



Module No.

5

TEA RESEARCH

Institute of Tanzania



A Tea Nursery



Villagers contributing their manpower at Lupembe nursery.

ESTABLISHMENT &
MANAGEMENT OF TEA
NURSERIES

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FOREWORD

This is the fifth of a series of Training Modules prepared by the Tea Research Institute of Tanzania (TRIT). The first was on Rehabilitation of abandoned Tea fields, the second on Fertilizer and manure, the third on Tea plucking and Quality control and the fourth on Weed control in Tea bushes. Proper establishment and management of tea nurseries is essential before field establishment, as it lays the basic foundations of the future of the tea bush. This module is meant to assist farmers, extension workers, managers and researchers in their efforts to establish and manage tea nurseries. TRIT welcomes suggestions from users and readers of this module and other previous modules so that improvements can be made while updating them.

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INTRODUCTION

This module has been prepared for trainers or facilitators to conduct theoretical and practical sessions on establishment and management of tea nurseries.

The guidelines are also developed for subject matter specialists, supervising officials and trainers of field staff to facilitate the training of front line extension and development agents.

Some chapters need to be tailored to meet the education level of target groups and in house rules of particular companies.

The performance of tea plants in the field depends on the management levels in the nursery. Nursery management should be done with proper care to reduce death of plants both in the nursery and in the field.

This training module provides the important steps and principles of tea nursery establishment and management.

The topics are presented in chapter form to facilitate understanding the course materials. These include:

- Instructions for course organizers, trainers and trainees (Presented in annex 1, 2, 3, 4,6,7).
- Five (6) chapters containing theoretical and practical materials on management of tea nurseries.
- Exercises, Action plan and Evaluation sheets (Presented in annex 8, 5, 9)

Although considerable material has been provided, the trainer must base on the participants' existing knowledge to decide on the appropriate subject matter, practical, visits etc., before conducting the courses.

The main text of each chapter could be used as background material for the trainer but is also suitable for reproduction as handouts which could preferably be given out at the end of each session.

TEA NURSERIES

What is a nursery?

A nursery is a place used for germinating seeds and propagating plants by vegetative means. Is a place used to raise young plants. Vegetative propagation is the production of new plants from the vegetative parts of a selected plant.

Importance of nursery establishment

- To conveniently obtain seedlings of required quality, quantity and characteristics.
- To know the plants cost of production and hence the profit or loss for the industry.

Steps for nursery establishment

- Pruning of mother bushes
- Site selection
- Nursery shed construction
- Purchasing nursery materials
- Preparing nursery beds
- Soil selection
- Construction of soil shed
- Pot filling & stacking
- Preparing cuttings.
- Planting & Care after planting

Proper time for nursery establishment

This differs from one place to another depending on weather conditions. Cuttings to be transplanted in new field in Tanga region stay for 12 months in nurseries while cutting for infilling stays for more than 12 months. Seedlings should be transplanted at the start of the long rains and farmers should always plan their plantings to coincide with this period for better fields establishment. For example in East Usambara cuttings are ideally planted in March to produce plants for planting in March the following year. In Mufindi and Njombe where low temperatures restrict growth, cuttings that are propagated in September/October become ready for field planting in March/April of the (second) next next year.

PREPARATION OF MOTHER BUSHES

Mother bushes

A mother bush is a tea plant specially managed so as to produce shoots for cuttings.

Selection of appropriate mother plants

The success of vegetative propagation of clonal tea depends on the proper selection of mother bushes with desirable characteristics that would be easily and rapidly propagated leading to high success rates.

Selection of the desired mother bushes is better to be done in fields of release clones which have been consistently giving high yields.

The following characteristics are useful for eye estimation of desirable mother bushes to propagate.

1. Appearance of a plucking table.

Bushes with high density of plucking points per unit area of the surface should be selected, as there is strong correlation between density of plucking points and the yield of tea.

2. Bush stature.

Weak frames with poor spread and unhealthy foliage should be discarded in favour of strong spreading bushes with healthy foliage.

3. Tendency to produce banjhi buds and flower freely.

Bushes which become dormant frequently are undesirable. Those that flower and seed at the expense of vegetative growth become poor leaf yielders.

4. Rate of recovery from pruning.

Clones with slow rate of recovery from pruning have low yields per annum.

5. Made tea quality.

Clones which are non or poor fermenters produce poor quality of made tea.

6. Drought tolerance.

Drought tolerant clones should be selected particularly for areas prone to drought and where irrigation cannot be practiced, as is the case for many smallholder tea growers whose tea fields are mostly rain fed.

7. Rooting abilities of planting materials.

Mother plants which produce cuttings which fail to root or which give low rooting percentage under optimal nursery conditions should be discarded irrespective of other desirable characteristics as it would be difficult to establish them in the field.

8. Overall yield through out the year

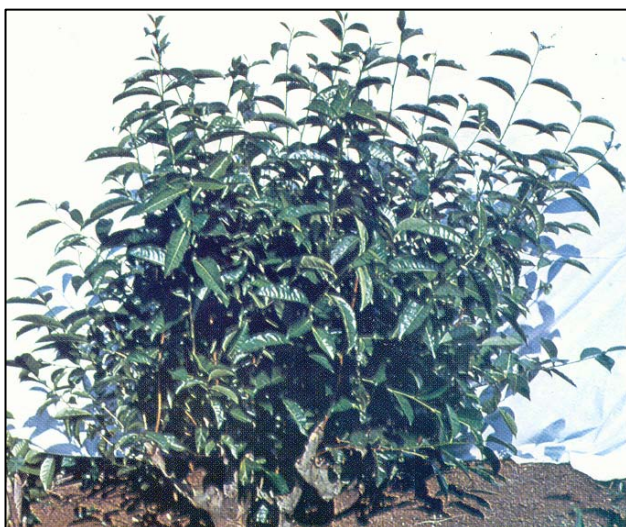
Clones with high overall yield through out the year are most preferred by tea farmers.

The selected clone should be tested for their suitability to the local conditions. A clone selected in one district may grow poorly in another district. In other words, tea plants have been found to be very highly affected by environment and therefore should be tested before one embarks on large scale planting of any clone.

Pruning of Mother bushes

This is practiced only if conventional cuttings will be used as planting materials.

