
TRA/DHUL 41*		TRA/Tarajulie 37*

Assam - Cachar (9 clones)

TRA/Chandighat 9*	TRA/Longai 17***	TRA/Narsingpore 18*
TRA/Lalamookh 4*	TRA/Longai 26*	TRA/Narsingpore 22*
TRA/Lalamookh 7**	TRA/Narsingpore 4*	TRA/Poloi 23*

Tripura (5 clones)

TRA/Huplongcherra 18***	TRA/Meghlibundh 11*	TRA/Meghlibundh 25
TRA/Huplongcherra 26***	TRA/Meghlibundh 20*	

West Bengal : Dooars (5 clones)

TRA/Hantapara 12*	TRA/Huldibari 19***	TRA/Turturi 22*
TRA/Hantapara 30*	TRA/Leesh River 9/34***	

West Bengal : Terai (10 clones)

TRA/Kamalpur 6***	TRA/Sanyasithan 9***	TRA/Sukna 7*'
TRA/Kamalpur 17***	TRA/Sanyasithan 10***	TRA/Sukna 23*
TRA/Mohargung&Gulma25***	TRA/Sanyasithan 27***	TRA/Sukna 25*
TRA/Sanyasithan 8***		

* Standard clone : With above average yield and quality
** Quality clone : With very high quality but average yield
*** Yield clone : With very high yield but average quality

1.3 TV clones for droughty areas in plains

TV 1, TV 14, TV 16, TV 17, TV 20, TV 22, TV 23, TV 24, TV 25, TV 26, TV 27, TV 28.

1.4 TRA certified clones for Darjeeling

Category	High elevation	Low elevation
Standard	TRA/AV2 (Balai)	TRA/Badamtam 15/263
	TRA/Balasun 7/1A/76	TRA/Phoobsering 1404
	TRA/Balasun 9/3/76	TRA/Tukdah 78
	TRA/Bannockburn 157	TRA/Tukdah 246
	TRA/Lingia 12	
	TV 14	
	TRA/Tukdah 78	
	TRA/Tukdah 135	
	TRA/Tukdah383	
	TRA/Phoobsering 312	
	TRA/Phoobsering 1258	
	TRA/Rungli Rungliot 17/144	
	TRA/Sikkim 1	
	TRA/Teesta Valley 1	
	TRA/Thurbo 3	
	TRA/Thurbo 9	
Yield	TRA/Happy Valley 39	TRA/CPI
	TRA/Rungli Rungliot 4/5	TRA/Kopati 1/1
	TV 19	TRA/Sundaram (B/5/63)
		TRA/Tukdah 253
Quality	TRA/Bannockburn 688	
	TRA/Bannockburn 777	
	TRA/Tukdah 145	

1.5 Clones for droughty areas in Darjeeling

TRA/AV2	TRA/Phoobsering 312	TRA/Thurbo 9
TRA/Balasun 7/1A/76	TRA/Rungli Rungliot 4/5	TRA/Tukdah 78
TRA/Balasun 9/3/76	TRA/Teesta Valley 1	TRA/Tukdah 145
TRA/Bannockburn 157	TRA/Thurbo 3	TRA/Tukdah 383
TRA/Phoobsering 1258		

1.6 Commonly used garden clones approved by Tea Board

Most preferred : S3A3, T3E3, P126, Teen Ali 17/1/54, N436
Others : S3A1, Dufflagur 90, Rupai 94, Rydak 2

1.7 Tocklai released biclonal Seed stocks

Stock	Parental combination**		
TS 378*	14.5.35	x	14.6.28
TS 379*	14.5.35	x	14.12.16
TS 449	TV 1	x	19.31.14
TS 450	TV 2	x	270.2.13
TS 397	TV 1	x	19.35.2
TS 462	TV 1	x	124.48.8
TS 463	TV 1	x	TV 19
TS 464	TV 1	x	19.29.2
TS 491	TV 1	x	S3A1
TS 520	TV 19	x	TV 20
TS 506	TV 1	x	19.22.4
TS 589	TV 20	x	TRA/Heeleakah 22/14
TS 557*	TRA/AV2	x	Teen Ali 17/1/54
TS 569*	TRA/AV2	x	TRA/Tukdah 78
TS =	Tocklai Stock		

* Suitable for Darjeeling and other hilly areas only.

** Supply of parental materials (generative clones) free to member estates.

All stocks are of above average quality. List of approved producers is published twice a year in every issue of Two & A Bud.

1.8 Biclonal seed stocks for droughty areas

TS449, TS464, TS397, TS463, TS462, TS450, TS506, TS378*, TS379*, TS557, TS569*.

*For Darjeeling hills.

1.9. Safety considerations

a) Proven material : Both clone and seed performances vary with local conditions. Ideally, estates should have observation plots of a wide range of materials, then, the best ones for their purpose should be chosen. To save time, materials doing well in other gardens in the same district can be used with TRA advice.

b) Clonal populations can all suffer or die at the same time. No clone/seed should exceed 10% of the total area of the estate.

c) For balanced yield and quality of the finished tea, estates should endeavour to establish approximately 45 to 50% under standard planting materials, 25-30% under very high yielding materials and the balance under materials known for their high quality.

Section 2. THE SEED BARI

2.1 Site

Barrier with tall grasses and trees between two seed baris and also between tea under plucking and seed bari is necessary. This prevents undesired outcrossing.

2.2 Spacing

It varies according to shape and size of trees as follows (with approx. plant population) :

Spreading types (TS450, TS491 TS463, TS520 and TS506)	:	5.5 m x 5.5 m (18'x18') = 330 ppha to 6.0 m x 6.0 m (20'x20') = 278 ppha
Erect types (TS397, TS449, TS462, TS464)	:	3.5 m x 3.5 m (12' x 12') = 816 ppha to 4.5 m x 4.5 m (15' x 15') = 494 ppha
Chinary types (TS378, TS379)	:	3 m x 3 m (10'x 10') = 1111 ppha to 3.5 m x 3.5 m (12' x 12') = 816 ppha

2.3 Pattern/design

For biclonal baris, alternating in both rows (chess board) except for TS 378 where 1:4 ratio of non-seed bearing to seed bearing parent to be followed, in square/triangular design (**Fig. 1**).

2.4 Establishment

a) **Direct planting :** Like commercial tea plants, but extra large pits (1 m x 1 m x 1 m) useful.

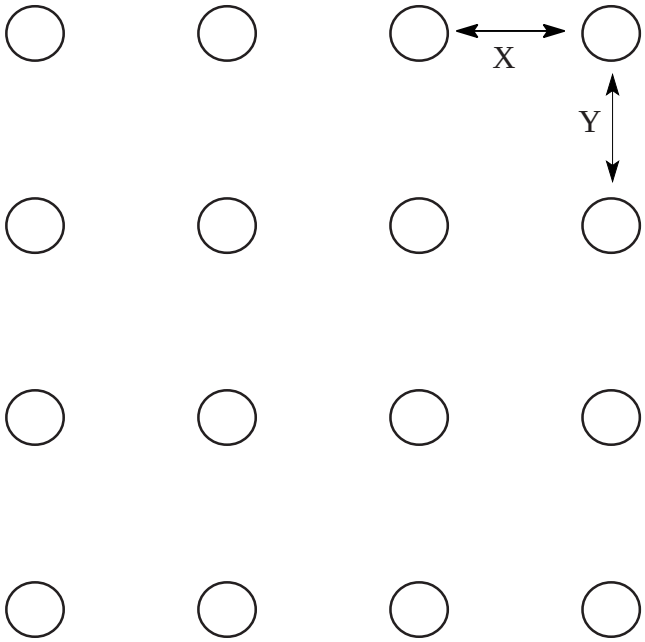
b) **Grafting :** Existing vigorous seed baris of obsolete/unwanted jats, biclonal stocks or vigorous clonal sections under plucking could be used to establish new seed baris quickly by grafting.

2.5 Bringing into bearing

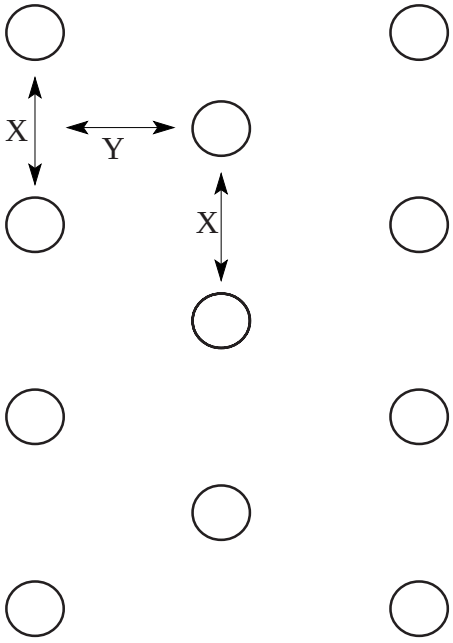
i) No pruning/skiffing and plucking except trimming the branches trailing on the ground and removal of water suckers/unproductive branches,

ii) High standard of pest control, weed control, drainage and regular inspection.

iii) **Manuring** :Upto 4th year after planting, apply YTD (Young Tea mixture D) of NPK2:1:2 or 2:1:3 depending on the available K_2O status in the soil, in the same way as in young tea. The dose per plant, varies according to the spread of the tree.



Square



Triangular

Fig. 1. Planting designs

Average spread (cm)	NPK 2:1:2 (gm/tree)	
30 cm (0 year)	20	To be
60 cm (+1 year)	90	applied in
90 cm (+2 year)	190	four splits
120 cm (+3 year)	340	
150 cm (+4 year)	530	

From 5th year onwards, apply NPK 2:1:2 mixture @ 100 kg Nitrogen/ha per year in spring during April/May. The fertilizer is to be applied in a ring till the seed trees become fully mature, and thereafter broadcast method may be followed leaving an area near the collar region.

2.6 Collection

Daily in season from October to January from clean ground.

2.7 Sorting

Discard floaters after floatation test in water overnight.

2.8 Storage

Single layer of seed on moist sand or charcoal, wrapped in plastic and boxed. Standard box of 20 kg is used as "Unit". Store shelves in dark and cool place. If required, seeds can be stored in cold storage upto one year. For this, dip seeds in 0.1% mercuric chloride solution for 15 minutes, wash thoroughly and surface dry, pack in polythene lined hessian bags and store.

2.9 Converting a seed bari

Seed bari selected for upgrading should be in good health and vigour as old and weak bushes fail to tolerate the shock of heavy cut required for grafting.

Cleft, bud, rind or composite method of grafting may be used for establishing seed baris [see Two and A Bud, Vol. 15 (1968) pp 103-109; Vol. 18 (1971) pp 22-44; Vol. 22 (1975) pp 68-71 and Vol 32 (1985) pp 17-20].

a) Cleft grafting

Rested stock is cut to a convenient height. Overhead shade is constructed, Scions are taken from rested bushes, pencil thick and 15-25 cm long (3 leaves). Cut above top leaf and taper 3-4. cm below bottom leaf.

The stock is split with the cleft held open, tapered scions are inserted lining up with the cambium layer (tissue between wood an bark). The area to be united is covered with a moisture holding material (squeezed out). A polythene bag is then put over the grafted stump.

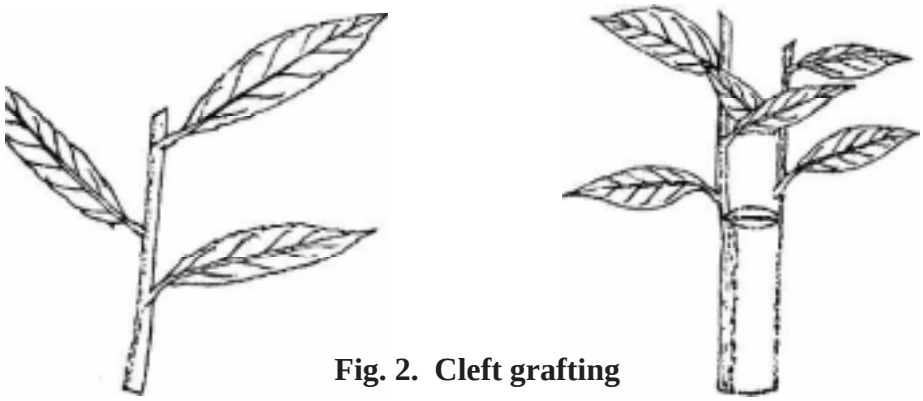


Fig. 2. Cleft grafting

b) Bud grafting

Stock is prepared by pruning in spring and allowing best shoots to run, trimming off the rest Bud wood (similar to shoots for V.P.) is collected in following cold weather. An inverted 'T', 1.5 cm x 3 cm is cut in the bark of a strong shoot, 10 cm from the base.

A bud is sliced off with about 2 cm of bark and a trace of wood, and is then inserted under the bark flaps. Bud bark below the 'T' and the leaf are trimmed off.

The graft is tied up firmly with polythene strip avoiding bud damage. After 3-4 weeks, the bud should join with stock. The stock shoot is then pruned 2 cm above the bud. Any growth from below the joint need to be removed until the bud becomes the shoot.

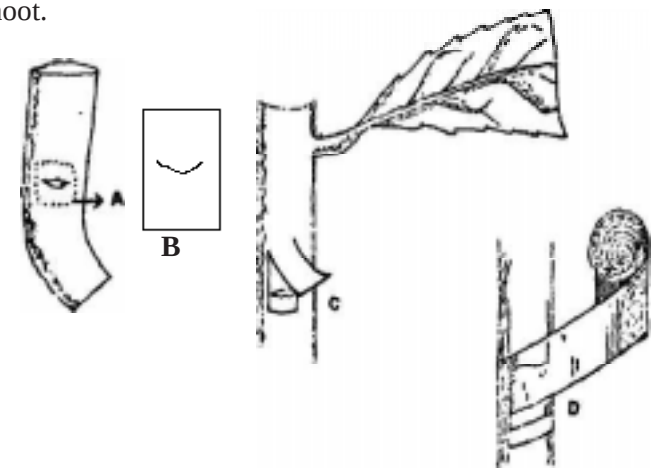


Fig. 3 : Bud grafting

A- Position of scion on mother stem,
B- Cut out scion with bark,
C- Scion inserted on stock,
D- Scion wrapped with wax cloth.

c) Rind grafting

It differs from cleft grafting only to the extent that grafting is done on the side of the stock branches without making cleft. At the time of grafting, the bushes are cut. to a convenient height. Peel the bark 3.5 to 5 cm in length on one side of the branch. Lift the edges of the cut bark slightly for fixing the scion. Scions are prepared by making long, slanting cuts of 2.5 to 3.5 cm on one side and inverted 'L' cut on the other side.

The prepared scion is inserted inside the cut bark in such a way that the inverted 'L' cut is rested against, the inner wood of the stock branch. The grafted portion should be wrapped with coir/jute/hessian cloth/cotton. Rest of the procedure is similar to cleft grafting.

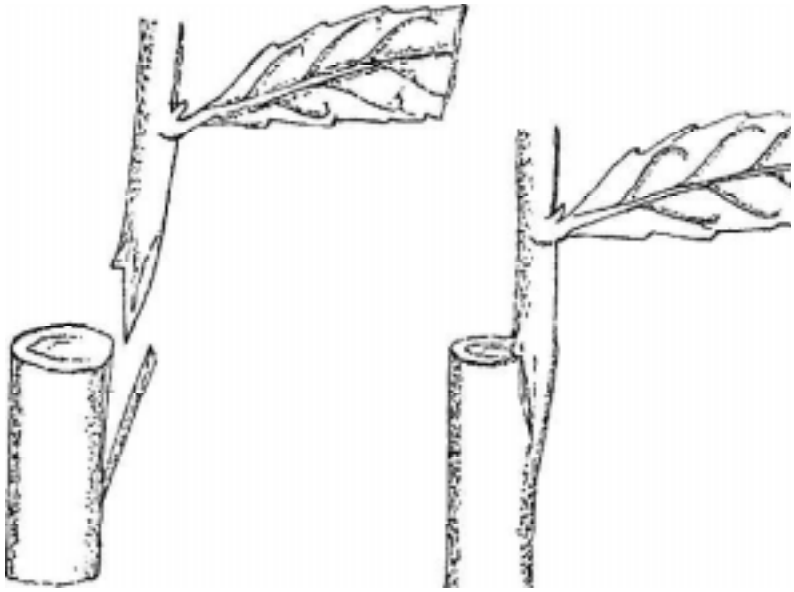


Fig. 4 : Rind grafting

N.B. Intimate contact of the cambium layers and protection against drying out are essential requirements for success in all the methods of grafting.

Generally during first year or so the graft junction remains a vulnerable point of damage by strong wind or storm. In such vulnerable areas, it is advisable to grow a row of suitable trees as wind break, or provide a strong support to the tree with a bamboo or wooden post

Section 3. VEGETATIVE PROPAGATION

3.1 Mother bush

Bush selected/planted and allowed to be used for vegetative propagation is called mother bush. Vegetatively propagated progenies from the cuttings of a single mother bush form a clone.

3.2 Nucleus plot

This is the multiplication area, maintained separately for each clone. Nucleus plot should be established at a convenient place where constant supervision is possible. The soil should be fertile and well drained. Shade is not required for the nucleus area.

A nucleus plot has to be built up for each clone to be used by (i) using an area already planted with the clone, (ii) planting a special area with the clone or (iii) converting an existing tea area by grafting (**See 2.9**).

A mature nucleus bush can give 50-300 good cuttings in a year. A minimum of 250 bushes must be allotted to supply cuttings for one hectare.

In plains vigorous bushes can give cuttings twice a year (e.g. autumn and spring).

Autumn cuttings : Deep skiff in early June to early July.

Spring cuttings : Light prune in mid October to early February, early September to early October in the hills.

Stagger prune at 10-15 days interval to ensure supply of good cuttings for extended propagation.

Nucleus plot is manured with 2:1:2 or 2:1:3 NPK mixture @ 120-140 kg N/ha when cuttings are taken twice in a year. If cuttings are taken once in a year, 100-120 kg N as 2:1:2 NPK mixture is sufficient. Half the quantity may be applied on moist ground in early spring and the balance half in June/July.

Nucleus plot should be sprayed with suitable pesticides/fungicides to protect from pests and diseases as and when required.

