KENYA/JAPAN

SOCIAL FORESTRY TRAINING PROJECT

PILOT FOREST SUB-PROJECT

NURSERY MANUAL FOR

TIVA NURSERY

BY

R.O. NYAMBATI
(ASSISTANT RESEARCH OFFICER)

SUSUMU HIRAO
(JAPANESE EXPERT)

AUGUST, 1991

ACKNOWLEDGEMENT.

We wish to extend our gratitude and appreciation to various individuals who in one way or another contributed to the successful preparation of this manual.

We are particularly indebted to the Kenya/Japan Social Forestry Training Project (SFTP) for the support and in particular Mr. Okabe for initiating the idea of writing this report/manual.

Special thanks should go to Prof. Asakawa of Tamagawa University for his important technical advises and proof-reading.

Special thanks should also go to Mr. S. Mbingu, S. Auka and Kimweli for providing us with most of the information relating to seed collection, procurement, handling and the unique aspects of seedling production at Tiva.

We would also like to record our gratitude to Pilot Forest Senior Technical Staff for their technical advice and moral support.

Institutional support from Kenya Forestry Research Institute is greatly acknowledged.

Finally we wish to extend special thanks to Catherine Kang'alikya for willingly typing and retyping the rough drafts with considerable dedication.

R.O. Nyambati (A.R.O.)
KEFRI-KITUI
Box 892
KITUI

S. Hirao (Japanese Expert)
SOCIAL FORESTRY TRAINING PROJECT
P.o. Box 892
KITUI

PREFACE.

Kenya/Japan Social Forestry Training Project (SFTP) started its preparatory phase for 2 years on 26th Nov. 1985 followed by a main phase of 5 years terminating on 25th Nov. 1992.

The Pilot Forest Scheme was established in Nov. 1986. In that year seedling production was not among the activities carried out in the Pilot Forest Scheme. The required seedlings were supplied by Kenya Forestry Research Institute (KEFRI) and Forest Department (FD).

Seedling production at Tiva nursery started in 1987 and this activity has continued for the last 5 years. This "Provisional Nursery Manual" for Tiva nursery has been written following the 5 years activities at the nursery.
It is however important to note that the technical aspects require further refinement. As this manual has been written through 5 years experience in Tiva nursery, I'm convinced that it could have wide application in especially Kitui district.

I must note that the making of this manual has a lot of meaning especially as it comes at the end of the main phase of SFTP.

This manual written by Messrs R.O. Nyambati and S. Hirao is a product of the good co-operation between Kenyan and Japanese experts attached to Tiva nursery.

Finally the Project wishes to thank Prof. S. Asakawa who has on annual basis since 1987 visited the Pilot Forest Scheme for his technical advices and guidance in the making of this manual.

H. Okabe
Chief Advisor (SFTP)

Dr. J. A. Odera
Director (KEFRI)

February, 1992

SUMMARY.

This manual has been prepared on request by the Kenya/Japan Social Forestry Training Project (SFTP). Since the start of the Project (1986) none has been written.

As we all know, not much has been done on Forestry Development in Arid and Semi-arid lands (ASALs) of Kenya.

We have therefore very little understanding of the technical aspects that will lead to successful seedling raising and subsequent tree growth in ASALs.

This manual deals specifically with all the activities aimed at the production of viable and healthy seedlings at Tiva tree nursery.

Most of the technical aspects mentioned here though unique to Tiva nursery may also be applied to other nurseries in the ASALs of Kenya.

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re-afforestation work in the trial plantation.

(b) To carry out trials to determine tree species that perform well in semi-arid regions like Kitui.

(c) To carry out seedling production and tending techniques that are biologically sound, socially acceptable and economically feasible in semi-arid regions.

1.2 Irrigation facilities.

As mentioned above, this is a semi-arid region and therefore water is a major limiting factor in re-afforestation work. We are however lucky to be operating close to one of the major rivers (Tiva) in the area. At the moment the nursery draws water from a shallow well constructed on the bank of Tiva river. The well provides sufficient water for use in the nursery throughout the year. The water from the well is pumped into the storage tank using a submersible pump. From the tanks the water is distributed all over the nursery by a piping system.

1.0 INTRODUCTION.

Tiva tree nursery is one of the sub-sections of the Pilot Forest scheme of the Kenya/Japan Social Forestry Training Project. It is located in Kwa-vonza location of Kwa-vonza Division - Kitui District.

The Nursery has been operational since 1987. The project is within a semi-arid area and receives an average annual bimodal rainfall ranging from 500-700 mm. The short rains come in March-April and the long rains October-November. The potential evapotranspiration is 1800mm per annum. The temperatures are normally high ranging between 22 - 33^{0}C. The soils here are shallow and poor mainly of sand and murram. The nursery covers one hectare and has a production capacity of 1 million seedlings. The operational capacity has been 1/4 million so far. The nursery operations are geared towards the production of high quality seedlings that should be ready for outplanting in the field at the onset of the October-November rains.

Going by some of the above factors and the fact that little has been done on systematic re-afforestation of ASALs, it has become necessary that we develop a nursery manual that will be used by the project and all other neighbouring parties that are interest in raising tree seedlings and subsequent tree planting.

2.0 SEED COLLECTION, HANDLING AND STORAGE.

2.1 Seed procurement and handling.

Seed procurement is a basic step in re-afforestation. The seeds should be collected from trees of superior quality growing in areas with similar environmental conditions to the area in which the seedlings are to be planted. Due to seed off years and other vagaries of climate, there is no constant supply of seeds annually.

To circumvent this problem, appropriate seed storage methods must be looked into. However for seeds of trees that may lose viability if stored for a long time, ways and means of getting a continous supply of seed must be looked into.