The farmer should choose mother bushes with the characters they want. Mother bushes need to be strong and healthy at the time of taking cuttings, pruning and fertilizer application (NPK) are necessary in order to achieve this. Recommended rate of fertilizer to be applied is twice the normal field application i.e. 600-700 kg



N/ha. It is advised that pruning should be done 4-6 months before cuttings are taken. Pruning height should be 2.5-5 cm above the last prune.

Water stress during the period cuttings are being produced reduces both the number and the quality of cuttings. If bushes are left to grow for too long, the vegetative growth phase ceases and the growth changes into the reproductive phase, at this stage the branches become unsuitable for use as cuttings.

Plate 1: A mother bush to produce conventional cuttings

Always use the prunings to cover the bushes to protect the frames from sun scorch.

The ultimate success in the nursery is very largely dependent on the standard of the cuttings taken. This standard is dependent on the treatment of the source bushes. It is therefore well worth taking the trouble to see that source bushes are correctly managed.

SITE SELECTION

Site selection

As the nursery may be a permanent structure, considerable thought must be given in deciding on a particular location.

The following points need to be considered to obtain a good nursery site

1) Site location

The location of the nursery should be such that large vehicles for transportation of soil and plants can easily access it. It is desirable if the nursery is centrally located for easy supervision. It shouldn't be located in valleys where frost and temperatures are low enough to retard growth. A warm site exposed to a morning sun is preferred.

2) Proximity to a source of water

The nursery site should be close to a source of water which should be freely available even during dry periods.

3) Good drainage but not too steep (10% slope maximum)

The nursery should be sited on a flat or gently sloping well drained land

4) Good security to combat theft of plants and materials

5) Not over shaded by trees

Sites under shade trees with overhanging branches should be avoided as may reduce light intensity, cause dislodging of cutting during heavy rains, damage roots and increase incidences of blister blight.

6) Large enough to accommodate nursery soil sheds

7) Should not be vulnerable to fire hazards

8) Protected from wind and unfavourable weather

Windy sites should be avoided. Nursery plants exposed to strong winds do not anchor properly and their leaves are easily damaged.

9) Proximity to the source of rooting medium

Since large quantities of soil are required periodically for propagation it is preferable to locate the nursery reasonably close to areas from which good soil could be obtained in order to reduce transport cost.

Nursery shed

Determine the required size of the nursery

The size of the nursery can be determined by the number of plants the farmer needs to plant in a specified size of the farm.

Example 1: Mr Abdul wants to plant tea in a 2 hectare field. What dimensions of field does he need to prepare to raise young plants if he is expecting to use 4" lay flat diameter polythene tubes.

1) The recommended number of plants per hectare can be arrived as follows:

If plant spacing is $1.2\text{m} \times 0.9\text{m} = 1.08\text{m}^2$ and
 $1\text{ ha} = 10,000\text{m}^2$

The number of bushes in 1 hectare will be $10,000$ divided by $1.08\text{m}^2 = 9,259.25$ or $9,260$

The number of bushes for 2 hectares is $18,520$

2) Considering a 10% allowance for plant death and infilling, the plant requirement for 2 hectares will be $0.1 \times 18,520 = 1,820 + 18,520 = 20,372$.

$0.1 \times 18,518.5 = 1,852 + 18,519 = 20,371$

Every 1 m^2 of the nursery bed holds up to 275 polythene tubes of 4 inch diameter. In general the length of nursery bed ranges from 15 to 30 cm.

If using a 20m nursery bed, total number of plants raised will be $20 \times 275 = 5,500$ approximately.

The number of beds needed will be $20,372 / 5,500 = 3.7 = 4$

3) Length of nursery shade will be $1\text{m} + 20\text{m} + 1\text{m} = 22\text{m}$

Width of nursery shade will be $1\text{m} + 1\text{m} + 0.5 + 1\text{m} + 0.5 + 1\text{m} + 1\text{m} + 0.5 + 1 = 7.5\text{m}$

Answer: Mr Abdul will need a field of 22m length and 7.5 m width i.e 165m^2 or 0.0165 ha.

After getting the required size of nursery, site clearing follows by felling all trees, uprooting them and removing weeds. Then the land is tilled to a depth of 30 cm before leveling it.

The nursery shed should be constructed so as to allow good aeration, an easy working environment and good drainage. There are two types of nurseries, low shade and high shade.

Low shade nursery

For building walls, woven bamboo laths are convenient but even sacking, bracken, tree branches, bricks etc can be used for the side shade. The beds are marked and the walls constructed. The beds can be of any length, though 30m seems convenient for large beds. The beds should lie in a North-South direction.

The sleeves are then stacked carefully, leaving a gap of about 50cm and 100 cm between the stacked sleeves and the side and end walls, respectively. The polythene sheeting will be sealed into this gap. To reduce overlapping of the cuttings' leaves, sleeves should be stacked triangularly as shown below.

Hoops to support the polythene sheeting should then be placed every 1m or less along the bed. These should be slightly curved or slope towards one side of the bed so that rainwater will easily run off the surface of the polythene. The hoops should not be less than 40 cm above the top of the sleeves depending on the width of the bed.

After the cuttings have been planted and thoroughly watered the clear polythene sheeting should be stretched taut over the hoops and sealed into the space between the sleeves and the walls. To effect this sealing, soil from the space between adjacent beds should be used to cover the edges of the polythene. The soil level between the beds will therefore be lowered. The difference in level between this pathway and the top of the sleeves should be at least 15 cm.

Until young plants have roots of about 7.5 cm long roots, they should be kept shaded under a uniform overhead shade which allows only a little dappled sunlight to pass through. The shade can be provided by bamboo lath frames, hessian sacks, coffee drying cloth, bracken woven into chicken wire frames or frames made from papyrus, maize and napier or elephant grass stems. This shade should be about 5 cm above the topmost part of the hoops in cooler areas but in warm areas the shade should be about 30cm above the hoops to increase the air space below the shade and thus reduce the temperature (smaller air spaces in cooler areas take shorter time to heat up and hence increase the temperature in the beds). If cuttings are grown in too high a temperature they become extremely susceptible to fungi. If such a fungal disease is noted, the polythene should be opened up immediately to reduce humidity of the air.

High shade nursery

They are common in E. Africa where walls are constructed along the outside perimeter of the nursery only and not for each individual bed. Overhead shades

should be placed 2.5m high for easy working which should be strong enough to carry an average man's weight. The shade should allow penetration of 25-40% of full light measured at midday. At rooting stage, the shade should allow 25% of full light at midday.