3.3 Taking cuttings

a) Skiffed primaries are carried to the propagation area either in loose bundles or placed loosely in baskets, without exposing to sun.

b) Clones differ in their growth and flushing behaviour, which may also be influenced by pruning time, soil and climate. The optimum time of taking cuttings can, therefore, vary in different clones.

c) Cuttings taken from the primaries should be preferred to cuttings taken from the secondary laterals developed from axillary buds of primaries. Best results are obtained in cuttings taken from primary shoots with dormant terminal bud and dormant or slightly softer axillary buds.

d) Technique : The stems are tested by flexing between thumb and fingers; the soft portion at the top and rigid brown portion at the bottom are not suitable. Good cuttings come from the flexible middle portion. Marginal cuttings can be used, but must be planted separately.

e) Tool: Anything really sharp, which does not bruise the stem and is convenient to operate, can be used.

f) Internode : Best to have single leaf 3-4 cm long cuttings with about 2.5 cm of stem below the node and about 0.5 cm of stem above it. Top cut is given immediately above the axillary bud and parallel to the leaf blade. Make the basal cut obliquely more or less parallel to the leaf blade.

Planting should be done soon after the cuttings are made.

g) Treatments of shoots and cuttings before propagation —

i) If not yet ready, tip the primary shoots 3-4 days in advance in plains and 6-7 days in hills before taking cuttings. The stem gets hardened and the axillary buds get swollen by this process.

ii) Store the cuttings in dark overnight before planting.

iii) Dip cuttings in 0.1% solution of zinc sulphate before planting.

Setting the cutting

a) Pierce soil surface with a 5 cm nail or thin dibber (thinner than the cutting) at required distance. The hole should be a little shorter than the stem of the cutting. Hole direction should allow the leaf to stand nearly upright

b) Cutting is inserted so as not to damage the cut point and the soil near the cutting is compressed with finger tips to eliminate formation of air pockets. Petiole should remain above soil surface.

Test for good setting : When the leaf is bent, the stem should not come up.

c) Soil surfact should be kept moist but not waterlogged.

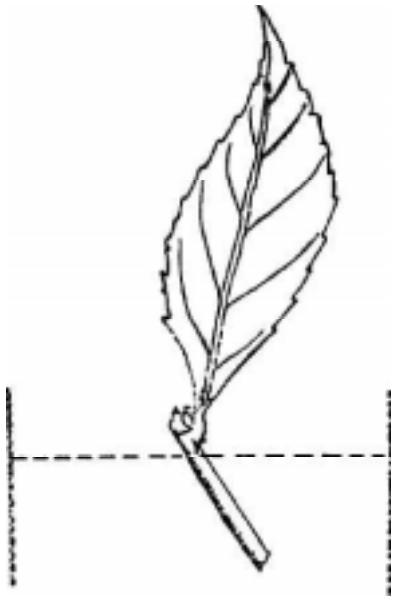


Fig. 5 : Correct method of planting single node cutting

d) Nursery shade should not allow more than 40-50% of day light. North light is ideal.

e) Spacing

i) When setting cuttings direct into sleeves, the point of the stem should be on the centre lines of the sleeve cylinder.

ii) To produce pretreated cuttings (for transport), 5 cm x 6 cm to 8 cm x 10 cm (depending on leaf size) triangular spacing in callusing bed is required.

Cuttings are ready when the cut bark is covered with a small ring of callus (4-6 weeks).

Section 4. THE NURSERY

4.1 A useful nursery requires all weather access, shade, drained beds and irrigation water. A permanent nursery using sleeves provides these economically.

4.2 Sleeves

Polythene lay flat tubes 15-17.5 cm (6"-7") wide, 22.5-25 cm (9"-10") long.
150 gauge - 300 sleeves in 1 kg
200 gauge - 230 sleeves in 1 kg
250 gauge - 185 sleeves in 1 kg

Recycled polythene of 150 gauge suffices for 12 month nurseries. For longer duty and for transit, heavier gauge is required.

4.3 Sleeve soil

Select well drained sandy loam of good tilth (sandy or clayey/silty soils unsuitable). Test, see **Chapter I, 3.1** and if more than half is fine silt, the sleeve soil has to have sand (preferably coarse) added until the test shows 50% sand.

Ideal pH is between 4.5 and 5.5. Sub-acidic conditions can be rectified by drenching rooting beds or sleeves with 2% aluminium sulphate solution (about 60 ml solution per sleeve) at least two weeks before planting cuttings. Dark coloured top soil requires no addition of organic matter to increase fertility. Very poor soil, in organic matter can have a little old dry cow dung or fine compost blended in, but not in top 5 cm of the sleeve where lean soil is better.

Soil is sieved through No.3 mesh. All this is done under shelter so that the soil does not dry out, turn muddy or be compressed. Addition of 500 g superphosphate per cubic metre soil can help in better rooting. No soil should be used unless representative samples are tested at TRA laboratories for eelworm. These samples must represent all the soil to be used in sleeves, be moist (neither dry nor wet) and sealed in a tin (**See also Chapter I, 3.4**). If more than 6 eelworms per 10 g soil are found, and better soil is not available, treatment is necessary :

a) Treat, soil with 2 gram of Furudan 3G per sleeve in two splits at monthly interval before planting cuttings.

b) Treat soil by heating on a metal pan 1 m square 10 cm deep over a slow fire until steam rises for 4-5 minutes. No overheating.

4.4 Sleeve filling and storage

Always under shelter, sleeves are filled to the tip without any ramming and kept under shade on the nursery beds. The top of the bed is spread with sand or grit in a thin layer

to support. the sleeves with free drainage. They are kept moist (say 2 cm water a week). Under rain/irrigation, the soil settles and the sleeve is topped up with lean soil. The degree of desired compaction is attained after about 6-8 weeks storage and topping up.

50 g Simazine in 5 1 water (2 kg in 200 1) used to moisten sleeve tops gives useful initial weed control.

4.5 Bed

Convenient size 1.2 m x 30 m (2500 sleeves approx.) running east and west on flat land or following contours on slopes, forming terraces. Bed surface cambered 3 cm and surrounded with drains 30 cm deep and 30 cm wide (minimum). A bamboo fence surrounds each bed about 20 cm high above ground, holding sleeves upright constructed by weaving split bamboo between upright pegs set 0.5 m apart along the edge of the bed. Material required for one bed : 30 bamboos 7 m long, more if drain sides are fenced.

4.6 Shade

a) Low level shade consists of 1.3 m x 1.3 m bamboo basket work frames laid across the bed fences with the uprights high enough to give a clearance of 25 cm above sleeve tops. Shade is controlled by raising the frame on a stick support when 2 leaf growth is generated, first on cloudy days, then morning and evening, and finally removing the frames when 4 or 5 good leaves have grown.

b) Overhead shade is a roof like structure supporting material like split bamboo, ekra, thatch, weeds, nylon or coir nets, high enough to allow all concerned to walk upright in the drains. Shade is varied by thinning out and re-arranging the shade material. The north light type of shade works well although takes more mattrial and care to build. Side screens are required on east and west sides.

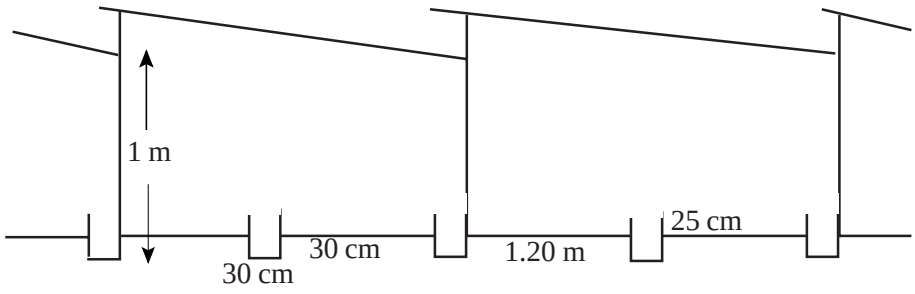


Fig. 6 Overhead shade design

c) At elevation above 1400 m, a polythene tent (200 gauge) supported on bamboo strips and hooks 50 - 60 cm above the bed will help in better success.

4.7 Irrigation

Drying out must be prevented; when there is not enough rain to keep sleeves moist, watering should be done once or twice a week. The whole sleeve should be moist but not wet. Overhead sprinklers are best. Free drainage in the sleeve and from the bed are essential.

4.8 Rooting bed

An ordinary well shaded bed consists of the top 15 cm of medium loam, well worked but firm and of average fertility. Cuttings are set at 5 cm to 8 cm in triangular, "fish scale" pattern depending on leaf size. When roots have developed (8-12 weeks), the rooted cuttings are transferred to sleeves. Where cuttings are set direct into sleeves, rooting beds are a reserve for replacing casualties.

Where indirect setting is done, all cuttings are rooted before transferring to sleeves.

4.9 Fertilizers

a) Application of fertilizer should commence when cuttings produce 3-4 leaves. YTD (2:1:2) mixed with soil/sand (1:9) should be applied @ 5 g/sleeve (1 tea spoonful) at 3-4 weeks interval until the required height of plants has been reached.

b) Foliar application can start when cuttings have produced 3-4 leaves. More effective at above 95% humidity and 20°C day temperature. Conc. of nutrients in the spray - NPK (2:1:*2)* 0.50%, zinc sulphate 0.10%, borax 0.05%, ammonium molybdate 0.05%, magnesium sulphate 0.30%.

Time : April, May, August, September, October, November.

4.10 Plant rearing

a) Shade regulation from 40% to 100% day light in 5-10 months.

b) Moisture control : free drainage of excess water and top up to field capacity, if rains inadequate.

c) Weed control : by hand.

d) Pest control : fortnightly rounds of pesticides 0.5 1 in 200 l water applied to both leaf surfaces with hand sprayer as soon as infestation is noticed.

e) Drip damage : top up sleeve with lean soil.

f) Tipping or debudding : Tipping should not be done at a lower height (below 50 cm) or long before planting. Debudding can be done in the nursery by removing the apical "2+Bud" and subsequent growth of leaf axil buds above 20 cm ground measure just before planting.

4.11 Seed nurseries

One seed per sleeve is set 2 cm deep into the soil and with 'eye' down soon after it is collected or received. No chemical weed control is possible. Fertilizer is not required until 3 good leaves are produced. One bed of 1.2 m x 30 m size takes about 8 kg seeds (1 kg gives about 320 seeds).

4.12 Inputs required for 1,00,000 nursery plants

Land	=	0.2 ha
Bamboos	=	1200 (7 m long)
Polythene sleeves	=	350 kg (150 gauge)
Sleeve soil	=	70 lorry loads (approx. 250 tonnes or 2.5 kg per sleeve)
Soil per sleeve	=	Approx. 2.5 kg

Land area to collect the top soil of 20 cm depth @ 1333 kg of soil per m^3 = 0.1 ha

Shade material for 0.2 ha

Bamboo	=	500 pieces
Thatch	=	2000 bundles
String	=	20 kg

Drain length and depth for 0.2 ha

20 cm deep drain	=	885 m @ 4428 m/ha
45 cm deep drain	=	160 m @ 800 m/ha
10 cm deep drain	=	20 m @ 100 m/ha

No. of mother bushes for 1 lakh cuttings = 400

Manpower @ 700 mandays/lakh/year

Chemicals :	Acaricides	0.8 lit
	Insecticides	2.5 lit
	Fungicides	2.0 kg

Skilled inspection weekly

Skilled care taking daily

Small quantities of fertilizers

4.13 Checklist for poor results

Effect	Cause
High mortality	Brown wood - too dry, insufficient shade, soft bark - too wet (waterlogged)
Cutting alive but does not root	Weak cutting, damaged stem, overshaded, waterlogged, sub-acid soil
Excessive callus and feeble roots	Soil too rich in organic matter, waterlogged, sub-acid soil
Poor growth	Leaves yellow and limp - eelworm, leaves pale - waterlogging or nutrient deficiency, leaves hard - too dry
Long internodes, leaves pale	Overshading
Rosetting, leaves turning white, sickle leaves	Micronutrient deficiency, zinc deficiency
Causes of waterlogging	Sleeve soil not permeable and free draining, mud seal between sleeve and bed, excess rain/irrigation, poor drainage system.

4.14 Nursery output

All off type plants and those which do not attain the required vigour and size in 10-12 months should be rejected.

Section 5. PLANTING

5.1 Preconditions

a) Planting programme, including decision on spacing and planting time
b) Prepared land, by clearance or rehabilitation
c) Supply of plants

5.2 Planting time

Soil moisture is essential :

a) Autumn planting, while rains moisture is still in the soil and is preserved by mulching.
b) Spring planting, as soon as early rain has penetrated top soil.
c) Planting with irrigation, protected by mulch, any time.

5.3 Operational sequences

a) Cutting cover crops and keeping material for mulch.
b) Staking (omitting space for path and shade).
c) Pits/holes making.
d) Soil conditioning.
e) Planting.
f) Mulching.

5.4 Staking

a) Use stakes according to planting pattern (i. e. rectangular, con tour, double or single hedge) as per the policy of the 'estate'. Ideally staking should be done before the cover/rehabilitation crop is put out.
b) Stakes for holding : Minimum requirement - no. of plants to be planted in 1 day x 2 plus 10%.

5.5 Factors affecting the spacing decision

i) Soil - poor soil needs more plants/ha,
ii) Bush character - small framed clones need more plants/ha.
For compact bush frame : 15000-16000 bushes/ha (upto 18300 in billy areas)
For spreading bush frame : 14000-15000 bushes/ha.
iii) More plants/ha can give earlier ground cover, particularly where spread is difficult to attain.
iv) Plucking productivity is poor unless the gap between hedges is not sufficient (minimum 105 cm).

For compact frames : 15000-16000 (In hilly areas upto 18500)

For spreading frames : 14000-15000

v) Minimum spacing between plants : 60 cm
Minimum spacing between rows/hedges : 90 cm (hills), 105 cm (plains)

Some spacings with calculated populations :

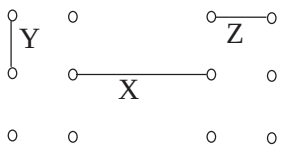
Spacing	Calculated plant population/ha
90 cm x 60 cm (Single hedge)	18518
100 cm x 60 cm (Single hedge)	16666
105 cm x 60 cm (Single hedge)	15873
105 cm x 65 cm (Single hedge)	14652
105 cm x 70 cm (Single hedge)	13605
105 cm x 75 cm (Single hedge)	12698
105 cm x 70 cm x 75 cm (double hedge)	17316
110 cm x 70 cm x 70 cm (double hedge)	15873
110 cm x 75 cm x 75 cm (double hedge)	14414
110 cm x 75 cm x 70 cm (double hedge)	14815
110 cm x 70 cm x 65 cm (double hedge)	16326
110 cm x 70 cm x 60 cm (double hedge)	16806

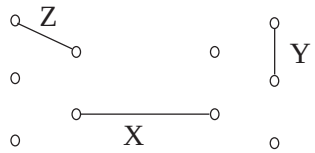
Since roads, culverts, drains etc. occupy about 8-10% of the plantation area, accordingly actual plant population will be 8-10% less than the calculated ones.

General formula :

$$\frac{N \times 100000000}{Y \times (X + Z)}$$

Where, N = Number of lines in a hedge (double hedge = 2)
Y = distance between bushes in a tea line
X = distance between hedges
Z = distance between tea lines (regular double hedge)
= distance between bush in one line and nearest bush in adjoining line (Staggered double hedge)





5.6 Digging pits

Excavation in 3 stages :

a) 15 cm deep x 45 cm (minimum) across - top soil cut with hoe and placed separately.

b) 30 cm deep x 45 cm across - sub soil cut and lifted with holing spade, separated.

c) 30 cm deep x 15 cm across - soil loosened with post hole auger or deep forking.

75 cm minimum depth of worked soil, old roots and stones to be removed.

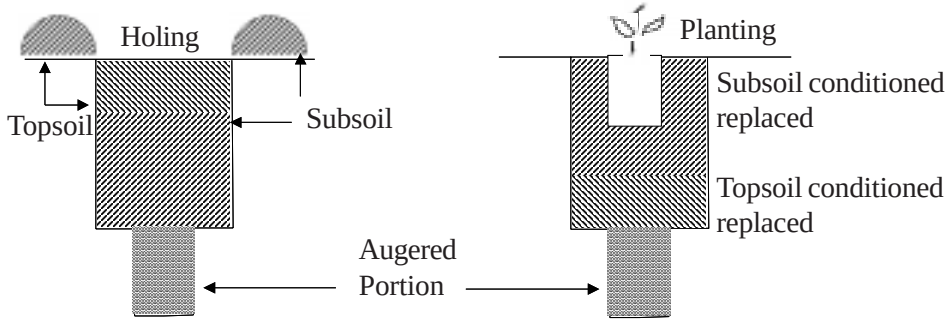


Fig. 7. Planting pit and correct planting method

5.7 Soil conditioning

a) Top soil 30 g superphosphate, bottom soil 30 g rock phosphate.

b) Well rotted dry cattle manure : 4-5 kg

c) Cattle manure should be mixed thoroughly with the excavated soil. Rock phosphate is to be applied at the bottom while super phosphate should be applied 5 cm below the ground level around 'bheti' after removing sleeve.

5.8 Planting

a) Plants irrigated in nursery, inspected and rejected if substandard. Selected plants should preferably have :

i) Stem thickness 0.5-0.8 cm at the base,

ii) Height 40 - 45 cm.

iii) Foliage 12-16 /plant

iv) Undamaged root system with soil around roots remaining intact at the planting time.

b) Pit/hole partly to be refilled with conditioned soil.

c) Sleeve aligned with stakes, placed with top at or just below ground level.

d) Sleeve removed from bheti, remaining soil replaced and rammed.

e) Levelling and mulching.

5.9 Mulching

a) Immediately after planting, a thin continuous layer of plant material (monocot leaves are ideal) is spread over the ground.

b) As soon as convenient, a 5-7 cm thick layer is built up, no material to touch the plant stem.

c) As the layer thins out, it is topped up.

d) Where rice straw is used, an additional 20 kg N/ha is required, applied together with the straw.

Section 6 BRINGING UP YOUNG TEA

6.1 Weed control

a) Hand weeding (short rounds).

b) Hand weeding of collar region, with herbicides for remainder :

i) Pre-emergent : Simazine (1:200) or Qxyfluorfen (1:400) on clean moist ground.

ii) Post-emergent : Glyphosate (1:200) against thatch and other grasses; 2,4-D and Paraquat (each at 1:400) to be used for spot spraying only using a protective shield.

N.B. Other herbicides can damage young tea.

Equipment : Hand operated sprayer at pressure 0.7 kg./cm^2 (10 psi) at the nozzle which is Floodjet with spray angle 25° to 40°, lance fitted with spray shield (hood).

c) Deep fork hoe for *Imperata cylindrica* (thatch) roots, if required.

d) Good mulching reduces weed growth.

6.2 Pest control

a) Weekly inspection for mites, insect damage and diseases.

b) If any pest or disease attack is noticed, take control measures as in mature tea.

c) Against red rust, ensure correct drainage, nutrition, soil acidity and shade status, alongwith using copper fungicide at 1:400.

6.3 Manuring

a) Dose of fertilizer as 10:5:10 or 10:5:15 NPK mixture during formative stage (0-5 yrs)

Year after planting	NPK mixture (kg/ha)	No. of splits	Method of application
0	200 - 400	2-3	Ring
+ 1	800 -1000	4	Ring
+ 2	1000 -1200	4	Ring
+ 3	1200 -1400	4	Ring
+ 4	1400 -1500	2	Strip
+ 5	1400 -1500	2	Strip

b) Foliar application

Zinc sulphate @ 10-12 kg/ha/annum alongwith NPK during early and back-end periods.

6.4 Frame formation by pruning and/or tipping

The timing and actual measurements of these operations will vary with the elevation and climate of the area and with management standards.

a) No decentre pruning to be done without starch tests (**see Chap. III, 1.2b**).

b) Tipping heights should be adequate to encourage vigour and spread and thickness of primaries.

c) Pruning on thin wood is not normally effective.

d) Unprune treatment is vulnerable to drought and disease.

e) Pruning height depends on spread achieved and type of bush.

f) Develop a permanent frame with a 3-tier ramification of 1:3:7.

g) Two prunes are normally necessary during formative stage to establish the frame.

h) The first frame forming prune must ensure removal of strong centre or heading back of thick branches on merit and criss cross branches.

i) Final frame forming prune is given after two years of the first prune. This prune does not require much of opening out at the centre if due care is taken in the first frame.

6.5 Shade

a) Temporary :

Indigofera teysmanii 5 m to 6 m (300-400 plants/ha), *Leucaena lucocephala, Sesbania aegyptiaca.*

Melia azedarach (Bocain, Ghoraneem) can also be used.

b) Permanent :

Albizzia odoratissima, A. lebbek, Dalbergia sericea, Acacia lenticularis, Derris robusta and *Albizzia chinensis.*

CHAPTER III

FIELD PRACTICES

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FIELD PRACTICES

Section 1. PRUNING

1.1 Pruning definitions

Collar Prune (CP) : All above ground portion is cut leaving only upto a maximum of 10 cm when bush frame becomes unproductive and root system is still healthy.

Heavy Prune/Rejuvenation Prune (RP) : 40-45 cm above ground in plains and 15-37 cm above ground in China hybrids in hills for frame renewal.

Medium. Prune (MP) : 50-65 cm in plains and 35-50 cm in hills for top frame renewal and height reduction.

Height Reduction Prune (HRP) : 70-75 cm in plains only.

Light Prune (LP) : 4 - 5 cm above last prune to renew the wood for growth of new branches and clean out the bush.

Deep Skiff (DS) : (i) At 10 cm measure above the light prune mark where 20 cm tipping measure is followed in the LP year in a LP-DS sequence, (ii) At 12-13 cm measure above the LP mark where 23-26 cm tipping measure is followed in the LP year irrespective of sequence of pruning/skiffing. (iii) At 12-13 cm measure above the LP mark irrespective of tipping measure in LP year in a LP-UP/LOS-DS sequence.

Level-off Skiff (LOS) : 5 cm above current year's tipping level used to cut off the highest plucking point and level up.

Medium Skiff (MS) : Just below majority of crow's feel ro remove congestion.

Light Skiff (LS) : At current year's tipping level to re-establish a level.

Unpruned (UP) : Untouched/Levelled by hand.

Cut Across Prune (CA) : Removal of one or more year's old wood leaving only 3-5 cm with a slashing knife of 20-25 cm length.

Clean-out Prune (CL) : Small snags and knots and unproductive shoots are cut following CA.

CA + CL = LP

Desnag Prune (DSN) : Snags, knots and dead wood are cut out following MP etc. and the cuts are smoothened.

Decentre Prune : Cut-off the main stem at 15-22.5 cm retaining 2/3 or more healthy laterals below in a young plant.

Lung Prune : A partial cut for decenter, leaving connection between bottom and top shoot

Finger Prune : Like lung pruning, done by partial breaking of the stem.

1.2 Requirements before pruning

a) Pruning programme and sample inspection

b) Starch test (particularly in young tea and tea that has not been rested until dormancy) : Iodine crystals (3 g) and potassium iodide (6 g) in one litre water (or weak hospital iodine solution) is painted on a newly cut, pencil thick root. The darker the developing colour on the cut, the better the starch reserve. If pale or no colour, rest for starch build-up is required before pruning.

1.3 Pruning administration

a) Supply of measuring sticks

b) Arrangements for sharp knives and sharpeners

c) Cut should be parallel to slope of the ground (use guide sticks)

d) Pruning litters to be preserved *in situ* as mulch

e) In case P and K are low, apply 20-40 kg/ha above normal dose for heavier prunes in spring before cut, then rest from mid October. However, if P and K status are already high in the soil, this extra dose may not be necessary.

f) Bitumen paint on large cuts

g) Winter wash oil for demossing

h) Caustic wash for frame cleaning : 12 kg washing soda (or 3 kg soda ash) and 4-6 kg quick lime in 200 litres of water

i) Knife with 15 cm blade should be used for light pruning youngish teas. For cleaning out operation a smaller knife of 7.5-10 cm should be used. Weight of knife used for Cut Across pruning should not be less than 450 grams. Lighter knives cause wood splitting.

1.4 Pruning time

December to mid January for mature tea, end January to early February for young tea

1.5 Factors affecting pruning time

a) Sun scorch danger

b) Drought danger / blister danger

c) Regrowth time desired

d) Rest period required

e) Crop required

1.6 Crop Distribution

a) The high crop treatments like UP, LOS, LS, MS in that order increase the first flush.

b) LP and DS increase the percentage harvest of main and back end crop.

c) HRP, MP, Heavy Prune increase the percentage harvest in the autumn crop.

1.7 Pruning cycles

Continuous high crop treatments lead to congestion and decline, continuous pruning decreases crop (the more severe the cut, the more severe the loss).

Alternation span of treatments for crop and vigour may be 3-4 years for plains and 4-5 years for Darjeeling, *e.g.*,

LP-UP-UP, LP-DS-UP, LP-UP-DS, LP-MS-DS, LP-UP-DS-UP, LP-UP-DS-LS-UP, LP-UP-UP-DS/MS-UP etc. (Darjeeling)

Section 2. TIPPING

2.1 Tipping height follows pruning height :

LP	—	20-26 cm (Average ht of 5 leaves)
DS	—	7-10 cm (Average ht. of 2 leaves)
MS	—	4-5 cm (Average ht of 1 leaf)
LS	—	at skiffing level to janam
LOS	—	at skiffing level to janam
UP	—	at last plucking level
CP	—	70-75 cm
RP	—	25-35 cm
MP/HRP	—	25-30 cm

Tipping heights for heavier prune depend on intended frame and spacing of tea.

2.2 "Banjhi Horizon"

Shoots on weak bushes go dormant before the tipping level is reached - tip the regrowth at predetermined level.

Knots on the frame also produce weak primaries.

N.B. Check NPK, Organic C, drainage, pest control.

2.3 Requirements

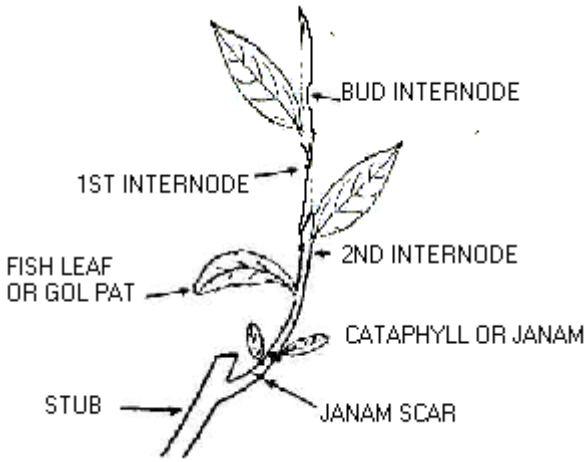
a) Tipping programme and samples

b) Tipping measures

2.4 Timing

a) Early tipping gives early density of plucking points. Shoots smaller than full grown 2+B should not be plucked from the tipping level

b) Delayed tipping may result in loss of early season crop in particular.



Section 3. PLUCKING AND LEAF HANDLING

3.1 Plucking round

Plucking round describes the time interval in days between consecutive pluckings. It varies from 4 to 14-days though 7-day round is the most common practice.

3.2 Standard of plucking

Black plucking removes all above tipping level, except unopened buds.

Standard plucking leaves buds and small one and buds on the bush, remainder plucked to tipping level.

Coarse plucking leaves buds, one and buds and small two and buds on the bush, remainder plucked to tipping level.

3.3 System of plucking

Janam plucking : plucked above janam; superior under normal condition in N. E. India.

Fish-leaf plucking: plucked above fish-leaf to raise the plucking table.

Single-leaf or Step-up plucking : plucked above a normal leaf to restore the volume of maintenance foliage when required.

3.4 Mechanical plucking

Shear plucking is useful as an aid to tide over difficult situations arising out of scarcity of pluckers during July to September.

Shear plucking at 9 to 11 days interval produces similar crop as that of hand plucking at 7 days interval during July to September.

Pluckers' productivity is found to be maximum in unpruned teas.

When compared to 7 days plucking by hand, pluckers' productivity increased by 38-50% from shear plucking at 9 days interval.

When shears are to be used in, LP, DS and MS teas, it is better to do a round of levelling of the plucking table with shear before emergence of the second flush since this will remove majority of the hard banjhis; subsequently the brokens will be less and quality of harvest will improve. To maintain acceptable quality of made tea from shear plucked leaf, level the plucking surface with shear before onset of the season and again at the end of first and second flush. Coarse cut leaves should be removed from the basket before weighment.

3.5 Leaf standards

Fine plucking takes all $1^1/_2$, all $2^1/_2$, single banjhis, remainder broken back to janam.

Medium plucking takes all $2^1/_2$, single banjhis and tender double banjhis, leaving $1^1/_2$, remainder broken back.

Coarse plucking takes all $2^1/_2$, and larger, no breaking back.

Per cent fine : from a bulked, weighed sample, extract all $1^1/_2$, $2^1/_2$ and tender banjhis, weigh against total, express as per cent.

3.6 Leaf transport

A transport basket 55 x 55 x 55 cm carries 15 kg leaf without damage.

A leaf carrying frame holds 120 baskets, 1800 kg a trip.

Formula for finding No. of vehicles required :

$$X = \frac{\text{Total kg green leaf expected on a day}}{\text{1800 x average No. of trips a vehicle will do}}$$

Extra baskets save trailer time, extra trailers save tractor time.

Section 4. SHADE

A light shade canopy prevents leaves from scorching and excess heat, which are not conducive to photosynthesis. Shade conserves moisture and adds organic matter to the soil.

4.1 Choice of species (See also Tocklai Memorandum 30)

a) Temporary shade species spacing :

4 x 4 m - 625/ha (N-S hedge)

Species like *Indigofera teysmanii, Sesbania aegyptiaca, Leucaena leucocephala, Melia azedarach* can be used as temporary shades. *Gliricidia maculeata* can also be used with the objective of adding loppings and trimmings to the ground for enrichment of organic matter.

b) Semi permanent species spacing :

6 x 6 m - 275/ha *Albizzia chinensis* approximately 30,000 seeds/kg, *Albizzia. falcata (moluccana)* 20,000 seeds/kg.

c) Permanent species spacing :

12 x 12 m - 68/ha

Albizzia odoratissima	approx	20,000 seeds/kg
" *lebbek*	"	8,000 seeds/kg
" *procera* (non droughty areas)	"	30,000 seeds/kg
Derris robusta	"	35,000 seeds/kg
Acacia lenticularis	"	27,000 seeds/kg
Dalbergia sericea	"	45,000 seeds/kg
Adenanthera pavonina	"	8,000 seeds/kg

4.2 Shade nurseries

A bed 120 cm x 30 m holds :

2000 tubes of 20 x 45 cm size and 300 gauge for short term; 1600 tubes of 30 x 60 cm size and 300 gauge for long term.

Soil : Light, eelworm tested, limited to pH 6-7, conditioned with dry cowdung or compost, mix 1 kg single superphosphate or 250 g DCP and 0.5 kg lime or dolomite with each m^3 soil.

Seedling : Moisten top of sleeves with 0.5 litre Endosulfan in 200 litres of water. Place 3 seeds 1-2 cm deep, keep best seedlings.

Drainage, irrigation and pest control : As for tea nursery.

4.3 Transplanting

Minimum size of seedling should be 30 cm taller than tea. Planting pit should be 90 cm deep, 75 cm in dia.

Planting mixture : 10 kg cowdung (dry)
0.5 kg superphosphate
0.5 kg lime or dolomite mixed with the soil in the pit

Planting time : After spring rain to early summer

Carrot planting : Roots cut to 60 cm

Stump planting : Maximum collar diameter -10 cm, seedlings pruned to 2 m while still in nursery, cuts sealed.

Planting pattern : To estate plan, mixed stands, minimum locally proven 4 species.

4.4 Shade maintenance

Pest control with high jet sprayer, thinning out according to canopy size, rotation by interlining and inter-planting, control of canopy by lopping lower branches, pollarding for controlled height.

Section 5. FERTILIZERS

5.1 Primary Plant Nutrients

May not be available in soil in sufficient quantities for optimum development and yield and hence annual application necessary.

Nitrogen (N) promotes quantity and speed of leaf growth. Phosphate (P_2O_5) promotes root growth.

Potash (K_2O) promotes vigour, helps metabolism, imparts resistance.

5.2 Secondary Plant Nutrients

Calcium (Ca) usually available in soil.

Magnesium (Mg) promotes health, growth. Foliar application in high yielding teas.

Sulphur (S) getting depleted in tea soils, hence need for soil application in well drained teas. Get soil analysed for sulphur need.

5.3 Micronutrients

Promote normal health, occasional site specific deficiencies have to be removed.

Boron (B), Manganese (Mn), Molybdenum (Mo) and Zinc (Zn) show promise. Zinc to be used @ 12-5 kg/ha/year as foliar spray.

5.4 Deficiency symptoms

N : Pale or yellow colour, slow growth, fewer shoots, small leaves.

P_2O_5 : Dull, small leaves, weak stem, slow development,

K_2O : Thin white stem, folded small leaves, poor recovery from prune or drought, fair central growth with poor side branches.

Ca : When pH value below 4

Mg : When pH value below 4, also in droughty condition depicted by interveinal chlorosis as inverted “V”.

S : Yellowing of upper leaves.

Trace elements : Discoloured leaves, curly leaf edges and stunted growth are general symptoms.

Zn : Sickle shaped leaves.

B : Rosetting of new growth.

5.5 Nutrients removed by harvest of tea

	N	P	K
Made tea contains	5%	1%	2%
2000 kg/ha crop removes	100 kg	20 kg	40 kg
Loss if pruning litter is not left in section	100 kg	20 kg	60 kg

Maintenance mixture (approximate) NPK 2:1:2
For low potash soils NPK 2:1:3 } for young tea

Current recommendation of NPK for mature tea : See Field Management in Tea

5.6 Commercial Fertilizers

Element	**N**	**P**	**K**	**S**	**Mg**
Analysis refers to	Nitrogen	Phosphate	Potash	Sulphur	Magnesiu
Common sources :					
Ammonium sulphate	20.6%			24%	
Ammonium sulphate nitrate	26%			15%	
Urea	46%				
Ammonium phosphate	20%	20%			
Di-ammonium phosphate	18%	46%			
Single superphosphate		16%		11.9%	
Triple superphosphate	43%			for young tea	
Dicalcium phosphate		42% (acid soluble)			
Rock phosphate		20-24% (-DO-)		2.3%	
Muriate of potash			60%		
Potassium sulphate			50%	16.22%	
Gypsum				18%	
Pyrites				22-24%	
Phosphogypsum				11%	
Magnesium sulphate				13%	9.88%

Micronutrients (common sources) :

	B	Mo	Zn	S	Mn
Borax	11.3%				
Boric acid	17%				
Manganese sulphate				15-17%	26-28%
Zinc sulphate			23-25%	11-18%	
Zinc chelate			9-14%		
Molybdic acid		40%			

5.7 Compound fertilizers (mixture)

a) Ratio shows proportion (balance) between N, P and K e.g. 2:1:2 equal amounts

of N and K, $^1/_2$ quantity P_2O_5 .

b) Figures show analysis of the compound in % of N, P_2O_5, K_2O e.g. 100 kg of 10:5:10 mixture supplies 10 kg N, 5 kg P_2O_5, 10 kg K_2O.

c) Fertilizer programmes allocate kg of N, P_2O_5 and K_2O to each hectare.

To find the quantity of commercial fertilizer required, allocation (programme) quantity is multiplied by 100 and divided by analysis % figures,

e. g. 120 kg N/ha allocated, Urea 46% is offered by suppliers.
(120 x 100) / 46 = 260 kg urea/ha

or 60 kg K_2O allocated, Muriate of potash 60% is offered :
(60 x 100) / 60 = 100 kg MOP/ha

or 30 kg P_2O_5 allocated. Single superphosphate 16% is offered :
(30 x 100) / 16 = 187 kg SSP/ha

d) Fertilizer orders : For straight fertilizers, name and analysis figure and for compound fertilizers, components to be used and ratio (supplier should give analysis).

e) Overage : With urea, the handling and application losses are substantial and 10% over and above the calculated quantity may be taken into account including foliar application.

f) Mixing :

For YTD 10:5:10

SOA 500 kg + SSP 312.5 kg + MOP 167 kg + 20.5 kg Filler makes 1 tonne of YTD.

(This is given as an illustration only, many other mixtures can be made).

g) Analysis : To check on supplies before application, 500 g samples of mixtures made up by taking small samples from every 10th bag of a consignment can be sent for nutrient % analysis to :

R. V Briggs & Co., Calcutta
Hindustan Fertilizer Corpn., Namrup.

h) Fertilizer Conversion Table :

Multiply By		To Convert	Multiply By
0.206	Nitrogen	Sulphate of ammonia	4.854
0.46	Nitrogen	Urea	2.170
0.260	Nitrogen	Ammonium sulphate nitrate	3.864
0.20	Nitrogen	Ammonium phosphate	5.0
0.18	Nitrogen	Diammonium phosphate	5.555

0.16	Phosphate	Single superphosphate	6.648
0.46	Phosphate	Diammonium phosphate	2.174
0.20	Phosphate	Ammonium phosphate	5.0
0.20	Phosphate	Rock phosphate	5.0
0.60	Potash (K_2O)	Muriate of potash	1.666

5.8 Ground application

To find dose for a bush, first calculate fertilizer/ha (**see Sec.5.7 c**) then divide by No. of bushes (known from spacing).

a) Young tea - In a circular band, corresponding to spread, omitting collar region.

b) Mature tea - Broadcast, omitting small collar region.

c) Application time - After first rain in spring has moistened soil to a depth of 45 cm.