High shade nurseries are often cooler than low shade ones and heavy drops of rainwater falling through the shade can damage cutting.

When a large annual planting programme is anticipated it is often worthwhile constructing a high shade nursery with permanent or semi permanent materials. This nursery site can be used year after year with a minimum of expenses.

Materials to be used to construct shades are poles and thatch/grasses which are durable; provide uniform light and are easy to adjust when more light is needed.



Plate 2: Initial stages of a nursery shed construction



Plate 3: Side view of high shade tea nursery

Nursery Beds



Plate 4: Marking out nursery beds

The nursery beds size should be one meter wide, raised 8-10 cm above the ground to allow efficient drainage of excess water and easy passage of workers. It should be as long as convenient depending on topography preferably 15 to 30 meters which should be oriented across the slope. Beds should be 30 to 60 cm apart to allow free access to each bed and should be sloping slightly down hill to remove excess water.

Beds should be placed in a manner that there is easy moving of materials between ends. Large nurseries should have a provision for central path which is approximately 1 m wide.

Nursery Soil

Both topsoil and subsoil are needed and should be tested well for pH before large amounts of soil are taken to the nursery soil sheds.

Soil sampling

A representative soil sample is needed for pH analysis, consequently a number of (at least three) sub soil samples should be taken and then mixed together thoroughly to produce a composite sample. The sample should be properly marked with date, field, its origin (top soil or sub soil) and if the soil is to be used as rooting or growing medium. Soil samples should be sent to the laboratory for pH analysis. It should be made clear that the samples are for pH determination to see if they are suitable for nurseries. However, it will help if someone could plan ahead and send in samples well in advance of filling pots for rooting.

Sub soil

This is the rooting medium, low in organic matter, free from grit, high water absorption and preferably with low clay content. To encourage root formation and reduce callus the pH for the rooting medium should be between 4.5 to 5.0.

Topsoil

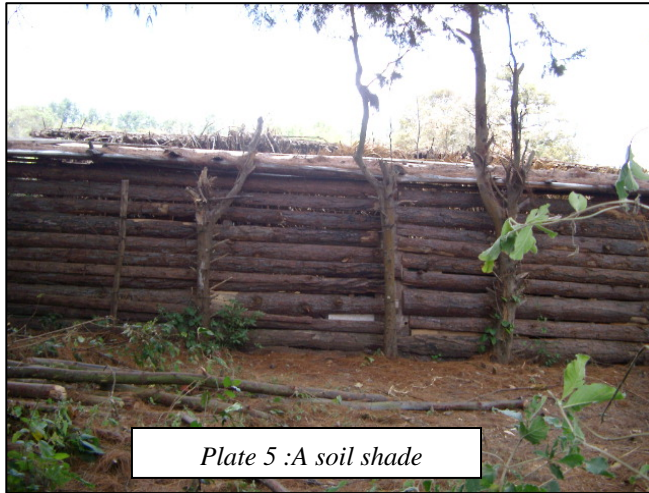
Topsoil should be dug from a selected forest area. The pH of the topsoil is not as critical as the subsoil as the former's function is to provide nutrients after rooting, it should be between 4.5 to 5.5.

It helps growth of the seedling after root formation. Good loamy, friable, free draining topsoil with high inherent fertility is ideal for growth.

Soil Storage

Building a soil storage shed is most strongly advised since it enables the filling of the polythene pots with dry soil at any time independent of the weather and limit direct sunlight which will break down the humic content. It is advisable to construct soil sheds which hold each of the 2 soils (top and subsoil) separately. The Shed

has to be large enough to hold soil for all the pots or trays and provide a comfortable space for working, protecting operators against sunlight and rainfall.



Before the soil is taken into the shed it should be sieved to remove roots, stones and other unwanted materials. The sieve should be made of mining mesh with 5mm aperture. The wooden frame should be made around the mining mesh which should be big enough to be positioned at 45° angle when sieving so that the soil can be thrown against the mesh, using a shovel/spade.

It is strongly recommended that the

soils should be tested for pH before collection for storage.

Fertilizer application

Response of fertilizer which are mixed with a rooting medium depend on the kind of soil used. Some soils are rich in nutrients and thus do not need additional fertilizers. Unless a grower has conducted trials to find out whether the soils used in the nurseries require any additional fertilizers, it is suggested that the rates shown below should be used.

The subsoil (rooting medium) should be mixed 600gms of SSP in 1M³ of soil. 1M³ is equal to 44 buckets of 20 litres flat filled with soil while the top soil (growing medium) should be mixed with 600gm of SSP and 300gm of MOP in 1M³

Propagation of cuttings

The two methods for propagation of cuttings are: (i) using standard size pots under polythene tents and (ii) misting with a knapsack sprayer using minipots without tent.

Propagation under polythene tent

Planting Containers

For planting the propagating material of different containers can be used

- Polythene pots
- Plug trays

Polythene tubes

The size of the sleeve will depend on the size of plants required by the grower. Larger plants will require larger sleeves and vice versa.

There are 2 types of dimension of polythene tubes used in new fields:

- 5 inch diameter, 35-40 cm length and thickness of 250 gauge.
- 4 inch diameter, 20-25 cm length and thickness of 250 gauge.

Jumbo polythene tubes

There are large sleeves called Jumbo used to raise plants for infilling. They have 10 inch (24 cm) diameter, 35-40 cm length and thickness of 250 gauge.

Plants raised in larger sleeve maximize use of space having better lateral shoot, but they have the following disadvantages.

- Fewer plants raised per unit area.
- High production cost per plant.
- High transport cost to the field.
- Fewer sleeves are obtained from 1kg polythene bag.

For the resources limited, smallholder growers, TRIT has tested for 21cm long sleeves, 10cm (4 Inch) diameter with 150 gauge post and produce plants for new establishments successfully.

Sleeves should be sealed at the bottom edge then cut at the two side corners (Vichupi) to hold soil in place and effect drainage respectively. Few holes (4-6) should be punched near the bottom edge to help drainage. If drainage holes are not adequate, excessive water accumulates and causes death.

Plug trays (Speedling trays)

Each pot of a tray should have a hole at the bottom adequate to facilitate drainage. Side walls of the pot should be flexible enough for easy squeezing and pushing out rooted cuttings /shoots with their rooting soils intact.