5.9 Foliar application

a) The target : Underside of leaves

b) Solutions : A 2% solution is made by dissolving 4 kg of fertilizer in 200 litres of water (one oil drum). Some chemicals can be dissolved in the same water provided that they are compatible and that the total solids do not exceed 4% (8 kg in 200 litres) in case of mature tea and 2% in case of young tea.

c) Coverage : As leaf area varies from Section to Section, the No. of drums used for one ha is recorded. The nutrient weight applied to that ha is calculated by taking the No. of drums, multiply kg of fertilizers dissolved in one drum, multiply by nutrient %, divide by 100. e.g., 2 drums x 4 kg x 46 / 100 = 3.68 kg N/ha.

5,10 Secondary and micronutrients (where trials show response)

a) Magnesium sulphate 4 kg in 200 litres of water, 3 to 4 rounds.

b) Zinc sulphate by foliar spray mixed with Urea at a concentration of 1 to 2%.

c) Manganese sulphate by foliar spray as above (a).

d) Time - Early part of growing season and after the rainy season is over.

5.11 Organic manures

These are valuable because they condition soil. These supply varying amounts of nutrients.

		Approx. NPK % in Organic Manures		
		N	P_2O_5	K_2O
1.	Tea Pruning	2.0	0.5	1.5
2.	Shade tree droppings	2.5	0.7	0.9
3.	Tea waste compost	3.6	0.6	2.3
4.	Guatemala loppings	1.6	0.6	1.7
5.	Napier loppings	0.8	0.4	1.3
6.	Mimosa invisa loppings	2.6	0.6	1.0
7.	Thatch loppings	0.5	0.1	0.5
8.	Paddy straw	0.5	0.07	0.6
9.	Compost	0.5 to 1	0.4 to 0.8	0.8 to 1.2
10.	Cattle manure	1.5 to 2.0	1 to 1.5	1.5 to 2.0
11.	Oil cake groundnut	7.4	1.3	1.5
12.	„ „ coconut	3.4	1.5	2.0
13.	,, „ linseed	4.7	1.7	1.3
14.	„ „ sesamum	5.5	2.1	1.3
15.	„ „ neem	4.15	0.9	1.2
16.	Horse dung manure	0.4	0.3	0.3
17.	Cattle dung fresh	0.4	0.2	0.2
18.	Poultry manure	1.4	1.6	0.8
19.	Maize straw	0.4	1.5	1.6
20.	Concentrated organic manure Mukta	3.5	1.5	2.5

Section 6. WEED CONTROL

6.1 Manual control

Hand uprooting : Ordinary weeds are left lying as mulch, quick rooting weeds like Mikania, Setaria (Nagahabii), Polygonum, Arundinella, Ferns are carried out of tea.

6.2 Mechanical control

a) Sickling

b) Cheel hoe

Note : Surface roots damaged, therefore, unsuitable immediately before fertilizer application.

c) Collar weeding

Note : Tools damage roots, can form depressions.

d) Deep forking for thatch roots

Note : All roots require removal.

6.3 Chemical weed control in tea areas

a) Pre-emergent, applied on clean moist soil

i) Goal 24 EC (Emulsified concentrate) 500 ml in 200 litres of water.

ii) Simazine 50 WP (Wettable powder) 1.5 to 2.0 kg in 200 litres of water.

iii) Diuron 80 WP 1 kg in 200 litres of water only in mature tea.

b) Post-emergent - Contact, wetting of entire weed population.

Paraquat - 500 ml to 670 ml in 200 litres of water.

- When diuron is used as cocktail with paraquat in mature tea, the diuron dose could be reduced to 400 g in 200 l of water with a standard dose of paraquat.

c) Post-emergent - Translocated, wetting actively growing parts of weeds. It does not require a thorough drenching of weeds.

i) 2,4-D - 500 g Sodium salt or 350 ml Amine salt in 200 litres of water for broad leaf weeds, but the same quantity as a cocktail with paraquat for mixed population of weeds.

ii) Dalapon - 1.75 kg in 200 litres of water, only in mature tea.

iii) Glyphosate - 1 litre in 200 litres of water. 1.5 litres in 200 litres of water on *Polygonum, Arundinella* and *Saccharum.*

6.4 Preplanting control of thatch

Deep ploughing, root collecting. Glyphosate 1.5 litres in 200 litres of water to be sprayed on regrowth.

6.5 Additives for herbicides

a) Spreaders/Adjuvants reduce surface tension between droplets and plant surface. In 200 litres of water, wetting agent (Teepol) or sticking agent (Triton AE) 120 ml to be used. Sticking agent reduces wash-off by rain.

b) Urea or SOA 1 kg in 200 litres of spray fluid increases herbicidal activity of 2,4-D. Only SOA at the same rate can be mixed with Glyphosate.

6.6 Weed flora

a) All dicotyledonous (broad leaved) weeds are controlled by 2,4-D (post-emergence), diuron and simazine (pre-emergence). Paraquat can also kill broad leaf weeds except *Ipomia* sp. (bind weed), *Borreria hispida* (Bagracote), *Mikania mikrantha*,*Eupatorium sp.* (Siam weed), *Polygonum* sp. (Tenga pata etc.)

b) Most monocotyledonous weeds (grasses and sedges) are controlled by dalapon (to be used only in mature tea), paraquat and glyphosate. The weed species are *Paspalum* (sour grass), *Imperata.cylindrica* (thatch), *Seteria palmifolia* (Nagahabi), *Digitaria sanguinalis* (Crab grass), *Cyperus* sp. (Nut grass) and *Cynodon dactylon* (dub, Bermuda grass)

c) Resistant species are best hand uprooted before they flower and seed.

6.7 Herbicide mixtures (dilution per 200 1 dram)

a)	Paraquat	(500 ml)	+	Diuron	(400 g)
b)	Paraquat	(500 ml)	+	2,4-D	(500 g)
c)	Paraquat	(500 ml)	+	Simazine	(1.5 kg)
d)	Dalapon	(1.75 kg)	+	2,4-D	(500 g)
e)	Glyphosate	(800 ml)	+	2,4-D	(400 g)
f)	Glyphosate	(625 ml)	+	Goal	(150 ml)

The quantities of herbicides will be the same as mentioned in **Section 6.3** in 200 litres of water for their use alone except (e) and (f).

6.8 Weed control outside the tea area

Double doses of herbicides for Holas, Jhoras and fencing sides.

6.9 Equipment

a) Any sprayer giving 700 to 1050 g/cm^2 (10 to 15 Psi) delivery pressure or continuous pumping type.

b) WFN 40 nozzle discharging 470 cc per minute, the common-tank sizes of 13 and 15 litres give about half an hour continuous spraying at full pressure; for small spot spraying, use nozzle No.24.

c) A spray shield to stop drift

d) Water of potable quality and a mixing tank 200 litres approx.

e) Herbicides not older than 2 years from manufacture date.

f) Area covered will vary with weed density, bush height and spacing affecting walking speed, row length etc.

g) Scale : One sprayer for every 15 ha tea, spares and non-weedicide uses extra.

6.10 Climatic factors affecting weedicide application

a) Paraquat is more effective without direct and strong sunlight.

b) Translocated herbicides require 4-6 hr rain-free period after spraying.

6.11 Safety precautions

a) Herbicides are poisons. Store those away from food and other agro-chemicals.

b) Workers deployed for spraying and mixing to put on goggles, gloves overall and boots.

c) Equipment to be thoroughly cleaned with soap/detergent and water.

6.12 Herbicide damage to tea

Accidental damage from mistakes or herbicide residues in sprayers or drift is seen as leaf burn or discoloured leaves and finally wilting.

The treatment for herbicide damage is :

Resting, followed by retipping where regrowth is there in general. Additional fertilizers either foliar or even ground application can be helpful. Foliar application of Urea + Zinc may help in recovery.

N. B. : For currently approved trade products of various herbicides, refer to the list published in the latest issue of “Two and A Bud”.

CHAPTER IV

PLANT PROTECTION

CHAPTER IV

PLANT PROTECTION

Section 1. GENERAL

1.1 A bush which is vigorous from correct field practices resists pest attacks better and recovers from attacks earlier.

1.2 Pest : The term pest means any insect, rodent, nematode, fungus or weed that causes economic crop damage.

1.3 The pesticide industry produces

a. Herbicides : Weed plant killers, general or selective

b. Pesticides : Acaricides or mite and tick killers

Miticides or mite killers

Fungicides or fungus killers/controllers

Insecticides or insect killers

Molluscicides or slug and snail killers

Chemosterilants make insects sterile

Nematicides or nematode killers

Pheromones - chemicals used by insects to communicate with each other

1.4 Groups of pesticides

Botanical/phytochemical

Organophosphates, also called 'OPs'

Chlorinated Hydrocarbons

Carbamates

Synthetic pyrethroids

Fumigants

Biopesticides

Insect Growth Regulators

1.5 Definitions

Active Ingredient :

The components in a product that are responsible for the pesticidal effects.

Formulation :

A compound containing active ingredients and additives to make applications easy,

e.g. solvent, diluent, emulsifier etc. It has a chemical name, but may have different commercial, proprietary or trade names.

Emulsifier : A chemical which aids in suspending one liquid in another.

Emulsion : A mixture in which one liquid is suspended as tiny droplets in another liquid.

Sticker : A material added to a pesticide to increase its adherence.

EC - Emulsifiable Concentrate : When concentrated pesticides dissolved in solvent are mixed with emulsifiers, they form EC.

ML - Miscible liquid : diluted with water to make spray fluid.

WP - Wettable powder, made into paste with a little water, then diluted.

LD50 - The amount in milligrams of toxicant per kilogram of body weight necessary to kill 50% of a group of test animals (usually rats or mice).

1.6 Preparation of spray solution

To calculate the quantity of insecticide required for treating an area at a required concentration, the following formula will be applicable.

Formula : S1 V1 = S2 V2

S1 = available strength of the pesticide.
VI = required quantity of the pesticide.
S2 = required strength (%) of the spray solution.
V2 = required volume of spray fluid.

Example 1 : To find out the quantity of ethion 50% EC required for spraying an area which required 1000 litres of spray fluid at 0.125% strength.

SI = 50%
VI = ?
S2 = 0.125%
V2 = 1000 litres .

Therefore, 50 x Vl = 0.125 x 1000

$$\text{Therefore, VI} = \frac{0.125 \times 1000}{50} \times 2.5 \text{ litres}$$

Example 2 : 2.5 litres of ethion 50% is mixed with 1000 litres of water. The strength of the ethion in spray fluid is :

S1 = 50%
VI = 2.5 litre

S2 = ?
V2 = 1000 litres

$$\text{Therefore, } S2 = \frac{2.5 \times 50}{1000} = 0.125\%$$

1.7 Dilution

For each pesticide there is an effective degree of dilution. If a lesser strength is used (sublethal dose), a resistant population of the pest may build up and control will fail. If the strength is increased pesticides are wasted.

Recommendations in this handbook give the quantity of compound to be used in 200 and 400 litres water with low and high volume sprayers respectively. The actual requirement of the spray fluid will depend on the leaf area, severity of infestation and the target pest.

Figures of "Chemical per ha." are useful for advance orders to supplier.

Section 2. SAFETY PRECAUTIONS

2.1 Operator safety

Concentrates should be handled only in a ventilated area, containers should not be opened in closed store rooms. Mixing and spraying men should be provided with gloves, aprons, eyeshields and boots. Skin should not be exposed to chemicals. All mixing is to be done with long sticks. Spraying men should have ear plugs against engine noise. Soap and water for washing is required in case of soillage and at the end of each spraying shift.

2.2 Medical examination

Every worker is to be medically examined before employment and periodically thereafter. Any person showing symptoms of poisoning should be immediately examined and given proper treatment (the Insecticide Rules under 37).

2.3 First Aid measures

Affected persons are to be removed to shelter and rest. Contaminated clothing is to be removed, contaminated skin washed. Affected eyes are to be rinsed with plenty of clean water. If there are breathing difficulties, artificial respiration must be given and a doctor should be called. If pesticides have been swallowed, induce vomiting with finger in throat or with a solution of 2 table spoons salt in a glass of water. The estate medical officer and staff should be aware of pesticides in use and possible danger. When accidents are referred to them, they must be informed of the chemical concerned. Supervisors are to be trained in safety precaution and first aid.

2.4 Protective clothings

The workers are to be adequately protected with the help of protective clothings and respiratory devices where necessary. A complete suit of protective clothings shall consist of the following :

a. Protective outer garment/overalls/hood/hat
b. Rubber gloves
c. Dust-proof goggles
d. Boots
e. Respiratory devices

The protective clothings should be made of materials which prevent or resist the penetration of insecticides. The material should also be washable (the Insecticide Rules under 39 & 40).

2.5 Training of workers

The workers involved in spraying are required to be trained on proper handling of sprayers and the safety measures to be followed.

2.6 Storage

Pesticides must never be stored in the building used for food stuff. Herbicides and pesticides should be stored in different parts of the godown. Labels on containers should be kept readable or replaced.

2.7 Equipment

Sprayers, mixing drums, mixing sticks and measures for herbicides should be separate from those used for pesticides. The equipment should be washed with detergent and water at the end of each shift.

2.8 Environmental protection

a. Spillage and leftovers of spray fluids and equipment cleaning water should not be allowed to run into drains which connect with streams or rivers, as this could contaminate drinking water and endanger aquatic life.

b. Empty containers should be destroyed by burrying deep in the soil or totally decontaminated before re-use.

2.9 Administrative precautions

a. Choice of pesticides is best limited to those registered by the Central Insecticides Board and having E.P.A. residue tolerance level declaration published in Two and A Bud, otherwise one round of plucking has to be discarded.

b. Purchase should be only in sealed original containers bearing manufacturers' name, batch number and date (shelf life normally not more than 24 months). Dealers should be state registered.

c. Records of chemicals issued and applied should be prepared on the same day.

Section 3. MITE ATTACKS

See Tocklai Memorandum 27 and Integrated Pest & Disease Management in Tea.

3.1 Mite damage

a. Mature leaves attacked, turning copper brown. Tested with finger tips, red smears appear. More on upper leaf surface than under : Red spider

b. Mainly young leaves attacked, turning yellow, mites more on under surface, mid rib brown and rough : Scarlet mite
leaf veins and edges pink : Pink mite

c. Mature leaves attacked, turning purple brown, mite more on upper surface : Purple mite.

3.2 Mite recognition

(magnifying glass 10X essential)

a. Bright red, oval : Red spider

b. Deep orange to purple, slim, oval : Scarlet mite

c. Light orange, carrot shape : Pink mite

d. Dark purple with white stripes : Purple mite

3.3 Acaricides

a. Contact: Dicofol, Ethion, Lime sulphur

b. Systemic : Thiometon, Dimethoate

c. Spray fluid : One litre acaricide in 200 1 water with low volume sprayer and one litre acaricide in 400 1 water with high volume sprayer

d. Spraying method : Wetting of all leaves, both surfaces (top hamper)

e. Spray interval : If mites remain or re-appear, a second round is given after 1-2 weeks (summer)

N. B. For currently approved formulations of various acaricides refer to the latest list published in Two and A Bud.

Section 4. INSECT ATTACKS

See Tocklai Memorandum 27 and Integrated Pest & Disease Management in Tea.

4.1 Leaves eaten : Looper or other leaf eating caterpillars

From March onwards, spreading from *Indigofera teysmanii* and other shades, 2-75 mm long.

Control :

a. Hand collection and destruction, in winter - collect chrysalids (dark brown, 25 mm long pupa) near collar - about 5 mm below ground surface.

b. When the caterpillars are still very small, 1 litre Endosulfan in 200 1 water with low volume and in 4001 water with high volume, complete wetting of all leaves and frames of tea and affected shade. In case of severe attack by later instars, use Deltamethrin at 1:2000 or 1:4000 with low or high volume sprayers respectively. Where the moths have been identified, they can be collected and destroyed during February/March.

c. Light trapping of Moth, Pest-o-flash

d. Hand collection of chrysalids in January-early February

4.2 Small plants in nursery or undersized plants in field, cut/bark eaten up near ground as seen from April onwards, holes on ground surface : Crickets.

Control :

a. Prophylactic : 1 litre Endosulfan in 400 l water with high volume for wetting top of nursery sleeves and 2 m strips of clean ground with burnt engine oil surrounding vulnerable areas.

b. Inhabited holes (plugged with fresh soil) are opened and 1 litre of solution is poured in. Repeat until no holes with fresh soil are seen.

4.3 Young tea, sick or dying

A ring of bark damage (with or without callus) Just below ground : Cockchafer grub

White with brown head, 15-40 mm, April-August

Control :

20 cm from collar to be cleared of mulch and lightly forked, then apply about 200 ml of liquid Endosulfan or Chlorpyriphos at 1:300 1 to the loose soil.

4.4 Mud runs and crusts on frame : Termites

Control :

a. Wipe off earth runs

b. Cut out all dead and decayed wood, plane cuts and paint with bitumen.

c. Drenching spray of lower frame and soil near collar with 1 litre Endosulfan or Chlorpyriphos in 300 l water. The best time of application of chamicals is October-January.

4.5 New flush stunted

a. Leaves curl down with brown ribs : Tea Jassid - Green fly

b. Leaves with 3 mm brown, translucent spots, distorted : *Helopeltis* - Tea mosquito bug

c. Bud attacked leaves scarred on either side of mid rib : Thrips

d. Crinkled and curled leaf below tipping level : Aphis

Control :

Any approved insecticide at 1 litre in 2001 water with low volume and 1 litre in 400 1 with high volume sprayed on canopy (see Integrated Pest & Disease Management in Tea).

4.6 Buds and young leaf tied up or rolled, small caterpillar inside : Flush worm

Control :

Pluck and destroy affected shoots. One round of insecticide spray (1 litre in 300 l) after plucking round (see Integrated Pest & Disease Management in Tea).

4.7 Labour stung by coloured hairy caterpillar : Nettle grubs

Control :

Collect with bamboo tongs (operators need protective clothing)

4.8 Labour bitten by ants

Control :

a. Cut out and destroy nests, spray frame.

b. Destroy aphis and scale insects with Malathion, Dimethoate etc. 1 lit in 400 1 water, spray on affected stems.

4.9 Branch dieback, grub in central tunnel, droppings on ground : Stern borer

Control :

Prune affected branch to sound wood, paint cut, kill grub.

4.10 Holes in tea chest panels, droppings in tea chest godown

Control :

a. Panels inspected one by one.

b. Walls and floors sprayed with Endosulfan *2* 1 in 200 1 of water, cracks repaired.

c. Suspect panels heated in dryer to 120°C for 10 minutes.

d. Stacking off the floor on treated scantlings.

4.11 Insecticides

For currently approved formulations of various insecticides refer to the latest list published in Two and A Bud.

4.12 Toxicity levels of pesticides

Classification of insecticides	LD50 mg/kg body weight		Co tifi of the label
	ORAL	DERMAL	
Extremely toxic	1-50	1-200	Brig
Highly toxic	51-500	201-2000	Brig
Moderately toxic	501-5000	2001-20000	Brig
Slightly toxic	More than 5000	More than 20000	Brig

Section 5. FUNGUS ATTACKS

See Tocklai Memorandum 26 and Integrated Pest & Disease Management in Tea.

5.1 Black rot

The fungus regrows from "sclerotia", resting stage in stem bark or petioles and infects mature leaves in spring. Spores develop on infected leaves in the rains.

The disease spreads by contact or with airborne basidiospores under dense shade and high humidity, particularly in UP areas. The pathogen enters dormancy after late September or October by forming "sclerotia", the dormant phase of the fungus.

Control :

a. Prune, clean out, caustic wash (12 kg washing soda in 200 1 water with 4-6 kg lime as marker).

b. Prophylactic spraying in areas known to be affected. In April/May, as the plucking table fills up, 2 fortnightly rounds of 0.5 kg copper-oxychloride in 200 1 water, plus sticker @ 60 ml/100 l if necessary.

c. Where the disease persists, flag the affected bushes and treat with copper oxychloride. All sprayings should be directed to the underside of maintenance foliage and the top frame.

d. Two monthly rounds of 'Carboxin'/ COC at 1:400 dilution during late season, November-December, to stop the formation of 'sclerotia'.

5.2 Blister blight

Tender young leaves and stems are infected by airborne spores in the plains, during Autumn and Spring and in the hills during Rains.

The disease builds up rapidly in cold, misty/moist, over shaded conditions.

Control :

a. Time pruning operation to reduce regrowth in danger period.

b. In Autumn, prune or skiff.

c. Pluck hard and black till the disease disappears.

d. In Spring and Rains (Darjeeling), a top spray of 0.625 to 1.0 kg of COC in 100-150 l of water with low volume sprayer in weekly rounds until the disease disappears.

5.3 Root diseases : Primary

Part of a mature bush (or all of it) dies suddenly, dead leaves remain attached.

a. Collar carries grey/black brittle crust, silky fan like mycelium under bark and deep black lines in wood : Charcoal stump rot

b. Brown soft fungal cushion at collar, roots have a soil crust and irregular brown lines in wood : Brown root rot

c. Chocolate red to black or film of mycelium (white on the inside) on the root bark, roots have a soil crust and solid wood tissues : Red root rot

d. Wooly grey fungus at collar, star like mycelium under bark and black dots and dashes in wood (common in Darjeeling, moderate in Assam) : Black root rot

Control :

Primary root diseases are mostly caused by contact with infected wood, hence good land clearing followed by 2 yrs. rehabilitation is very effective. Affected bushes and the ring of adjoining bushes have to be uprooted, removed and burnt. If immediate uprooting is not possible, isolate the area by a trench atleast 90 cm deep and 30 cm wide. *Trichoderma* bioagents (under advice of TRA) can be tried.

5. 4 Root diseases : Secondary

Affected roots violet/black, unpleasant smell, only in waterlogged soil : Violet root rot

Root bark normal but black wood inside with faint black lining, only on debilitated bushes : Diplodia

Control :

Rectify drainage, shade and soil aeration. In case of death, only the dead bush has to be uprooted.

5.5 Stem Diseases

Certain fungi, their spores either carried by wind or by pruning knives enter damaged stems causing disease that can spread throughout the frame and kill the bush.

Entry point : Sunscorch lesions, pruned or broken branches not planed or painted, bark damage from severe hail.

a. On medium and heavy branches : Branch canker *(Poria)*

b. On weak tender branches : Branch dieback *(Fusarium/Nectria)*

c. On medium branches in weak hill tea : Thorny stem blight *(Aglaospora)*

Prevention :

Entry points like pruning cuts or mechanical wounds are to be painted with COC

paste or bitumen paint Diseased branches should be knife cleaned before painting. 5-10% spore suspensions of *Trichoderma* bioformulations can be applied on the pruning cuts immediately after pruning.

If bushes die, only the diseased bush has to be uprooted.

N.B. For currently approved formulations of various fungicides, refer to the latest list published in Two and A Bud.

Section 6. MISCELLANEOUS DISEASES AND DISORDERS

6.1 Tea (more often young tea) with discoloured leaves and die-back of lateral; orange/red patches on stems, April-June, purple/black patches, August-March : Red Rust

Bushes suffering from bad drainage, insufficient or unbalanced fertiliser, adverse soil pH, poor shade etc. can be attacked by the airborne spores of red rust alga.

Sources of infection :

Airborne spores liberated from green crops like *Tephrosia desmodium* as well as infected tea stems.

Prevention & Control :

All field practices resulting in bush vigour; routine spraying of infected young tea with 0.5 kg fungicide in 200 1 water on stems, April-June.

0.5 kg fungicide in 200 l water, two fortnightly, followed by two monthly rounds, directed at the red fruiting patches on one or two year old stems, Young shade may also need spraying.

6.2 Brown blight, Grey blight

Old, weak, diseased or damaged leaves can be affected by these secondary fungi. Control on causes, not by spraying.

6.3 Sun scorch

a. Leaves : Burnt by heat after rain, if severe, rest and retip.

b. Branches : Bark burnt in patches if pruned before November.

Prevention :

Raise shade in advance, whitewash, keep pruning litters on top of frame for reducing direct sunlight.

6.4 Lightning strike

Separate affected bushes by deep drain. Uproot dead bushes at the earliest. Soil rehabilitation before infilling.

6.5 Hail damage

a. Leaf damage : If severe, rest and retip.

b. Stem and bark damage : **See 5.5 above**. Spray with fungicide 0.5 kg in 2001 water within 24 hrs, additional NPK according to severity of damage after regrowth.

6.6 Herbicide damage

Yellow or brown scorch : Paraquat

Rosette & stunted growth : Glyphosate (selective to cultivars)

Chlorosis and yellowing of veins : Diuron

Chlorosis and leaf necrosis, banjhi shoots, : Dalapon

Twisted shoots and leaves : 2,4-D

Repair with rest and extra N K fertilizer after regrowth at $^{1}/_{4}$ - $^{1}/_{2}$ of the annual application rate.

Heavy single dose of fertilizer applied too near to the collar can burn plants.

6.7 Canker of shade trees

Beetle larvae cause bark and wood damage which develops into large sores that can kill trees.

Prevention :

Monthly rounds of insecticides, 1 l in 400 1 water, directed at tree trunks upto 4.5 m above grounds, particularly March-May and August-September

Control :

As soon as gummy exudations are found on bark, that portion of bark and adjoining wood (if damaged) should be stripped off and burnt. The wool is to be knife cleaned, painted first with 0.1 litre insecticide and 25 g fungicide in 10 l water, then with bitumen.

6.8 Shade tree removal

a. Ring barking in spring for winter removal.

b. After felling/winching, damaged tea to be pruned and cuts treated.

c. Roots to be traced and dug out.

6.9 Utility timber

Wooden fence, post and bridge materials should be treated against fungal decay.

Section 7. SPRAYING EQUIPMENT AND ORGANISATION

7.1 Motorised sprayers

a. Scale : One sprayer for 20 ha tea under treatment, 1-3 ha a shift, depending on leaf area.

b. Coverage : 2 ha a shift full spray, 3 ha a shift top spray.

c. Spraying : 1 l petrol and 40 ml SAE-30 oil for each running hour of sprayer, note maker's instruction for mixture.

Required : Water supply (clean, ideally potable), pesticide supply and separate measures for each chemical. Mixing drum or tank, mixing stick.

7.2 Diluting and mixing

a. Liquid chemicals are slowly added to water in the mixing tank.

b. Dry chemicals are turned into paste with a little water, then added to water in tank.

c. When using more than one chemical, they are added to the water one at a time, each is stirred.

d. Compatibility - Refer T.E. Serial No. 110/5, under J.3.

7.3 Spraying squad

a. The chosen no. of machines each with one operator.

b. A mixer responsible for safe handling of concentrate and correct dilution.

c. A sprayer mechanic with tools and/or a spare machine.

d. A supervisor

e. Transport to and from the work place

7.4 Common operational problems in spraying equipment

Power sprayer :

a. Carburetor jet pins often get blocked.

b. Distributor points often get worn out.

c. Spark plugs need frequent cleaning.

Hand sprayer :

a. Nozzle washer may be loosened and/or displaced.

b. Nozzle orifices (apertures) often get blocked.

c. Swirl plate often gets blocked or misplaced.

7.5 Engine maintenance

a. Every 2 hrs - correct fuel mix.

b. Daily - check air cleaner, clean if necessary.

c. As per instruction manual, clean carburator, check/adjust plug & magneto gap, decarbonise.

d. New engines are run in 4 hours half throttle, 2 hours three quarters throttle.

7.6 Spray unit maintenance and precautions

a. Pressure inside the fuel tank should be maintained.

b. Check whether system is clean.

c. Check whether tank and pipe unions are tight, filters clean.

d. Clean after use.

7.7 Hand sprayers

One sprayer for every 10 ha

Weedicide : WFN Nozzle 24 and 40

Insecticide/Acaricide : NMD 60/460 nozzle

Foliar spray : BAN (75/450) nozzle

7.8 Tips for effective spraying

a. Demarcation of areas to be treated with pesticides to avoid overspraying or underspraying.

b. Spraying operators should be made to understand or instructed about the target pest and they should be aware of their responsibility.

c. Spraying should be done along the direction or across the direction of wind.

d. Spraying operation should be avoided during hot sunshine hours.

Section 8. PEST CONTROL CALENDAR

Pest incidence varies with weather, elevation and area; the table is a general guide only

Month	Inspect	For	Acti
January onwards	1-2 yrs. old pruned wood	borer	prur
	mature leaves of young tea	red spider	sten spra
.Jan.-Feb.	pruned tea	termites	soil
Sept.-Oct.			trea
March	whole garden,	mites	spra
	shade, mature tea, young tea and nurseries	looper cricket	spray trea
throughout tipping period	whole garden	mites, borers flush worm red rust discoloured leaf	spray pluck off & spray spray diagonose & treat
April-May	maintenance leaf treatment	black rot	spra
May-June	young tea	cockchafer grub	soil
July-August	maintenance leaf	black rot	spra
Nov.- Dec.	maintenance leaf & stem	black rot	spra
	pruned tea	nectria & poria	prur
	young tea	mites	spra

CHAPTER VI

ESTATE SERVICES

CHAPTER V

GARDEN PLANNING

Section 1. GENERAL

1.1 Break-Even Yield analysis (see Two & A Bud, Dec. '76)

a) Records : Yield/ha (sections and estate) and yield tendency, sale price (average), current and expected fixed expenses (per ha.), variable expenses (per kg)

b) Formula : $BEY(kg) = \frac{\text{Fixed expenses/ha}}{\text{Sales average — Variable cost/kg}}$

c) Comparison of BEY with actual yields as guide

1.2 Classification

a) Young tea : from planting until formation of permanent frames over the ground and BEY is reached.

b) Standard tea : rising yield with current practices, above BEY even with low market.

c) Substandard tea : stable or falling yield, above BEY only with high market, expected to improve with applicatin of available technology.

d) Sick tea : below BEY even with a high market, beyond economic rehabilitation.

1.3 Programmes

a) Extension : for all land suitable or which can be made suitable

b) Uprooting and replanting : for sections actually or potentially sick

c) Rejuvenation : for substandard teas

d) Tea and shade nursery : in connection with (a) (b) and (c)

e) Mulch and cover crop : in advance of (a) and (b)

1.4 Financial assistance for estate development

a) Tea Board schemes

i) Tea Plantation Finance Scheme for replanting, replacement, extension

ii) Replantation Subsidy Scheme

iii) Tea Machinery Hire-Purchase Scheme

iv) Tea Area Rejuvenation and Consolidation Subsidy Scheme (hill areas only)

b) Term loans from banks

c) Industrial Development Bank of India bill discounting scheme for machinery (through own bank)

d) Agricultural Refinance Development Corporation loans for approved field and factory development schemes (through own bank)

Section 2. EXTENSION

2.1 Administration

a) Preliminary survey of suitable areas

b) Tea Board procedure : Under legislation, an area not already registered as a tea area cannot be planted without a permit; this is obtainable on application to the Tea Board and can cover several years. The planting operation cannot legally commence until the permit is in hand; application during the preceding financial year (April-March) or at least 90 days before commencement is advisable.

c) Tea nursery programme :

$$\frac{\text{No. of ha to be planted x bushes/ha}}{\text{Sleeves per bed}} = \frac{\text{No. of beds reqd x 100}}{\text{\% success of nursery}}$$

d) Cover crop programme (preplanting) :

Pusa napier/ guatemala grass	: 0.1-0.2 ha Nucleus for 1 ha planting
Thornless Mimosa	: 50 kg seed for 1 ha planting
Citronella	: 0.05-0.1 ha Nucleus for 1 ha planting
Eragrostis penisetum	: 25 kg seed for 1ha planting
Any legume	: sufficient seed for dense hedging

e) Mulch programme (post planting) :

First round : 1 ha fully grown mulch crop for 1 ha planting (40 tonnes/ha)

Subsequent rounds : 0.25 ha planting (10 tonnes/ha)

f) Shade nursery programme : 500/ha temporary, 150/ha permanent

g) Fencing programme

2.2 Land clearance

a) Winching preferable to felling and digging skimps

b) Removal of all hard wood, soft growth left, no burning

c) Levelling by disc or hoe - *2* tractor days/ha

d) Contour survey, cut drains

e) Lay out roads, bridges

N.B. : On steep slopes, strip clearing on contour lines

2.3 Termite hills

a) Remove top soil, if any

b) Dig out termite soil for roads

c) Refill with drain soil, replace top soil

2.4 Soil tests

pH value, organic matter and nutrient status on clearance.

2.5 Land planning

a) Contour survey, marking of drainage lines on the basis of topography

b) Roads on crests as far as possible

2.6 Cover crop

a) Soil conservation

b) Mulch

2.7 Planting

See Chapter II, Section 5

2.8 Records

a) The extension area(s) are surveyed by a government approved surveyor and the resulting maps are filed.

b) The Estate Area Statement as submitted to Tea Board annually is updated, i.e., the extension reported results in a corresponding increase in the registered tea area.

Section 3. REPLANTING

3.1 Uprooting programme

a) Survey

i) Section yielding less than 65% of the estate

ii) Section having more than 25% vacancies

iii) Section noticeably below garden mark in quality

iv) Section below BEY

b) The list gives priority to the section with the smallest contribution and is updated every year.

c) Where young tea practices are effective, sections well above BEY may also be considered for uprooting to maintain the age balance of the estate to even out work load and to benefit from the yield and quality potential of new material.

d) Target : 2.5% of old tea areas

3.2 Uprooting operation

a) Shade is killed before removal to prevent primary root diseases. Method : Ring barking at least one year ahead. Removal of dead shade by winching or by felling and digging stumps.

b) Tea is deep skiffed before uprooting (5-10 tonnes organic matter/ha)

c) Tractor uprooting

i) 50 HP tractor with 10 tonnes winch and anchor

ii) Specially made, high tensile, uprooting tackle, 2 sets

ii) Attention to safety

3.3 Land planning

a) Contour survey, identification of catchments

b) Marking of drainage lines

3.4 Land preparation

a) Filling up unwanted drains and shade stump holes.

b) Applying lime or dolomite (**see Chap. I, 3.5**). Ideal pH is 4.5 to 5.5; 2 tonnes of dolomite is necessary to incease approx. 0.5 unit of pH.

c) Ploughing to level land and help the rehabilitation crop.

d) Subsoiling to break pans, if any, and for aeration/drainage to 90 cm, can be done in the plains if 100 HP crawler tractors are available. Where this is not

practical, like in hill areas or teelahs, extra deep holing at the time of planting is a useful substitute.

e) Drains are dug to a comprehensive plan.

f) Guide stakes to outline the staking pattern planned can be fixed up

3.5 Soil rehabilitation

a) Supply of rehabilitation crops : Large deep rooting grasses like Guatemala and Pusa Napier are best. Multiplication baris are required @ 0.1- 0.2 ha for each ha uprooted per year. Fresh stem cuttings with one node or rooted slips are required.

b) Spacing, planting : 60 cm x 100 cm is ideal; planted into tilled, moist soil; infilled and weeded by hand or cheel hoe.

c) Fertilizer, lopping : Basal dose 60 kg N as 2:1:2, first lopping at 60 cm ground measure. After each lopping, 30 kg N as 2:1:2, each round lopping 15 cm higher. Where soil potash is less than 100 ppm, apply potash in form of 2:1:3 NPK mixture. No lopping after mid September.

d) 2nd Year : Fertiliser and loppings are repeated.

Rehabilitation is not complete unless the growth of the grass crop is over 2 m, thick and even and root penetration is 90-100 cm, Subsoiling helps root growth.

3.6 Planting

See Chapter II, Section 5

3.7 Mulching

The rehabilitation crop cut at 25-30 cm from ground level is the first round of mulch for the newly planted tea.

The top up supply comes from the mulch bari which would be 0.25 ha for each ha of 1st year tea.

3.8 Young tea practices

See Chapter II, Section. 6

3.9 Records

a) The replanted area is surveyed by a Govt. approved Surveyor and the resulting map is filed.

b) Where the replanted area is less than the uprooted area, the balance can be planted elsewhere without altering the registered tea area.

c) Where the replanted area is more than the uprooted area, the balance has to be adjusted against existing extension permits.

Section 4. REJUVENATION

4.1 Rejuvenation calendar

Year	Time	Action
-2	Spring	All the vacant spaces should be planted with Guatemala for rehabilitation.
		Establish shade nurseries © 200% of calculated requirements.
-1	Spring	Plant shade, both temporary and permanent; keep infilled; build up soil potash status.
	Autumn	Establish tea nurseries
		Leave section UP, ring overaged shade.
0	Spring	Apply normal dose of N and P_2O_5; additional K_2O need to be applied based on K status.
	September	Rest, remove dead shade, fill saucers.
	November	Infill if soil is moist and mulch defer to spring if dry.
		Heavy or medium prune
	December	Cut back the poria and termite infested or dead branches to the healthy part; uproot the bushes infected by primary root diseases.
+1	January	Survey, repair or realign drains.
	Spring onwards	Revise infilling, mulch and shade, apply NPK (2:1:3) : N (90-130 kg/ha).
		Tip at 80-90 cm from ground irrespective of height of prune, 100% weed and pest control.
	December	C/A and desnag (LOS if weak), infill the vacancy created by dead infills and also bushes which failed to recover.
+2	Spring	Head back and remove strong centre and cross branches of infills at 40 cm. Pluck at same height with other bushes. Now, follow all other field practices at highest standard.
	December	LP and revise desnag. Infills cut across at 45-50 cm and tip at same height as in old bushes.