Plate 6 :A small speedling tray

By using speedling trays cuttings are planted into the trays filled with subsoil until they produce roots and then transplanted into standard pots.

These trays come in two different sizes:

The small trays have 60 planting holes where each planting hole needs 22 grams of soil to be filled.

The big trays have 96 planting holes where each planting hole needs 50 grams of soil to be filled.

Apart from high initial cost, speedling trays cause little disturbance to the root ball, raise plants that are easy to handle, are reusable, save space and facilitate fast transplanting

Pot filling

There are 2 methods used in pot filling which are two soil layer method and three soil layer method.

Two soil layers method

The topsoil is put into the pots first, which should be filled to a height of $\frac{2}{3}$ of the polythene tube.



The pots containing the topsoil should be carefully transported to the beds and stacked neatly in lines. Maximum use of available space should be considered at stacking.

The polythene tubes should then be filled with subsoil at the top $\frac{1}{3}$ of the polythene tubes.

The soil in the sleeves should be fairly firm but should never be packed brick hard. The $\frac{2}{3}$ to $\frac{1}{2}$ sleeves filling is conveniently common in many tea nurseries in

Plate 7: Stacked polythene tubes

Tanzania.

Three soil layers method

Three layers of soil are used in this method which are topsoil, subsoil and a mixture of top and subsoil.

The topsoil is put into the pots first which should be filled to a height of $\frac{1}{2}$ of polythene tubes.

The pots containing the topsoil should be carefully transported to the beds and stacked neatly in lines. Maximum use of available space should be made

A mixture of top and subsoil is then filled to a height of $\frac{1}{4}$ of the polythene tubes (above the top soil) and lastly subsoil is filled to another height of $\frac{1}{4}$ of the tubes.

Tray filling.

- Before filling subsoil in the rooting tray, ensure that every pot has a drainage aperture. Spread the soil on the tray without firming and shake to settle it.
- Use well sieved and dry subsoil.
- Stake.

PREPARING MATERIALS & PLANTING

Preparing Cuttings

There are two types of cuttings used for propagation. Conventional cuttings (usually single node) and Pluckable shoots. Methods of preparation for planting differ for the two types.

Conventional Cuttings

Single node cutting

Take the stems from bushes pruned 4 to 6 months earlier. Wrap these stems in wet sacking and take to a shelter near the nursery or in the nursery where they are immediately watered. Cuttings should be made under shade and kept shaded at every stage there after. Remove the soft uppermost parts and any lower parts where bark is forming. If the cuttings are too soft they will be damage at planting and many of them will die. If they are too hard they will grow poorly and produce flowers which exhaust the food reserves leading them to stunted growth or death.



Plate 8 :Conventional cuttings

The good material is now made into individual cuttings of a single leaf with an axillary bud and 3 to 4 cm of stem below the leaf. Cut off any extra length of stem if necessary. The top cut should be just above the auxillary bud and slanting away from it. Thirty to fifty grams of wettable fungicide powder are usually mixed with 10 to 20 litres of water in a plastic basin. Keep the cutting soaked in a solution of fungicide for 30 minutes. Too many cuttings should not be placed in a

container otherwise the top ones will not be in water and the bottom ones will be pressed so hard that the leaves may be damaged. Cuttings with damaged leaves should be rejected as they generally grow slowly and are prone to fungal infection through the wounds.

Conventional cuttings require a period of 12 to 18 months (depending on the weather conditions of a place) to produce rooted plants for field planting.

Advantages of Single node cutting	Disadvantage
Many plants may be raised from a limited supply of the source material.	Mother bushes remain unproductive for about 6-8 months.

Double node cutting

Two or three leaf cutting can be used but the number of cuttings per branch, hence per bush, decreases as the number of leaves per cutting is increased. Multi leaf cuttings give more branches to the young plant and are ideal if there is plenty of material. One disadvantage of making double node cuttings is that few plants may be raised from a limited supply of the source material

Pluckable shoots

A pluckable shoot is the side shoot growing from the axillary bud in the angle between a leaf and the stem after previous plucking. It comprises four or more true leaves and a terminal bud. Below the lowest leaf is a janum and its auxillary bud.



Plate 9: Pluckable shoots

The use of plucking shoots as an alternative to conventional green stem cuttings has the following advantages:

- The use of plucking shoots does not require any special agronomic attention as in the case with the mother bushes for conventional cuttings.
- Propagating clonal tea from plucking shoots is not limited to a particular growing season.

- Using plucking shoots will allow more material to be harvested and planted in the nursery in one growing season compared to propagation using conventional cuttings.

- The technique make it possible to pluck the bushes for made tea production in the main growing season and then still produce a large number of clonal plant from the same field in the off season period.
- The plants generated have more branches from the beginning unlike the conventional cuttings which starts with a single shoot.



- Preliminary research work of TRF (CA) has shown that plants raised from pluckable shoots have earlier lateral branches development and that they may be transplanted after seven months with very good field establishment and survival.
- Would serve time and money rendering source bushes unproductive

The two types of pluckable shoots used in tea nurseries

Plate 10 :Earlier branching in Pluckable shoots

are: (i) pluckable shoots with full set of leaves and (ii) those with trimmed leaves.

Preparing pluckable shoots with trimmed leaves

Make a cut through the fully lignified stem 3-5 cm below the node.

Remove the terminal bud. The cut should slope in the same direction as the mother leaf as it attaches to the stem.

Reduce leaf surface area by 1/3 to minimize loss of water through the leaves and over congestion and shading.

Care before cuttings are planted

The time from pruning mother bushes to the time branches are delivered for the cuttings preparation in shade should be as short as possible. Branches should not be exposed to direct sunlight as leaves may scorch easily or wilt due to loss of water. Compressing branches will damage the leaves. Branches should be wrapped lightly in hessian sack. Tight wrapping or heaping up the branches when they have to be transported by vehicle should be avoided.

Note: Cuttings should be immersed in a solution of fungicide at a rate of 30 to 50g of fungicide powder in 15-20 L of water for 30 minutes before planting. Pots should be watered to field capacity two days before cuttings are planted.

Planting the cutting



Plate 11: Planting conventional cuttings.

Plant the cutting in the middle of each polythene tube ensuring that the leaf does not rest on the soil. Cutting should be inserted into the soil leaving 12mm of stem above the soil. Gently firm the soil around the planted cutting. Plant one cutting in one pot and make sure that there is minimum overlapping of leaves and the auxillary bud is not heavily obstructed.