In the hills, tea nurseries take longer to establish, shade not required above 900 m elevation, infilling best in early rains, one or two years skiff before C/A, desnag.

4.2 Infilling

a) Single vacancies in square and triangular planting needs 3 infills. In multiple vacancies, (2 x vacancy + 1) infills should be planted in staggered double hedge (**Fig. 1**).

b) Vigorous clones like TV 19, TV 20, TV 22, TV 23, TV 24, TV 25, TV 26, TV 29 and seed stocks like TS 449, TS 450, TS 462, TS 468, TS 464 of 60 cm height should be used.

c) Cattle manure (4-5 kg), rock phosphate (30 g) and SSP (30 g) should be used in planting pit.

d) Mulching, clean weeding, trimming of side branches of mature bush are required.

e) Frame forming at the level of other bushes, protect against suppression.

4.3 Interplanting (Fig. 2) to convert into hedges

4' x 4' into 2' x 4' = 6944 plants required/ha

4' x 5' into 2.5' x 4' = 5555 plants required/ha

5' x 5' into 2.5' x 5' = 4444 plants required/ha

in addition to infills

4.4 Area selection for rejuvenation

a) Tea with poor frames, but good collar.

b) Tea below estate average in yield which will not be uprooted for 12 years or more.

c) Tea pruned for height reduction, even if yield above average.

4.5 Drainage

A thorough check on the drainage layout and design is required before the prune. Any work found necessary is to be done after the prune.

4.6 Shade

Temporary shade to protect the newly pruned bushes. Permanent shade to serve with the rehabilitation section.

4.7 Mulch

Without this, infilling and interlining will not succeed.

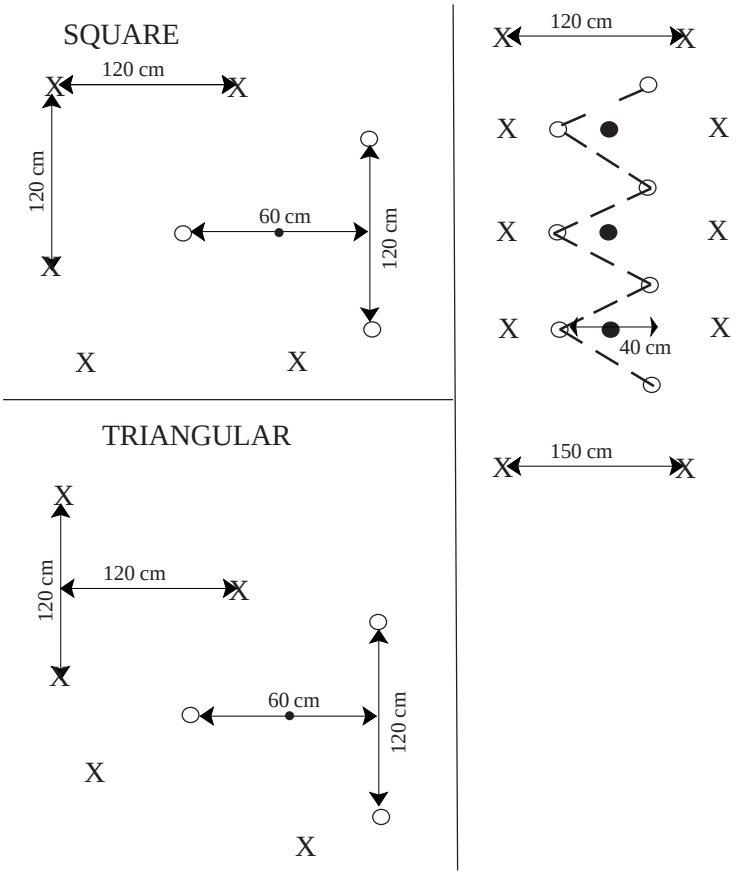


Fig. 1. Infilling (X = Existing bush O = Infills ● = Vacancy

4.8 Weed and pest control

To obtain full value from rejuvenation, pest management practices have to be 100%.

4.9 Fertilizer

Young tea mixtures of NPK 2:1:3 are required until full frame forming.

CHAPTER VI

ESTATE SERVICES

Sec. 1 : Garden roads

Sec. 2 : Bridges

Sec. 3 : Building materials

Sec. 4 : Water supply

CHAPTER VI

ESTATE SERVICES

Section 1. GARDEN ROADS

1.1 Drainage

Roads have 5 cm camber (crest line higher than sides). Roads should have side drains sufficiently deep to stop road crests being softened by high water table.

1.2 Soling

Use stones, bricks or rubble as weight bearing layer in well drained, firm soil, 10 cm thick; in badly drained, soft soil, 20-26 cm thick. Approx. 150 vehicle loads will be required for 1 km road, 2.75 m wide, to take loaded lorries. For leaf trailer and jeep traffic only, soling can be reduced to 50%.

1.3 Metal

Use broken stones or bricks or shingles to harden the roads. 2.5 m wide.

a) 6 cm layer of 2-3 cm stones (blinded with sand/soil) 52 loads/Km.

b) Consolidation by traffic or by hand roller drawn by tractor,1 m dia x 1.2 m long, normally 3 tonnes.

c) Surfacing with 3 cm layer of 1-2 cm stone chips, 26 loads/Km.

1.4 Bitumen

For grouting — 7 tonnes/Km, 2.5 m wide

For sealing — 4.5 „ /Km, „

For blinding — chips or sand, 8 loads/Km

I. 5 Passing bays

2 x length of longest vehicle, 2.5 m wide

1. 6 Plucking paths

Every 30-50 bushes, across plucking direction in plains, according to ground diagonal to plucking lines, in hills in wide spacing, side branches trimmed in close spacing, one bush left out.

Section *2.* BRIDGES

2.1 Plucking path over smaller drains

Permanent : T section RCC, 45 cm wide, 25 cm deep, 3-4 m long

channel section RCC, 45 cm wide, 12 cm deep.

Temporary : Wood or bamboo, oiled against wood rot.

2.2 Roads over drains

RCC pipe culvert, size wider and level lower than drain, top of culvert, minimum 45 cm below road surface.

2.3 Road over large drain

Sloped retaining walls with upstream guide walls and drain holes. RCC beams — rough rule of thumb for spans from 2 m to 5 m depth = 10% of span, width 2% of span plus 3 cm, 2 or 3 such beams for each wheel track depending on traffic deck of RCC 10 cm thick or timber scantlings.

***2.* 4** Main roud over large drain or water course, copy approved PW.D. design.

Section 3. BUILDING MATERIALS

3. 1 Bamboo

Weight, of mature culm (sheath dropped)

Jati, Betu, Makal, Bakal — 12 Kg.

Kako, Jaora — 18 Kg.

Bholunka, Barua — 30 Kg.

Muli, Dalu, Mirtinga, Bijli — 1 Kg (bundles of 20)

Ordering : Girth at 1.8 m from ground, length without thin top.

Seasoning : Cut in cold weather only, soak in running water one week or boil $2^{1}/_{2}$ hrs, oil after air drying.

3. 2 Cane (Jati)

1 kap = 5 whole piece 4-5 m long or 10 splits

1 bundle = 20 kaps

3.3 Thatch

Uloo — thin stalk, narrow leaf, 1.5 m long

Rangi — thick stalk, wide leaf, 2.5 m long

Mature after flowering

Small bundles 30 cm circumference

Large bundles 60 cm „

3. 4 Timber

Only heart wood is building material

Battens : 1 cm — 4 cm thick, 4 cm — 15 cm wide

Planks : 2 cm — 10 cm thick 15 cm — full log diameter wide

Scantlings : 5 cm — 15 cm thick and wide

Beams : 15 cm — 30 cm thick and wide

Log measure is midgirth divided by 4, squared $(^{g}/_{4}.)^{2}$, strong timber weighs above 800 Kg/m^3 (50 lb/cft), air drying is the gradual evaporation of fibre moisture, seasoning is the gradual evaporation of cell moisture, pressure treatment is to replace timber moisture with creosote or chemical preservative, surface treatment

is painting with oil, varnish, chemical or paint.

Common construction timbers will last

1 — 5 yrs if unseasoned

5 — 15 yrs if seasoned and surfaced

15 — 50 yrs if seasoned and pressure treated, depending mainly on exposure.

3.5 Bricks

1 st class : bright colour, even surface, uniform shape, straight edges, metallic ring.

2nd class : sound, but not so uniform and straight edged.

3rd class : dull sound.

l m^3 brick work is approx. 450 bricks and mortar 0.75m^3

1 m^2 25 cm wull — 110 bricks

12 cm wall — 50 bricks

7 cm wall — 33 bricks

Laying of 200 bricks with 0.8 cm joints requires 45 kg. cement and 0.08 m^3 sand.

3.6 Sand

0.5 mm — 2.5 mm washed in tray or trough

Lime and Sand mortar — 1:2 plastering, 1:3 stone joints

Cement & Sand mortar

pointing, grouting	— 1:1
plaster outside	— 1:2
plaster inside	— 1:4
for brick on edge 7cm wall	— 1:3
for single brick 12 cm wall	— 1:4
for multiple bricks 25 cm wall	— 1:5
plaster on ekra/split bamboo	— 1:5
damp-prooiing, water-tight	— 1:2 plus additive

3.7 Lime Concrete

Proportions for light duty foundation or flooring : 1 lime, 1 sand, 1 surki (ground brick), 4-6 aggregate or 1 lime, 2 sand, 5 aggregate or 1 lime, 2 surki, 5 aggregate.

3.8 Cement Concrete

Consists of cement, small aggregate (sand) and coarse aggregate (gravel, broken stone). In strong concrete, the spaces in sand are filled with a cement and water paste, the spaces in the coarse aggregate are filled with a mixture of sand and cement paste.

a) Spaces commonly found :

broken stone or broken brick	:	35 — 45%
gravel	:	25 — 35%
gravel and sand mix	:	20 — 25%
sand	:	30 — 40%

graded aggregate (the particles are of different sizes, mixed) has fewer spaces to fill.

b) Aggregate size maximum :

foundation	:	1 cm
common work	:	2 cm
thin reinforced	:	0.5-1 cm

c) Cement

1 bag = 50 Kgs = 1 box 30 cm x 30 cm x 30 cm

d) Water

The suitable quantity is the smallest which allows thorough mixing and gives the required workability. It may vary from 12-40 litres for each bag of cement, varying with aggregate size; rich mixtures (more cement) require less water than lean mixtures (more aggregate). When sand and aggregate are wet from rain or washing, very little extra water is required.

e) Mixing

by hand	:	Spread sand, cement, and mix dry Spread this mixture over clean aggregate, mix dry, add water gradually and continue mixing
by mechanical mixer	:	put in 1/3 water, put in 1/2 aggregate, put in 1/2 sand, and put in 1/2 cement. Repeat sequence and add only enough water for the right workability towards the end.

f) Commonly used proportions :

High road structures, small precast	— 2 : $1^1/_2$: 3
Low „ ,, , floors, slabs, stairs	— 1:2 : 4
Foundations, thick walls, piers	— 1:3 : 6
Mass concrete	— 1:4 : 8

These mixes are some examples and require adjustment for aggregate size and application.

g) A rough guide for estimating quantities required for 2.8 m^3 (100 cft) of various mixes of cement mortar and cement concrete:

mix ratios	bags cement	in boxes 30 cm x 30 cm x 30 cm SAND/AGGREGATE	
1: 1	57	69	–
1:2	39	94	–
1:3	29	105	–
1:4	23	110	–
1:5	20	114	–
1:6	16	118	–
1:8	13	122	–
1:1:2	32	38	76
1:$1^1/_2$:3	22	41	82
1:2 : 4	17	42	85
1:3:6	12	44	89
1:4:8	9	45	92

3. 9 Roofing materials

a) Galvanized corrugated iron sheets 10/3 (ten corrugations, 75 mm pitch) normal width 81 cm (32")

order by bundles containing	7 pcs.3 m long
	9 pcs.2.5 m long
	12 pcs.2 m long
thickness in trade	26 gauge
	24 gauge
to order	22 gauge

b) Corrugated aluminium

similar, but ordered in running feet, normally 24 gauge, other thicknesses to order.

c) Ridges

are fabricated from plain sheets 1.8 m or 2.5 m long, should not be thinner than the sheets used, width must be sufficient to give a 15 cm minimum lap.

d) Gutters

must be wide enough to give a

15 cm lap for a 3 m roof

22 cm lap for a 6 m roof

30 cm lap for a 9 m roof

one 15 cm down pipe for every 60 m^a roof area.

e) Asbestos corrugated sheets
1 m wide, 7 corrugations

1 m wide, 4 corrugations, 3 flats (semi corrugated) standard length

1.75 m

2.00 m

2.25 m

2.50 m

2.75 m

3.00 m all 6 mm thick.

f) Fittings — galvanised iron

screws, 6 mm, 56 mm long — 70 pc. in 1 kg
62 mm long — 60 pc. in 1 kg
75 mm long — 46 pc. in 1 kg

join bolts with nuts, 6 mm,

18 mm long — 90 pc. in 1 kg

30 mm long — 70 pc. in 1 kg

limpet washers — 500 pc. in 1 kg

hookbolts with nuts, 8 mm,

100 mm long — 16 pc. in 1 kg

112 mm long — 14 pc. in 1 kg

125 mm long — 13 pc. in 1 kg

3.10 Steel wire nails

Thickness of wire and manufacturing methods are not standardised but approximate numbers found in 1 kg are :

12 mm	-	1/2"	-	7500/kg
18 mm	-	3/4"	-	4000/kg
25 mm	-	1"	-	2300/kg
31 mm	-	1 1/4"	-	1400/kg
37 mm	-	1 1/2"	-	840/kg
50 mm	-	2"	-	460/kg
62 mm	-	2 1/2"	-	250/kg
75 mm	-	3"	-	170/kg
100 mm	-	4"	-	95/kg

3.11 Rolled steel structurals

Weight in kg per m of commonly used sections

Angles	50 mm x 50 mm x 6 mm (2" x 2" x 1/4")	4.5 kg
	65 mm x 65 mm x 6 mm (2 1/2" x 2 1/2" x 1/4")	5.8 kg
	75 mm x 75 mm x 6 mm (3" x 3" x 1/4")	6.8 kg
	150 mm x 150 mm x 10 mm (6" x 6" x 3/8")	22.8 kg
	75 mm x 50 mm x 6 mm (3" x 2" x 1/4")	5.6 kg
Channels	100 mm x 50 mm (4" x 2")	7.9 kg
	125 mm x 65 mm (5" x 2 1/2")	12.7 kg
	150 mm x 75 mm (6" x 3")	17.5 kg
R.S.J.	100 mm x 50 mm (4" x 2")	8.0 kg
	125 mm x 75 mm (5" x 3")	13.0 kg
	150 mm x 80 mm (6" x 3")	14.2 kg
	175 mm x 90 mm (7" x 3 1/2")	19.3 kg
	200 mm x 100 mm (8" x 4")	25.4 kg

Section 4. WATER SUPPLY

4.1 General

a) Rotary pumps, single or multistage, are used for general work.

Piston pumps are used to deliver comparatively small quantities of water against a high total head eg. outlying employee housing or nurseries, or where high pressure is required.

b) The performance of a rotary pump of given size varies with motor size, as below :

Pump size	Motor size		Maximum head	Capacity
mm	KW	HP	m	litre per min
25	0.37	0.50	18	40
	0.50	0.75	33	25
	0.75	1.00	44	10
32	0.75	1.00	36	35
	1.00	1.00	67	20
	1.50	2.00	76	13
38	1.50	2.00	24	125
	2.00	3.00	30	160
	3.00	4.00	45	140
	3.70	5.00	67	75
50	3.70	5.00	18	370
	5.50	7.50	45	280
	7.50	10.00	68	180
63	7.50	10.00	27	520
	11.00	15.00	52	370
76	15.00	20.00	18	880
	18.50	25.00	49	650

(Capacities are given as examples only;
they vary with pump and pipeline design)

c) the performance of a pumpof given size varies with total head

Pump mm	Motor (multistage rotary pumps ±10%) HP						
25 —	1.0 head (m)	44	40	30	16		
	1/min	10	15	25	40		
32 —	2.0 head (m)	75	72	56	47	28	
	1/min	13	15	25	30	40	
38 —	5.0 head (m)	67	59	49	37	25	12
	1/min	75	100	125	150	175	200
50 —	10.0 head (m)	68	60	50	40	32	19
	l/min	180	220	260	300	330	370
63 —	15.0 head (m)	52	49	41	,33	24	14
	1/min	375	400	450	500	550	600
76 —	25.0 head (m)	49	43	38	31	24	14
	1/min	650	700	750	800	850	900

4. 2 Total Head = static head + pipe friction

a) Suction lift = the vertical distance from water supply level to pump.

N. B. Pump performance falls off sharply at suction lifts exceeding 7 m and there is no lift beyond 8 m, unless special devices are fitted or submersible pumps are used.

b) Delivery height = the vertical distance from pump to discharge point.
(a) + (b) = static head.

c) Pipe friction depends on flow rate

Pipe size (mm)		Losses in m (for each 100 m of pipe) which have to be added to the static head					
25	1/min loss	10.0	15.0	25.0	40.0		
		1.0	1.3	3.2	7.8		
32	1/min loss	13.0	15.0	25.0	30.0	40.0	
		0.5	0.6	0.9	1.2	2.0	
38	1/min loss	75.0	100.0	125.0	150.0	175.0	200.0
		3.0	5.2	7.8	11.0	14.7	18.8
50	1/min loss	180.0	220.0	260.0	300.0	330.0	370.0
		5.2	8.1	10.1	13.9	16.2	18.6
63	1/min loss	375.0	400.0	450.0	500.0	550.0	600.0
		6.8	7.9	9.8	12.0	14.0	16.0
76	1/min loss	650.0	700.0	750.0	800.0	850.0	900.0
		8.1	9.2	11.0	11.8	13.3	14.8

4. 3 Ordering a pump

Calculate total requirement and divide by acceptable pumping period = litres per minute.