If the soil has been allowed to compact excessively before planting, then a planting hole must be made using a

wire nail to dibble slightly shorter and narrower than the stem of the cutting.

Ensure when planting fingers do not touch the top and bottom cuts as this may contaminate the cuttings.

Make sure that there is minimum leaf overlapping and that all leaves planted on a nursery bed are pointing upward and in one direction.

Apply light watering using fungicide solution to seal air spaces around the cutting. Watering should be done gently as strong jets may displace cuttings.

Establishment of microclimate

Young plants or newly planted cuttings/shoots need to be well protected against adverse temperature, drought, wind, dry soils and dry air until they are rooted because they lose more water through transpiration than they can take from the soil. Until rooted, they require dappled sunlight which reduces evaporation but is enough for normal growth. Excessive darkness prevents cuttings from developing and encourages excessive callusing where as full sunlight will kill them. The normal surrounding environment can be modified forming a Microclimate by using polythene tents.

Raising cuttings under polythene tent.

After planting sealing with clear polythene sheets follows immediately whereby flexible bamboo / woody hoops are bent across the bed at 50cm space and the polythene sheeting is then stretched over the semicircular hoops that are 30 –40 cm above the sleeves level at the middle. The sheet is then sealed into the soil around the bed. To help in stretching the polythene sheet and sealing it, an extra length and width are usually allowed for in the plan. Condensation should occur on the inside of the polythene tents within one day after planting.



Plate 12: Hoops bent across the bed



Plate 13: Cuttings raised under polythene sheet

The polythene cover serves the following functions:

- It prevents loss of soil moisture hence preserves high atmospheric humidity
- It increases the air temperature
- Saves labour cost in watering
- Protects cuttings from rain and wind damage
- Keeps the temperature range inside the polythene cover low

If there is no condensation then the following could be the cause:

- Insufficient water supply
- Polythene sheeting torn
- Polythene not properly sealed
- Nursery is over shaded



Plate 14: Appearance of cuttings inside the tent.

Propagation by misting

With the escalating cost of polythene sheeting and the frequent theft of polythene sheets from nurseries, the technique of misting the cuttings with a knapsack sprayer on a commercial scale have been explored to see if misting could successfully replace the polythene tents in VP nurseries. The result was that misting can be used successfully on commercial scale, with equal or better results. The stages of raising single node cutting in minipots are described below.

Filling the minipots

Minipots measuring 12.5 cm long and 8.5 cm lay flat are used and these are filled with sieved dry subsoil having a pH of 4.5 (CaCl₂). After filling the pots are placed on beds

1 metre wide and with a length that suits the terracing in the nursery. The 1 metre bed width is recommended to ensure that all leaves are conveniently sprayed with the mist. There must be adequate drainage holes in the minipots to ensure that excess water drains away.

Planting the cutting

The pots should be watered heavily, using a watering can, a day or two before planting. The single node cuttings should then be inserted into the soil leaving 12mm of the stem above the soil. The cutting should be firm in the soil and a light watering should be applied to close up any air spaces around the cutting.

Mist spraying

Water mist spraying is performed using a knapsack sprayer until the cuttings have rooted. The frequency of spraying will depend on the weather conditions and on the age of the cuttings. For the first three months a spraying regime of once every 30 minutes commencing at 7 a.m. and stopping at 4:30 p.m. is known to be satisfactory for all conditions except when the cuttings are very young and the weather very dry, when the frequency should be increased to 20 minutes. The spray should be fine and blue or green polyet or equivalent type nozzle is ideal. Under these conditions 15 liters of water will cover 100,000 single node cuttings in 15 minutes. After 3 months the frequency of spraying can be reduced.

Transplanting

Five months after planting the cuttings will have rooted and some shoot growth will have developed. The cuttings should then be transplanted into standard pots (22.5 cm high x 8.5 cm diameter). Fill the pots half full with topsoil then carefully remove the rooted cuttings from the minipot, and place in the pot (the core of soil held by the roots should not be disturbed). More topsoil should be added until the pot is full.

Advantage of Misting

The advantage of using misting with a knapsack sprayer over raising plants under polythene tent are listed below

- The leaves of the cuttings are exposed so more photosynthesis will occur, which will speed up rooting.
- The humidity is less, air movement is freer and maximum temperatures are reduced, so the chances of fungus disease developing will be considerably reduced.
- Weed growth is reduced, for the leaves of the cuttings completely cover the soil in the minipots. Weeding can be done easily.
- Labour requirement for spraying is very low. One man can look after 100,000 cuttings compared with one man for 20,000 cuttings under polythene tent.

MANAGEMENT AFTER PLANTING

Pre rooting operation

1. Watering

Correct watering is the most important operations in pre rooting and post rooting phase. Over watering must be avoided as this tend to lead to water logging which may lead to collar rot, stunted growth or shoot dieback while under watering results in heavy callus which hinders root formation.



The best guide for determining whether watering is being carried out properly is by regular checking of soil moisture by feel method. If the soil is very sticky too much water is being supplied. If the soil is crumbly and loose the soil is drying out and the pots need watering. Another method of checking soil moisture is by observing concentration of moisture inside the polythene tent. High concentration of water

Plate 15: Watering with horse pipe fitted with showerose
vapour means there is enough water in the soil while low concentration means the cuttings need to be watered.

Daily checkups should be made to ensure that the cuttings are not allowed to dry out or seedling infected with diseases.

Post rooting operations

Since rooting is done under controlled conditions very different form growing conditions, rooted cuttings or shoots must be hardened off or acclimatized first before being exposed to outside conditions.

1. Removal of polythene

This involves loosening the polythene sheeting at both ends of the bed and leaving the polythene sheet loose on the ground for a week. One week later the polythene is rolled up at both ends and left that way for a week so that air may circulate. Then the polythene is rolled up 30 cm (1 ft) at each end a week later it is rolled up 120 cm (4 ft) at each end. This weekly opening continues to increase by 1.2m (4 ft) per week until the whole bed is uncovered. The polythene sheeting is then washed, dried and stored as before. Care should be taken that the soil in the sleeves does not dry up during the hardening off period.

There could be many variations of hardening off plants, but whatever method is used, the hardening off should be gradual to give the young plants time to acclimatize themselves to their new conditions and be able to withstand any adverse weather which may set in later.

After unsealing the tents, water requirements will increase. Infrequent, heavy watering is better than little and often, but over watering must be avoided.

Rooted cuttings require a lot of attention up to the time they are transplanted to the field. The problems generally encountered at this stage include poor and uneven growth, sometime with some cuttings looking very stunted with pale yellow leaves, scorching, shoot die back and wilting of plants.

2. Fertilizer application

Fertilizer application has also been successfully used to boost shoot growth but it is always essential to fully dissolve the fertilizer making a solution that has no danger of scorching plants. For cuttings rooted in mini pots, trays containing only infertile subsoil, fertilizer application may start 3-4 weeks after transplanting into standard pots. For plants raised in standard pots containing fertile topsoil in the lower part of the sleeve, fertilizer application may start immediately after the cuttings have been hardened off or preferably before the rooted plants look yellow.

In either case, Sulphate of Ammonia (21%N) is applied by dissolving 500g of SA mixed in 200L of water and 10L of solution administered in 1M² of a bed. One application per week over three weeks would be adequate to promote shoot growth.

Later application can be replaced altered with NPK 25:5:5 at 1gN/M². 1gN dissolved in 1.3L of water and plants washed with plain water after application to avoid scorching.

OR

For just rooted cuttings 1 gm of nitrogen (either Sulphate of Ammonia or NPK) per 1 m² of nursery bed dissolved in 1.3 litres of water should be applied on weekly basis for 3 months. After 3 months fertilizer should be applied monthly at a rate of four to five gms of Nitrogen per 1 m² of nursery bed as SA or NPK respectively, dissolved in 1.3 litres of water. In both applications an immediate application of

plain water should follow, to wash the fertilizer solution off the leaves of the young plants. *Remember 1 gm N/m² =5 gm SA/m², 1 gm N/m² =4 gm NPK 25:5:5*

3. Weeding

Weeds should never be allowed to establish, as they will compete for water and nutrients which cause yellowing and stunted growth of the cuttings. They should be removed by hand immediately they are seen.

4. Sorting and Grading

Sorting is a practice done, to separate weak from strong plants. Plants will require grading after having had the polythene sheet removed. The grading is done by placing large plants in one side of the bed and small plants to the other. This allows retarded plants to grow uniformly without excessive competition for light.

5. Hardening off

Plants must be hardened off a few weeks before transplanting to the field. This is done by gradual thinning the overall shade and then exposing the plants to full sunlight before they are moved to the field. This is very important otherwise plants will get sun scorch and die, soon after transplanting.

It might be necessary to regrade prior to final period of hardening off as this will prevent over shading by plant and subject them to better exposure to sunlight. The aim is to have plants completely hardened about 2 to 3 months before they are transplanted in the field.

Size of new plants at transplanting time

It is suggested that plants with one shoot 20 cm (8 inch) tall, or 15 cm (6 inch) if decentred, or with two or more shoots 15 cm tall and with roots which have reached the bottom of sleeves (25 cm or 10 inch long) are ready for transplanting in a new clearing. Plants which reach a height of 30 cm (1 ft) tall in the nursery for about 18 months are pruned at 15 cm (6 inch) and again at 20 cm (8 inch) when they reach a height of 35 cm (14 inch). This pruning will encourage low branching. If at transplanting infills have long soft shoots, they should be transplanted during dull weather or be shaded lightly.

Preparing for Transplanting.

Enough carrying facilities (e.g. Boxes) should be prepared to enable plants to be packed ready for dispatch to the field early the following morning.

Plants should roughly sprinkled so that water has enough time to soak/ink into the whole pot. This will ensure that pots are easier to handle and travel to the field without severe damage.

The plants can be lightly watered again just prior to moving them to the field.

Table 1.A guide to some common nursery problems and their remedies.

Problem /Symptoms	Causes	Remedy
Blackening and rotting of the collar of unrooted cuttings under misting or polythene tunnels	Water logging causing the stem base to rot and die. This result from: - Poor bed or planting pot drainage. - Too much shade - Use of medium with too high clay content.	- Reduce nursery shed or open polythene sheet periodically to allow channels - Examine pots for perforations or drainage holes; add more if necessary - Reduce watering.
Rooted cutting wilting at the tip followed by dieback. Roots dying, mostly brown or black with no new white roots.	Roots death due to water logging resulting from the same causes as above	As above.
Excessive growth of pale yellow or whitish shoots	Excessive callusing and poor rooting. This can be caused by: - High pH - Excessive aeration due to loose soil or loose planting - Poor cutting material with flower buds - Low soil moisture in the planting pot	- Firm the soil around the cutting. - Remove flower buds from cuttings - Improve watering regime - Increase nursery shade if necessary
Exposed plants developing scorched maintenance leaves followed by defoliation but without general wilting	Excessive direct sunlight on insufficient hardened off plants. Watering during late morning or mid-day often aggravates it. The disease brown blight has a similar effect on plants but rarely occurs on exposed plants	- Hardening off should be done gradually, avoiding sudden exposure of plants to strong light. - Do not stimulate tender growth by applying fertilizer or foliar feed immediately prior to hardening off. - Do not water directly on to leaves on a hot day.
Drooping leaves and wilting of shoot from the top. Leaves may eventually	Water stress. This often occurs in well growing plants after hardening off.	- Adequate watering of affected plants especially on the edges of the bed.

fall off and the plant dies without showing any sun scorch symptoms		
Young leaves curling down and deformed. Often seen on cuttings under polythene tents	Black citrus Aphid sucking plants sap on underside of young leaves	- Spraying both upper and lower leaf surface with dimethoate at 1.5ml/l of water.