Measure static head, add pipe friction

Pump specification : to give Z litres per minute against a total head of Y, with suction lift of Z.

Manufacturers' offers are compared and that pump is selected which equals or exceeds all requirements as to 1/min, total head and suction life

4. 4 Planning a pipe line

a) Measure distances to be covered and calculate friction loss in chosen pipe sizes. If the loss is high relative to static head then the pipe sizes need to be increased. Pipe sizes larger than the pump connections are good practice.

b) High level storage (for gravity distribution) is best connected to the pump (s) by a straight line, as elbows, and sharp bends add to the pump load.

4. 5 Rough rules for calculating requirements

a) Factory

Floor area of G. L.process unit + surface area of G.L. process machines + floor area of fermenting unit + area of fermenting surfaces (all in m^2) multiply by 10 1 = single wash down

Washing a jeep — 150 1

Washing a lorry — 800 1,

b) Garden

2000 1 for each spray gang shift

0.5 1 for every brick laid

c) Domestic

150 1 a person a day + 150 1 a household a day

d) Storage tank size

48 hrs off take at the water points served.

CHAPTER VII

MANUFACTURE

CHAPTER VII

MANUFACTURE

Section 1. WITHERI NG

1. 1 Definitions :

a) Chemical Wither : Desirable bio-chemical changes from plucking to initiation of processing (manufacturing), normally 14-20 hrs

b) Physical wither : Moisture loss, leaf becomes flaccid.

c) Percent wither (% wither). The weight of 100 kg fresh leaf at the end of the withering process.

Different % moisture contents of fresh leaf results in different % moisture contents of withered leaf, even when the "% wither"remains the same :

Fresh leaf moisture	Withered leaf, i.e. 100 kg fresh leaf reduced to							
	80kg	75kg	70kg	65kg	60kg	55kg	50kg	45kg
82%	78%	77%	75%	73%	71%	68%	65%	61%
80%	76%	74%	72%	70%	68%	65%	61%	57%
78%	73%	72%	69%	67%	64%	61%	57%	52%
76%	71%	69%	67%	64%	61%	57%	53%	48%
74%	68%	66%	64%	61%	58%	54%	49%	43%

d) Percent wither can be calculated by measuring the recovery % of made tea against withered leaf

Fresh leaf
moisture Recovery % of tea made against withered leaf (theoretical)

82%	19	22	25	27	30	31	35	38
78%	23	26	30	33	35	38	42	47
74%	28	31	36	38	42	45	50	56
Calculated % wither	90	80	70	65	60	55	50	45

The same recovery % indicates light wither on dry leaf
medium „ „ average leaf
hard „ „ moist leaf

Fresh leaf moisture content determines withering (and drying) loads; 8 percentage points less moisture results in 40-45% increase in recovery.

Example : At 80% wither, a reduction from 82 to 74-% moisture gives an extra 10 on 22, i.e. 45%.

1.2 Controlled Wither

(i) Normal requirements for :

	Moisture content of withered leaf	Equivalent % wither on moist average dryish		
CTC	70%	58	73	80
Orthodox (plains)	66%	52	65	74
Orthodox (hills)	33%	26	33	39

(ii) Equipment : Heated lofts, drums, Tocklai tunnels and troughs.

(iii) Method : When more moisture is there in the fresh leaf, more % wither must be given to achieve 70% moisture in withered leaf:

Example : To achieve 70% target moisture content, from fresh leaf of any moisture %

Fresh leaf moisture %	82	80	78	76	74
Required % wither	58	65	70	77	83

N.B. As specific moisture meters for the purpose are not available at present, experience has to be applied for an estimate of leaf moisture %. Rains leaf, with surface moisture, has about 82-84% moisture. Dry leaf in a dry spell, just going limp, has 72 -74% moisture.

1. 3 Green Leaf Storage System (GLSS)

Keeps green leaf in fresh and undamaged condition upto 48 hours. Can be used in conjunction with the existing troughs so that the same troughs may be used upto 3 times a day. Adds to saving on power and space upto 60%.

Dimensions : 37.27m x 2m x 3.7m
Capacity : 14000 kg
Power required : HP-6
KW - 4.5

1.4 Spreads

a) In lofts - for orthodox, 1 kg on 2 m^2, 0.5 kg per m^2
for CTC, 1 kg on 1.5 m^2, 0.7 kg per m^2

b) In troughs

	CTC	Orthodox	
		Plains	Hills
Kg per running m of trough 1.8 m wide	38-48	33-43	28-38
Kg per m^2	20-25	17-23	15-20

1.5 Withering air in troughs

a) Air volume controlled with fan and damper (or bypass) ratio varies from 0.4 m^3/kg with fine leaf at 15 cm deep to 0.7 m^3/kg with standard leaf at 20 cm deep depending on leaf quality and spread, the air volume per m^2 trough surface will vary from 8 to 18 m^3/min

b) Temperature

Controlled by adding hot air
Heaters should supply 1/10 of the required volume at 100°C maximum
Fan inlet temperature should not exceed 38°C (plains) and 30°C (hills)

c) Hygrometric difference

The depression of wet bulb below dry bulb temperature should ideally be about 4°C.

High differences speed up moisture removal, but can give uneven wither. They can be used for drying off surface moisture initially.

d) Air pressure

Normally 12 mm Water Gauge. This should not drop below 6 mm when working against the normal spread of leaf.

1.6 Building troughs

a) Selecting a fan for an existing trough : Kg leaf to be loaded x air ratio selected (**see 1.5a above**) = air requirement in m^3. Compare this with air delivery figure in fan manufacturers' table, at 12 mm Water Gauge pressure : choose nearest larger standard size of axial flow fan.

Larger dia fans use less power per volume than smaller fans. By using pairs of smaller fans, flexibility is obtained, but this requires troughs 3-4 m wide.

b) Making a trough for an available fan

$$\frac{\text{fan capacity (rating), } m^3}{\text{air ratio selected}} = \text{Kg leaf capacity}$$

Divide leaf by spread selected (**see 1.4b above**) to get running m of a 1.8 m wide standard trough, or required m^2 of trough surface.

c) Calculating requirements

$$\text{Total no. of troughs} = \frac{\text{1\% of extimated annual GL (Kg)}}{\text{Spread selected } (^{kg}/_{m^2}) \text{ x Planned area per trough } (m^2)}$$

(includes additional capacity large enough for any anticipated peak day; will prevent the collapse of quality control under adverse climatic conditions.

Section 2. GREEN LEAF PROCESSING

2.1 Sifters

To extract sand etc. 4-5 mm perforation in reversed bossed sheet. Well inclined, 180 RPM.

2.2 Rolling

Rolling is a process where rollers are used to rupture the cell walls of the withered leaves for oxidation of the polyphenols in the presenc of oxygen from air

Roller size		90 cm (36")	115 cm (46")
Charge capacity (withered leaf)		90 -150 Kg.	260 -350 Kg
Table RPM	S A	58-60	45-50
	DA	50	40-45
Power required	H P	7.5-10	12.5-15
	K W	6-7.5	9-11

2.3 Green leaf sifters

		Shaker	Rotary (wire)	Rotary (sheet)
Perforation size		9-11mm	8 -4 mm mesh	10-6 mm
Capacity/hr (rolled)		1500 Kg	500 kg/m length	350 kg/m
	RPM	260-280	18-20	25-30
Power req.	HP	1	2	2
	KW	0.75	1.5	1.5

2.4 Leaf Conditioner

	37 cm Rotorvane	BLC.
Capacity/hr	35 Kg/rev	1200
RPM	35- 50	38
Power req. HP (KW)	15 (12.5)	15 (12.5)
With cutter	20 (15)	20 (15)

2.5 Boruah Continuous Roller (BCR)

	45 cm 1st Roll-2 passes	40 cm 2nd Roll	37 cm 3rd Roll
Capacity,			
Kg/hr	1750	1350	1000
Power, HP (KW)	10(7.5)	15(11.25)	10(7.5)
Space required	4.35 m long x 1.71 m wide.		

2.6.1 C.T.C. (Conventional)

a) Machines

Size	61 cm (24")	76 cm (30")	91 cm (36")	122cm (48")
Capacity* (rolled)	600	750	900	1200
Capacity (RV)	800	1000	1200	1600
Power KW	10	11.25-15	15-18.5	18.5-22.5
HP	15	15-20	20-25	25-30

*with standard plucking (65-70% fine)

b) Segments

Bore : 16. 1925 cm O.D. 20 or 21 cm
Width : 5.080 cm or multiples

	Pitch (mm)	No./Seg	Depth mm
Circumferential grooves	3.15 (8 TPI)	$15+2x^1/_2$	2.03
(chasing angle 55°)	2.54 (10 TPI)	$19+2x^1/_2$	1.59
Helical grooves	1.32-1.13	50	1.73
(lead 60 cm)	1.10-0.94	60	1.27
Circumferential grooves	3.15 (8TPI)	$15+2x^1/_2$	2.46
(chasing angle 45°)	2.54 (10TPI)	$19+2x^1/_2$	1.98
Helical grooves	1.32-1.13	50	2.13
(lead 60 cm)	1.10-0.94	60	1.73

Cutter angle for helical groove to maintain length of tooth :

Roller diameter (cm)	18	19	20	21
Cutter angle (theoretical)	67°	69°	70°	71°
Cutter angle (practical)	65°	65°	70°	70°

2.6.2 C.T.C. (33 cm dia)

Machines		76 cm (30 in)	91 cm (36 in)
Capacity, kg/hr (Rolled)		1000	1200
Power, KW (HP)	1st Roll	18.5 (25)	22 (30)
	2nd Roll	18.5 (25)	18.5 (25)
	3rd Roll	15.0 (20)	18.5 (25)
RPM	HSR	600	600
	SSR	60	60
No. of helicals	8 TPI	80	80
	10 TPI	100	100

Section 3. FERMENTATION

3.1. Definition

Fermentation is the process during which the polyphenols in the tea leaf are oxidised in presence of the enzymes and subsequently condensed to form coloured compounds contributing to the quality attributes of tea. Fermentation starts immediately after cell rupture.

3.2 Temperature

Optimum : 24°C — 29°C

Factors affecting temperature :

i) leaf temperatures at the end of green leaf processing,
ii) thickness of spread
iii) temperature of air in fermenting room.

3.3 Humidity

Optimum : 1°C - 1.5°C Hygrometric Difference
Any larger H.D. requires humidification of the room.
Normal method : mist chambers or spray units.

3.4 Spread

On floor, sheet or table

Thickness	Orthodox	CTC
2 cm thick, 1 Kg leaf takes	0.18 m^2	0.12 m^2
3 " " "	0.12 "	0.08 "
4 " " "	0.09 "	0.06 "
5 " " "	0.07 "	0.05 "

Approx. space requirements	Orthodox	Roll/CTC	RV/CTC
for 1000 Kg throughput per hr	600 m^2	225 m^2	450 m^2

3.5 Air for floor fermentation

10-12 changes of air per hour. If natural ventilation does not assure that all air in the room is renewed every 5-6 minutes, fan assistance may have to be given, air speed to be kept as low as possible.

3.6 Fermenting Troughs

Pressure in trough : 2-5 cm water gauge depending on depth of leaf and particle size.

Hygrometric difference : dry air blackens leaf. For a 1000 Kg GL. throughput per hr. -

CTC. 100 gamlas

3 roll Orthodox 150 gamlas

2 roll Orthodox 160 gamlas

3.7 Fermenting Machine

Size and capacity varies from manufacturer to manufacturer. Dimensions of 17 m x 4 m x 3.5 m would suffice to supply two 1.8 m dryers.

Section 4. DRYING

4.1 Definition

Drying is the process during which the enzyme activities are stopped and the moisture content is brought down to 2-3%.

4.2 The load on dryers depends on wither.

Kg of water to be evaporated in dryer/100 kg of fresh leaf containing different percentages of moisture.

Moisture content of fresh leaf (%)	100 Kg fresh leaf reduced to (Kg i.e. Percent Wither						
	90	80	75	70	60	50	45
82	72	62	57	52	42	32	27
78	68	58	53	48	38	28	23
74	64	54	49	44	34	24	19

N.B. Respiration losses of solids and moisture remaining in dryer mouth tea more or less balance and have not been considered in this Chapter.

With a soft wither on rains leaf, 3.77 times drying capacity is required compared to a hard wither on dryish leaf (72:19) under average conditions. A percentage wither of 85 instead of 75, means 17% more dryer hours. A change from 75% to 65% wither will save one dryer in 5 or reduce drying hours by 1/5.

4.3 a) Dryer adjustments :

Variables	Affected by
Exhaust temperature	Inlet temperature, spread, air-volume, tray speed
Spread	Spreader adjustment
Time through dryer	Tray speed adjustment
Air volume	Damper adjustment
Inlet temperature	Heater adjustment
% moisture at dryer mouth	Time through dryer, inlet temperature, air volume

b) limiting factors for adjustments :

	Too high	Too low
Exhaust temperature	Waste of heat	Low temperature stewing
Spread	Reduced air flow, incomplete drying	Loss of air
Time through dryer	Burning	Incomplete drying
Air volume	Leaf blow out	Stewing
Inlet temperature	Burning/case-hardening	Exhaust too low
Moisture % at discharge	Incomplete drying	Waste of heat.

4.4 Dryer capacity

a) It varies with : Dryer design and condition, Air volume, Available heat, Operational adjustments.

and is measured in Kg of water evaporated/hr

b) The weight of dryer mouth tea is a measure of capacity only if the moisture content of fermented leaf is stable and known.

% Moisture in fermented leaf	Dryer mouth Kg	Water evaporated Kg	
29	100	41	Darjeeling wither
50	100	100	Darjeeling wither
65	100	186	Plains orthodox
70	100	223	CTC optimum
75	100	288	Soft wither
80	100	385	Wet leaf

Depending on wither, 30 cm of dryer width can give 25-40 Kg made tea/hr. Fluid Bed Dryer (FBD) which is used for CTC manufacture only gives 280-400 Kg made tea/hr depending on the degree of wither and the design of the machine.

c) Capacity Test : i) Stabilise the exhaust temperature, inlet temperature and time through dryer,

ii) Weigh all fermented leaf, before feeding it into dryer for 60 mins. starting and finishing without reserve leaf at spreader,

iii) Weigh all dryer mouth tea for 60 mins.

Dryer capacity = (ii) — (iii) Kg of water evaporated.

4.5 Dryer trays :

3 kinds of perforations :	Bold	9-11 SWG, 2.8-3.2 mm
	Medium	13-14 SWG, 2.2-2.5 mm
	Fine	15-16 SWG, 1.6-1.8 mm

Traditional designation, eg. 72/13, indicates 72 perforations/square inch, each of 13 SWG.

4.6 a) Conventional Dryer — 6 feet (180 cm) 4 feet (120 cm)

Power for chamber drive	HP	2	2
	KW	1.5	1.5
Fan	HP	12.5-15	10-12.5
	KW	9-11	7.5-9
Floor space		4m x 13.5m	3m x 12.5m

b) Fluid Bed Dryer : 3 feet (90 cm) 4 feet. (120 cm)

Power (Installed capacity)			
Drying system	HP	23-28	33-56
	KW	17-21	25-42
Dust collection	HP	10	22.5
	KW	7.5	16.8

4.7 Moisture uptake :

a) At the dryer mouth :
If not ventilated/cooled, the newly fired tea re-absorbs moisture, 'sweats', also called high temperature stewing.

b) From ambient air during sorting etc. :
In high temperature and high relative humidity (small wet bulb depression) tea absorbs moisture rapidly to 8%, more slowly to 15%. Redrying, 'final firing', again reduce the moisture content to approx 3%.

4.8 Fuel utilization :

a) Assuming leaf of average moisture content, 100 Kg = 78 Kg water, 22 Kg tea
Assuming 75% wither, the remaining water content is 53 Kg, or 2.40 Kg

water for 1 Kg tea.

Theoretically, it takes 600 kilo-calories to evaporate 1 Kg water.

$$\% \text{ Efficiency} = \frac{1440 \text{ kilo-calories x Kg tea made x } 100}{\text{Kilo-cal/Kg fuel x Kg fuel used.}}$$

b) Common fuel consumption figures per 1 Kg tea.

i) Conventional Dryer

	Coal (Kg) Hand stoked Indirect	Oil (1) Direct	Oil (1) Indirect	Natural gas (m^3) Direct
Drying only	1-1.10	0.3-0.4	0.5-0.6	_
Including wither	1.15-1.25	0.4-0.5	0.6-0-7	0.50-0.85

ii) Fluid Bed Dryer

	Coal (Kg)	Oil (1)	
Drying only	0.39-0.70	0.17-0.20	0.17 Kg

Section 5. SORTING, PACKING AND STORAGE

5.1 Definition of Sorting

Sorting is the operation in which particles of bulk tea are separated into various grades of different sizes conforming to the trade requirements.

5.2 Equipment types

a) Manual - Hand sieves and stalk picking

b) Sizing over screens

Revolving drum types	- ghoogies
Revolving crank types	- Moore's
Reciprocating	- McIntosh, Arnott, Trinick, Britannia bossed sheet - Myddleton

c) Gravity separation

Blowers	- McDonald, Benton
Suction	- Wind tunnels

d) Fibre extraction

Electric	- Shizuoka
Friction	- Plastic roller type

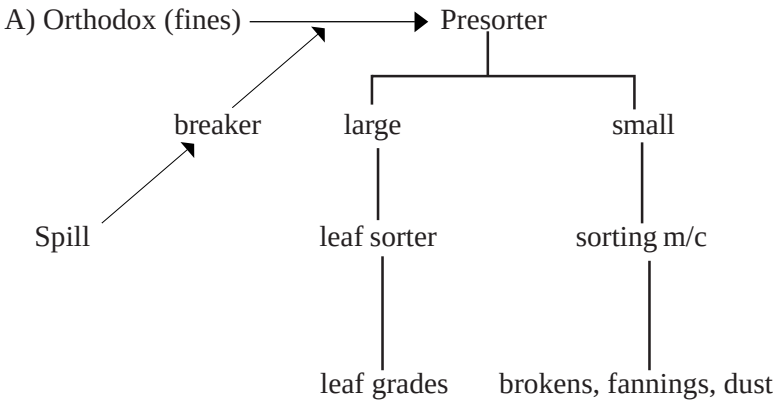
e) Combination

Fibre extractor mounted on sizing sorted -Hobro, Vibro screen

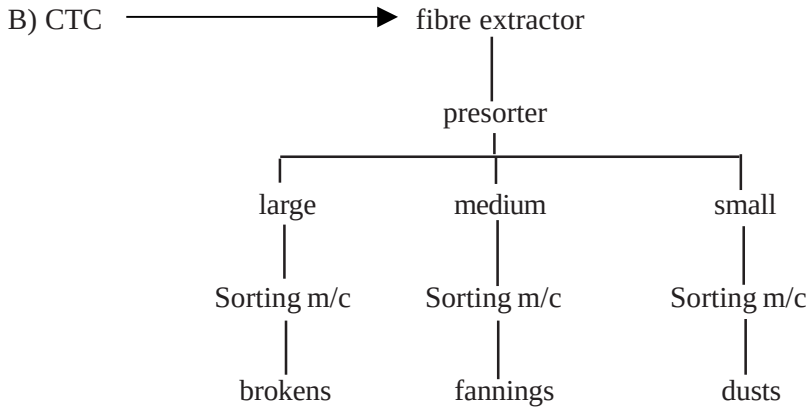
f) Breakers -

Tocklai Tea Breaker (TTB), Andrews Breaker, Cellular or Savage Cutter.