Recommended insecticide and fungicides for control of pests and diseases in tea nurseries

Technical name	Trade name	Rate/litre	Pest/disease controlled
Insecticides			
1. Alphacypemet hrin	Fasts 10% EC	0.25ml	Caterpillars, grubs, mosquito bug, weevils and black tea thrips.
2. Cypermethrin	Cymbush 20 % EC	0.25ml	Same as No. 1
	Ripcord 20 %	0.25ml	
	Sherp 20% EC	0.25ml	
3. Deltamethrin	Decis 2.5%	0.5ml	Same as N0.1
4. Dimethoate	Perfekthion 40% EC	1.5ml	Aphids, black tea thrips, caterpillars, grasshoppers, mosquitor bug, scales, tea thrips.
	Rogor 40% EC		
5. Endoosulfan	Thiodan 35EC	1.5ml	Mosquito bug, tea leaf weevil, Aphids.
6. Fenitrothion	Folithian 50% EC	2.0ml	Same as No5
Fungicides			
1. Captan	Kaptan 50% WP	1g	Brown and grey blight, eye spot damping off, dip for cuttings.
2. Copper	Cupravit 50%	2.5g	Brown and blight, eyespot, and damping off.
3. Oxychloride			
4. Dithane	Dithane M45	2.5g	General fungal growth including early and late bright
5. Ridomil	Ridomil MZ68WP	2.5g	General fungal growth including early and late bright

GLOSSARY

Axillary bud: A bud found in the angle between leaf and stem

Cutting: Small piece of a plant used for propagation

Pruning: The removal of vegetative material of a plant at long interval

Topsoil: The upper or top layer of soil rich in organic matter

Sub soil: The layer of soil under the topsoil which contains little organic matter

Banjhi: The dormant phase of the cyclical growth of tea. Also applied to the dormant bud at the apex of a dormant shoot. (An Assamese word)

Clone: Plants which are all derived from one bush (the mother bush) by a method of vegetative propagation.

Field capacity: The maximum level of water which the soil can hold in or attached to the soil particles

Infilling (supplying): The operation of replacing vacant sites in a field of tea with new plants

Mother bush: A bush selected for its desirable characteristics which has been multiplied by vegetative propagation or tissue culture. The plants so produced form a clone.

pH: The standard measure of acidity or alkalinity. It is the negative logarithm of the hydrogen ion concentration. The neutral point is at a value of 7. Higher values are of alkaline while lower are of acidic.

Vegetative propagation (VP): Growing new plants from a piece of an old one, thereby perpetuating the exact character of the mother plant. In general terms VP includes budding, grafting and tissue culture. In the tea industry it refers only to the raising of plants from cuttings and shoots

Pesticide: A substance used for destroying insects or other organisms harmful to cultivated plants or to animals

Insecticide: A substance used for killing insects

Fungicide: A fungus destroying substance

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ESTABLISHMENT OF NURSERIES FOR SLEEVED CLONAL TEA PLANTS

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By Njuguna
May 1976

DETAILS OF THE TRAINING

DATE

VENUE

DURATION

COURSE TITLE

TARGET GROUP

Managers, Team leaders and Supervisors in charge of plucking team/gang

NUMBER OF PARTICIPANTS

20 trainees per session

COURSE DELIVERY

The course will cover both theory and practical. 1 day will be spent for indoor workshop and 1 day for field practical. Where applicable, trainers will practically demonstrate all theoretically covered topics.

TRAINING METHODS

Participatory Approaches will be used in order to increase participation. Methods to be used are discussion in Plenary, Groups, Cards, Buzz groups, Drawings, Trainees to practice demonstrations etc

TRAINING MATERIALS

Item	Quantity
Flipchart, Flipchart stand, Marker pens, Notebooks Black soil, Red soil, 1m ³ box	2 rolls, 1, 3 boxes, 1 per each, 1
My clear bag, Over head projector, PowerPoint Projector, A sisal rope	1 per each trainee, 1, 1, 1 roll
Ruler, Rubber Pencil, Pen, Transparencies, 30m tape measure, Lazor blades, Plastic bags	1 per each trainee, 1 box, 1, 1 dozen, 10
Reams of paper, Masking Tapes, Pegs	3, 3, 40
Staple machine, Staple pins, Handouts, Speedling trays, Pruning saw	1, 1 box, 1 per each trainee, 3, 1
A sharp knife, Water basins, Pruning knives, Soil orgor, Polythene sheets, Polythene tubes	10, 3, 2, 1, 1 roll, 1 roll
Watering can, A site for nursery establishment	1, 1, 1

COURSE PROGRAMME

DAY 1

WHEN	WHAT	WHY
8:00-9:00	TEA NURSERIES	Trainees to get the overview of tea nurseries.
9:00-10:00	PREPARATION OF MOTHER BUSHES	Trainees to know ways of increasing Plucker productivity.
10:00-10:30	TEA BREAK	
10:30-11:30	SITE SELECTION	Trainees to know characteristics of a good site for nursery
11:30-12:30	NURSERY SOIL	Trainees to know different types of soil used and their characteristics.
12:30-1:30	LUNCH	
1:30-2:30	PREPARING PLANTING MATERIALS & PLANTING	Trainees to know preparations and principles of planting.
2:30-4:00	MANAGEMENT AFTER PLANTING	Trainees to know care needed by the cuttings after planting.

DAY 2

WHEN	WHAT	WHY
8:00-9:00	RECAP-What have you learned from last day's workshop? What was hard for you to understand	Will help the trainer to concentrate on parts, which were not well understood.
9:00-12.30	PRACTICALS	To equip trainees with practical skills.
12:30-1:30	LUNCH	
1:30-2:30	EXERCISE	To equip trainees with practical skills.
2:30-3:45	ACTION PLAN	Trainees to construct guideline of their future activities regarding the theme which will be followed up.
3:45-4:00	COURSE EVALUATION	Trainers to know understanding level of trainees and where to improve for future courses.
4:00-4:30	CLOSING REMARKS	

SESSION PLANS

SESSION PLAN 1

WHEN	WHAT	HOW	AIDS	WHO
15 MIN	INTRODUCTION	SELF		ALL
30 Min	OFFICIAL OPENING	PLENARY		ALL
10 Min	WORKSHOP PROCEDURES, PROGRAM, METHODOLOGY		FLIPCHARTS, MARKER PENS	
20 MIN	EXPECTATIONS, FEARS & WORRIES	TRAINEES TO WRITE THEIR EXPECTATION, & FEARS	CARDS, MARKER PENS	TRAINEES
5 MIN	COURSE OBJECTIVES	PLENARY	OHP, POWER POINT, FLIPCHART	TRAINER
45 MIN	TEA NURSERIES RMS	BUZZ GROUPS		ALL
45 MIN	PREPARATION OF MOTHER BUSHES	PLENARY GROUP WORK	FLIPCHARTS, MARKER PENS	ALL
30 MIN	TEA BREAK			
60 MIN	SITE SELECTION	PLENARY, Q & A	POWERPOINT	ALL
60 MIN	NURSERY SOIL	PLENARY, GROUP WORK	FLIPCHARTS, MARKER PEN	ALL