5.3 Basic Processes



Coarse leaf can go direct to leaf sorters.

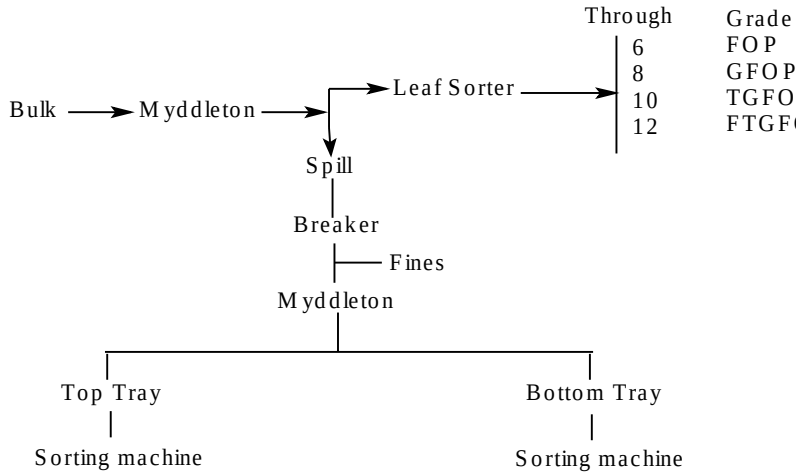


C) Residues are milled.

Spills are broken and resorted

5.3.1 Typical example of commonly practised sorting systems

5.3.1.1 Orthodox



Through	Over	Grade	Through	Over	Grade
10	12	BOP	22	24	FOF/GOF
12	14	BP	24	28	PF
14	16	FBOP	28	30	OPD
16	18	GBOP	30	40	OD
18	-	GFBOP	40	-	OCD

5.3.1.2 CTC

Presorter

Over mesh no. 18	Large
Below 18/over 30	Medium
Below 30	Small

Large - Sorting machine

Over 10	BPS
Below 10/over 14	BP
Below 14	BOP

Medium - Sorting machine

Over 20	OF
Below 20/over 24	PF
Below 24	PD

Small - Sorting machine

Over 30	PD
Below 30/over 40	D
Below 40	CD

5.4 Ordering sorting meshes

(a) No. of mesh - Number of intervals between wires for every 25 mm. Number of wires in 25 mm is mesh number plus 1. Count to be correct in both directions and throughout the length ordered.

b) SWG of commonly used sorting meshes

Mesh size	8, 10,12	SWG	22
	14,16	„	25
	18	„	27
	24	„	30
	30,40	„	35
	50	„	37
	60	„	38

Example : With 30 mesh, if wire of SWG 30 is used in place of SWG 35, the particle size will be reduced by 1/5.

c) Width - Standard is 89 cm and 119 cm plus edges

d) Length - As required

e) Material - G.I., brass, stainless steel

5.5 Glassing Volumes (commercial)

100 g of the grade are gently poured into a glass cylinder graduated in cubic centimeters and tapped lightly to level the surface.

CTC	Brokens will measure	250- 270 cc approx.
Fannings	„ „	210- 230 cc approx.
Dusts (not CD)	„	180 - 200 cc approx.

5.6 Cubic content of tea chests and bags (nominal)

Code letter	T 48 x 48 x 60 cm	138240	cc
in sale	V 48 x 48 x 56 cm	129024	cc
catalogue	S 40 x 50 x 60 cm	120000	cc
	X 46 x 46 x 50 cm	105800	cc
	R 40 x 40 x 60 cm	96000	cc
	Z 40 x 40 x 45 cm	72000	cc
Bags	61 x 50 x 23 cm	70150	cc
	69 x 54 x 26 cm	96876	cc

5.7 Bin capacity

One bin for each grade likely to be sorted plus one for resorting.

Size of each bin : 2 days' peak production of the grade or weight of a packing break plus 50%, whichever is more.

Section 6. FACTORY ELECTRIFICATION

6.1 Motors

a) Approx. motor sizes required for individual drives

Withering trough fans - should be direct driven

Rolling Tables	90	cm	7.5 — 10	HP	5	—7.5	KW
	115	cm	12.5 — 15	IIP	9	—11	KW
Green Leaf Sifters			1 — 2	HP	0.75	—1.5	KW
Rotorvane/BLC			15	HP		11	KW
Rotorvane with cutter			20	HP		15	KW
BCR			10 — 15	HP	7.5	—11	KW
CTC	61	cm	15	HP		11	KW
“	76	cm	15 — 20	HP	11	—15	KW
“	91	cm	20 — 25	HP	15	—18	KW
“	122	cm	25 — 30	HP	18	— 22	KW
Fermenting Trough (approx 100 ‘gamla’)			3—5	HP	2	— 3.5	KW
Dryers	4 feet		2 +10	HP	1.5 + 7.5		KW
“	6 ,,		2 +15	HP	1.5 + 11		KW
“	CTD		3 +7.5	HP	2 + 5		KW
FBD			45— 65	HP	33— 50		KW
D. F. Heater			7.5	HP	5		KW
Sorting m/c			1— 2	HP	0.75— 1.5		KW
Breaker			2	HP	1.5		KW
Packing m/c			2	HP	1.5		KW
Dust Extraction			5—10	HP	3.5—7.5		KW

b) Motor type : AC or DC :

Single phase 230V or three phase 400V

Slipring or squirrel cage

Screen protected, drip proof or TEFC (Totally enclosed fan cooled)

For tea processing machines, AC Three phase 400V, squirrel cage TEFC are suitable

c) Motor RPM :

No. of poles	Synchronous speed	Standard speed
2	3000	2880
4	1500	1440
6	1000	960
8	750	720

6.2 Finding the cable size suitable for connecting electric motors a)

HP to current in Amperes

HP	Single phase 230 V A	Three phase 400 V A	HP	Single phase 230 V A	Three phase 400 V A
0.5	4.0	1.2	7.5	38.0	11.5
1	7.0	2.0	10	50.0	15.4
2	11.0	3.5	15	72.0	22.0
3	16.0	5.0	20	90.0	29.0
5	26.0	8.0	25	110.0	36.0

b) Current to nominal cross section area of conductor.

Single phase Copper A	Twice Alumn A	3 phase Copper A	3 core Alumn. A	Conductor area mm^2	SWG	Normal diameter mm
13	10	11	9	1.5	17	1.40
17	13	15	12	2.5	15	1.80
23	18	20	16	4.0	13	2.35
29	23	26	20	6.0	11	2.80
40	31	35	27	10.0	9	3.60
52	41	46	36	16.0	6	4.52
69	54	60	47	25.0	4	5.68
88	69	71	60	35.0		6.80
123	90	108	84	50.0		8.00

These conductor sizes suffice for distance inside the factories. For longer distances, larger diameters are required.

c) Conductors are labelled :

Cable : Cross section area (mm^2), number of strands, dia of strand (mm), bare wire - SWG or diameter in mm.

6.3 V-Belt Drives

a) Dimensions (mm)

	A Section	B Section	C Section
Top width	13	17	22
Thickness	8	11	14
Minimum length inside	500	600	900
Minimum pitch dia (smaller pulley)	75	125	200
Pulley O/D exceeds pitch dia by	6.6	8.4	11.4
Minimum top width of groove	13	15	20
Minimum depth of groove below O/D	12	15	20
Centre to centre of groove	15	19	25
Width of groove at pitch circle	11	14	19

Pitch diameter on the pulley is the circle touching the belt. Pitch length on the belt is the line touching the pulley. Pulley grooves are checked with templates.

b) Power rating KW

at 720 RPM	0.4	1.3	3.9
690 RPM	0.5	1.6	4.8
1440 RPM	0.7	2.2	6.1
2880 RPM	1.0	3.0	

c) Designing a V-Belt drive

i) Find the operating HP, divide by 0.75 for reduction drives and by 0.6 for speed up drives. The result is the design H.P. Multiply by 0.746 and round up. This is the design KW.

ii) Select a belt section

Design	KW below 2	2-4	4-7	7-10	15-20
Section	A	A or B	B	B or C	C

iii) Select a drive pulley diameter between the minimum in a) above and 1/3 above the minimum.

iv) Calculate the size of the driven pulley

$$D = \frac{d \times \text{motor RPM}}{\text{RPM of D}}$$

d = pitch diameter of driving pulley
D = pitch diameter of driven pulley

v) To find number of belts required

$$N = \frac{\text{Design KW} \times 1.3}{\text{Power rating of chosen section (b) above}}$$

Note : For speed up drive, the driven pulley is subject to the minimum dia.

d) Matched sets

Where more than one belt is used, their sizes must be within certain limits. Grading Nos. are marked on belts near the size code.

For belts upto 1500 mm inside length, grading Nos. differing by 1

For belts upto 1500-1900 mm inside length, grading Nos. differing by 2

For belts upto 1900-2500 mm inside length, grading Nos. differing by 3

For belts upto 2500-4000 mm inside length, grading Nos. differing by 4 can still be used in a matched set.

CHAPTER VIII

MISCELLANEOUS

CHAPTER VIII

MISCELLANEOUS

Section 1. CONVERSION TABLES

Metric Units

10 Millimetres (mm) = 1 centimetre (cm)
100 cm = 1 metre (m)
1000 m = 1 Kilometre (km)
100 square millimetre (mm^2) == 1 square centimetre (cm^2)
10000 cm^2 = 1 square metre (m^2)
l0000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)
1000 cubic millimetres (mm^3) = 1 cubic centimetre
(cm^3) = 1 millilitre (ml)
1000 ml = 1000 cc = 1 litre (1)
100 1=1 hectolitre (hl)
1000 milligrams (mg) = 1 gram (g)
1000 g = 1 Kilogram (kg)
100 kg = 1 quintal (q)
l0 q = 1 tonne (t)

Conversion Ratios

1 mile = 1.609 km
1 fluid oz = 28.41 ml
1 pint = 568.25 ml
1 hundred weight (cwt) = 50.80 kg
1 ton= 1.016 t
1 oz/yd^2 = 33.9 lg/m^2
1 oz.yd^3 = 37.08 g.m^3
1 oz/gal = 6.236 g/litre
1 lb/in^2 (psi) = 70.3 g/cm^2
1 fluid oz/100 gal = 6.236 ml/100 1
1 gal/acre = 11.2331 1/ha
ft/minute = 0.005 m/sec
miles/gal = 0.353 km/litre

Inch	<— cm/inch —>	cm	ft	<—m/ft —>	m
0.394	1	2.540	3.280	1	0.304
0.787	2	5.080	6.561	2	0.609
1.181	3	7.620	9.842	3	0.914
1.575	4	10.160	13.123	4	1.210
1.969	5	12.700	16.404	5	11.524
2.362	6	15.240	19.685	6	1.828
2.756	7	17.780	22.965	7	2.133
3.150	8	20.320	26.246	8	2.438
3.543	9	22.860	29.527	9	2.743
3.937	10	25.400	32.808	10	3.048
7.874	20	50.800	65.616	20	6.096
11.811	30	76.200	98.425	30	9.144
15.748	40	101.600	131.233	40	12.192
19.685	50	127.000	164.041	50	15.240
39.370	100	254.000	328.083	100	30.480
sft	<— m^2/sft—>	m^2	cft	<—m^3/cft—>	m^3
10.752	1	0.093	35.314	1	0.028
21.505	2	0.185	70.628	2	0.056
32.258	3	0.278	105.943	3	0.084
43.010	4	0.372	141.257	4	0.113
53.763	5	0.464	176.572	5	0.141
64.516	6	0.557	211.886	6	0.169
75.628	7	0.650	247.207	7	0.198
86.021	8	0.743	282.515	8	0.226
96.774	9	0.836	317.830	9	0.254
107.526	10	0.929	353.144	10	0.283
215.052	20	1.858	706.289	20	0.566
322.580	30	2.787	1059.434	30	0.849
430.107	40	3.716	1412.578	40	1.132
537.634	50	4.645	1765.723	50	1.415
1075.268	100	9.290	3531.447	100	2.831
gal	<—lit/gal—>	lit	*oz*	<— g/oz—>	g
0.220	1	4.546	0.035	1	28.35
0.440	2	9.092	0.071	2	56.70
0.660	3	13.638	0.106	3	85.05

0.880	4	18.184	0.141	4	113.40
1.100	5	22.730	0.176	5	141.75
1.320	6	27.276	0.212	6	170.10
1.540	7	31.822	0.247	7	198.45
1.760	8	36.368	0.282	8	226.80
1.980	9	40.914	0.317	9	255.15
2.200	10	45.460	0.353	10	283.50
4.399	20	90.919	0.705	20	566.99
6.599	30	136.379	1.058	30	850.48
8.799	40	181.838	1.411	40	1133.98
10.999	50	227.298	1.764	50	1417.47
21.997	100	454.596	3.527	100	2834.95
lb.	<— kg/lb—>	kg	acres	<—ha/acres—>	ha
2.205	1	0.454	2.471	1	0.405
4.409	2	0.907	4.942	2	0.809
6.614	3	1.361	7.413	3	1.214
8.818	4	1.814	9.884	4	1.619
11.023	5	2.268	12.335	5	2.023
13.228	6	2.722	14.826	6	2.428
15.432	7	3.175	17.298	7	2.833
17.637	8	3.629	19.769	8	3.237
19.842	9	4.082	22.240	9	3.642
22.046	10	4.536	24.711	10	4.047
44.092	20	9.072	49.422	20	8.094
66.139	30	13.608	74.132	30	12.140
88.185	40	18.144	98.843	40	16.187
110.231	50	22.680	123.554	50	20.234
220.462	100	45.359	247.108	100	40.468
lb/acre	kg/ha-Ib/acre	kg/ha	mds/acre	q/ha-mds/acre	q/h
0.892	1	1.121	1.115	1	0.896
1.784	2	2.242	2.230	2	1.792
2.677	3	3.363	3.345	3	2.688
3.569	4	4.483	4.460	4	3.584
4.461	5	5.604	5.575	5	4.480
5.353	6	6.725	6.690	6	5.376
6.245	7	7.846	7.805	7	6.272
7.137	8	8.967	8.920	8	7.168
8.030	9	10.088	10.035	9	8.064

8.922	10	11.209	11.152	10	8.966
17.844	20	22.417	22.304	20	17.932
26.765	30	33.626	33.456	30	26.898
35.687	40	44.834	44.608	40	35.864
44.609	50	56.043	55.760	50	44.820
89.218	100	112.085	111.501	100	89.686

gal/acre	1/ha-gal/acre	1/ha
0.089	1	11.233
0.178	2	22.467
0.267	3	33.700
0.356	4	44.933
0.445	5	56.167
0.534	6	67.400
0.623	7	78.633
0.712	8	89.867
0.801	9	101.100
0.890	10	112.333
1.780	20	224.667
2.671	30	337.000
3.561	40	449.334
4.451	50	561.667
8.902	100	1123.334

Note : Conversion example : 1 kg./ha = 0.892 lb/acre
and 1 lb/acre =1.121 kg./ha

Temperature

°F	°C	°F	°C
32.0	0	125.6	52
35.6	2	129.2	54
39.2	4	132.8	56
42.8	6	136.4	58
46.4	8	140.0	60
50.0	10	143.6	62
53.6	12	147.2	64
57.2	14	150.8	66
60.8	16	174.4	68
64.4	18	158.0	70
68.0	20	161.6	72

71.6	22	165.2	74
75.2	24	168.8	76
78.8	26	172.4	78
82.4	28	176.0	80
86.0	30	179.6	82
89.6	32	183.2	84
93.2	34	186.8	86
96.8	36	190.4	88
100.4	38	194.0	90
104.0	40	197.6	92
107.6	42	201.2	94
111.2	44	204.8	96
114.8	46	208.4	98
118.4	48	212.0	100
122.0	50		

°F = (°C x 9 / 5) + 32
°C = (°F - 32) x 5/9

For quick conversion : °F to °C — Add 40 : Multiply by 5/9 : Subtract 40
°C to °F — Add 40 : Multiply by 9/5 : Subtract 40

Rough Equivalents :

inch	mm	SWG
1/64	0.4	28
1/32	0.8	21
3/64	1.2	18
1/16	1.4	16
5/64	1.8	15
3/32	2.3	13
7/64	2.8	11
1/8	3.2	10
9/64	3.6	9
5/32	3.9	8
11/64	4.3	7
3/16	4.7	6
13/64	5.1	5
7/32	5.5	5

15/64	5.9	4
1/4	6.3	-
9/32	7.0	-
5/16	7.3	-
11/32	8.7	-
3/8	9.5	-
13/32	10.3	-
7/16	11.1	-
15/32	11.9	-
1/2	12.7	-

Section 2. FIRE SAFETY PRECAUTIONS — GENERAL

2.1 Factory hazards

Spontaneous combustion of coal, tea waste, rubbish, faulty handling and storage of petrol, kerosene oil and diesel oil, blaksmith's fire welder's flame or spark, faulty electrical equipment

2.2 Garden hazards

Thatched roofs
Unguarded domestic fires
Nursery shade Mulch

2.3 Precautions

Vigilance and education
Control of smoking
Fire fighting equipment with men trained and made responsible
Electricity

2.4 Equipment to be earthed
off switches easy to see and reach

2.5 Inspection for damp, defects and overloading

2.6 While working on line, ¦working has to carry fuse or link, switch board attendants to stand on rubber mat. All concerned to be trained Acci dent hazards

2.7 Moving machinery parts, drives etc. — guards and suitable clothing
Who is permitted to remove guards ?
No brushing of CTC rollers while they move Circular saws to be fed from distance or with pusher

2.8 Working at a height

Security of supports, safety ropes while roof painting, tools and work pieces tied against dropping

2.9. Lacking of light and untidy floors are dangerous.
No grinding, chipping without goggles

2.10 Flame screen for oil firing

2.11 Vehicles

No riding on top of load
Care when off loading heavy items.