SESSION PLAN 2

WHEN	WHAT	HOW	AIDS	WHO
60 MIN	RECAP	ROTATION		ALL
240 MIN	PRACTICALS	BY DOING	AS MENTIONED	ALL
60 MIN	LUNCH			
60 MIN	EXERCISE	GROUP	FLIPCHARTS, PENS	TRAINEES
60 MIN	ACTION PLAN	CONSTRUCTION OF ACTION PLANS	FLIPCHART, PEN	TRAINEES
15 MIN	COURSE EVALUATION	EACH PARTICIPANT WILL FILL IN EVALUATION SHEET	COURSE EVALUATION SHEET	TRAINEES
30 MIN	CLOSING REMARKS			GUEST OF HONOUR

PRACTICALS

Trainees to know and practice:

- Site layout and dimensions
- Lay out of nursery beds
- Pruning of mother bushes
- Handling of pruned branches
- Top soil and subsoil selection
- Preparing polythene tubes
- Filling polythene tubes
- Stacking
- Preparing conventional cuttings and pluckable shoots
- Irrigation
- Planting
- Fertilizer application
- Sorting and Grading
- Hardening off

ACTION PLANS

Name: _____ Organization _____

Title _____

ACTION	EXPECTED RESULT	COLLABORATORS	BY WHEN

Trainees should fill in 2 copies of his / her Action plan. One copy will be returned to the trainer while the other will help him / her in implementation.

WORKSHOP ASSUMPTION

- That the workshop facilitators are participants in the learning process
- That the objectives have direct implication for/impact on participants work
- That the workshop topics provide an initial focus for discussions with and among participants
- That the workshop will provide opportunity for mutual sharing of experiences and expertise with particular emphasize on gender issues

LEARNING LOGS

We will be using a number of different methods to help you gain as much as possible from this workshop. As one of these methods we will use 20-30 minutes of workshop time each morning to look into our 'rear –view mirrors' i.e. e, to reflect on the most significant events of the previous day (s).

To increase the value of these daily reflection periods, we ask that each participant to take some time each evening to write down his /her reaction in a learning 'log'.

- What were the most important things you have learned today?
- What point/Topic was hard for you to understood?

What you write in the leaning log is for your own benefit.

We will begin every morning of this workshop with 20-30 minutes discussion of your responses to these and similar questions.

EXERCISE:

Name.....Date.....

1) The recommended rate of fertilizer application in mother bush is:

- a) Twice the normal field application rate
- b) 500 to 600 kg N/ha in Tanzania
- c) 250 to 300 kg N/ha in Tanzania

2) Mother bushes of pluckable shoots should be pruned:

- a) 3 to 4 months before planting.
- b) 4 to 6 months before planting.
- c) 6 months before planting.
- d) None of the above.

4) The soil pH required to initiate root formation is:

- i) 4 to 5
- ii) 4.5 to 5.5
- iii) 4.5 to 5
- iv) None of the above

3) Differentiate the following terms

➤ Mother leaf and mother bush

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➤ One node cutting and single node cutting

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➤ Top soil and subsoil

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.....

➤ Polythene tube and polythene sheet

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.....

➤ Conventional cutting and pluckable shoot

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.....

5) Write T for the true and F for a false statement at the end of each sentence.

- a) Speedling trays reduce the time needed for cuttings to be raised in nursery. _____
- b) Tea propagation by seedling is most recommended because it reduce genetic diversity. _____
- c) Hardening off should be done gradually otherwise plants will get sun scorch and die. _____
- d) Plants raised from conventional cuttings have earlier lateral branches development than those raised from pluckable shoots. _____
- e) Grading is done by placing large plants at the centre of the bed to expose them with full sunlight. _____
- f) Weeds are usually removed by using dibbles in nurseries. _____
- g) There are 2 types of cuttings used for propagation which are conventional cuttings and double node cuttings. _____
- h) Using pluckable shoots will allow more materials to be harvested and planted in the nursery in one growing season compared to propagation using conventional cuttings. _____

6) Mention three characteristics of subsoil used in nurseries?

- (i).....
- (ii).....
- iii).....

7) List down four disadvantages of Jumbo plants?

- (i).....
- (ii).....

(iii).....

(iv).....

8) Mention 3 importance of using polythene sheets to cover nursery beds.

(i).....

(ii).....

(iii).....

9) List down one pre rooting and 5 post rooting operations required by a Tea nursery.

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.....

10) Write down 4 advantages of misting.

i).....

ii).....

iii).....

iv).....

11) Mention two methods of propagating cuttings?

(i).....(ii).....

12) Mention four advantages of using misting over polythene tents.

(i).....

(ii).....

(iii).....

(iii).....

13) Why is it essential to apply SSP in subsoil and SSP and MOP in topsoil?

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14) Mention 2 types of nursery beds, which one do you prefer and why?

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15) Mention two advantages and two disadvantages of using pluckable shoots.

No.	ADVANTAGES	DISADVANTAGES
1		
2		

16) Mr Mwaipopo and Mr Mwakapeja are friends who want to establish a tea nursery. Mr Mwaipopo has 2 hectares while Mr Mwakapeja has 2 ½ hectares to be planted with tea. What is the size of nursery shade do they need to clear?

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COURSE EVALUATION:

Your frank assessment is needed in order to improve future Trainings.

Please circle:

1=Very good

2=Good

3=Average

4=Bad

5=Very Bad

1) Please give your comments on the following:

	<i>Ranking</i>	<i>Reason</i>
Method of training		
Group Exercise	1 2 3 4 5.....	
Participation of trainees	1 2 3 4 5.....	
Field Work	1 2 3 4 5.....	
Training materials	1 2 3 4 5.....	
General standards of Training	1 2 3 4 5.....	
Course Content		
Tea nurseries	1 2 3 4 5.....	
Preparation of mother bushes	1 2 3 4 5.....	
Site selection	1 2 3 4 5.....	
Nursery soil	1 2 3 4 5	
Preparing materials& planting	1 2 3 4 5.....	
Management after planting	1 2 3 4 5	

2) General assessment of the training course and the course material

- What were the most useful part, and why?

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- What were the least useful parts, and why?

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3) What topics were not understood?

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.....

4) What suggestion will you make to improve the training course?

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