2.2 Seed procurement in Kenya.

Presently in Kenya, there is one institution authorized to play a key role in provision of forest seed. The Kenya Forestry Research Institute (KEFRI) under the Ministry of Research Science and Technology coordinates the collection, selection, storage and distribution of tree seed. KEFRI is responsible for coordination and management of seed collection and processing at its central facility in Muguga. Collection is undertaken by the other regional sub-centres as well. Thus the routine quality control function is lodged within this institution.

2.3 Seed provenance.

The seed collection site is called a seed provenance and finding a good provenance is just as important as the choice of species. It is advisable to collect seed from trees that are growing on similar sites to those where the seed will be sown, because those trees will be fully adapted to the particular physical conditions of that environment (rainfall, soils, etc).

A good seed provenance will consist of a stand of several healthy, vigorous trees of same species (mother trees).

2.4 Seed collection.

Seed should only be collected from fruits, pods or cones that are ripe or mature. Since different trees flower at different times, it will be important therefore to note flowering periods of trees so as to monitor seed maturity closely (Appendix 1). This will go along way in aiding seed collection at an appropriate time. As a general rule, mature seed pods will be almost dry and brown in colour (e.g. *Leucaena leucocephala* pod or *Grevillea robusta* capsule) and just about to open. A simple way of checking ripeness is to extract some seeds from a sample of pods and cut them in half; the inside should be white, firm and should fill the seed coat. If possible, seed should be gathered from the entire crown of the tree.

The more accessible fruits on lower branches tend to contain fewer good seeds than those higher up, so these are the ones that are worth climbing for. Fruits or pods that have been damaged by insects or disease should be avoided.
The same also applies to the fruits of species such as *Markhamia lutea,* which tend to remain attached to the tree for along time and may have deteriorated.

When collecting seeds, it may be useful for the seed collection team to keep records of seed provenance specifying location, altitude, soil type and details of climate for future reference.

2.4.1 Mother tree.

Usually trees which produce good quality seeds are used continuously as the seed source until they lose the fruiting vigor. These trees are called "Mother trees". Selection of mother trees is the first step of seed collection. Mother trees must be healthy, vigorous, well formed and sustain good quality and quantity of seeds.

2.4.1.1 Selection.

Once a provenance has been identified, Mother trees that are healthy, vigorous, well formed to sustain good quality and quantity of seed should be chosen (see fig. 2.1)

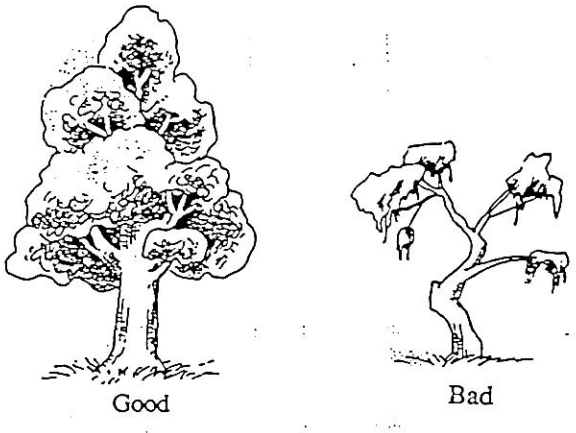

Figure 2-1: Mother tree

It is advisable to avoid trees that appear diseased or generally unhealthy as well as those that are young and isolated. Although an isolated tree may appear healthy it may nevertheless be a genetic fluke. The seed of such a tree may not be viable because it is likely that the tree has self-pollinated, its offsprings could turn out to be weak or stunted.

A good seed source should consist of a stand of several healthy, vigorous trees of the same species. Inorder to guarantee sufficient genetic variation, a seed lot is generally best if it contains seeds from more than ten trees. Note however that it may not be possible to maintain such criteria for some indigenous tree species that tend naturally to grow in isolation.

2.4.1.2 Conditions required.

Characteristics of the trees to be planted depend on the purposes of tree planting. Mother trees must therefore be superior in all the points.

2.4.2 Seed collection methods.

There are many seed collection methods, and these depend on tree height, thorniness and behaviour of pods once mature.

2.4.2.1 Thornless trees whose pods do not burst.

Seed collection in this case is done by either climbing up the tree, from natural seed fall or after shaking the tree. Tree species in this category include: *Acrocarpus fraxinifolia, Cassia spectabilis, Croton megalocarpus, Delonix regia, Ficus natalensis, Grevillea robusta, Jacaranda mimosifolia, Melia azedarach, Melia volkensii, Terminalia brownii, Terminalia mentalis, Terminalia pruinoides, Tamarindus indica* and *Sesbania grandiflora.*

2.4.2.2 Thornless trees whose pods burst.

For the trees in this category, seeds must be collected before pods burst and release seeds. In this case, seed collection is done by either climbing up the tree or by shaking the tree and collecting fallen seeds. The tree species in this category include: *Albizia anthelmintica, Cassia siamea, Leucaena leucocephala* and *Newtonia hilderbrandtii.*

2.4.2.3 Thorny trees whose pods do not burst.

This is done in several ways, seed from natural fall or those that fall after shaking the tree can be collected. Seed can also be collected with the help of pole implements or by use of the ladder. The trees in this category include: *Acacia albida, Acacia gerrardii, Acacia nilotica, Acacia polyacantha, Acacia tortilis, Balanites aegyptiaca, Parkinsonia aculeata* and *Prosopis juliflora.*

2.4.2.4 Thorny trees whose pods burst.

The seed in this case must be collected before the pods burst. This means the trees must be climbed and shaken for the seed to fall or a ladder and or pole implement used. The species in this category include: *Acacia mellifera, Acacia senegal* and *Caesalpinia decapetala.*

2.5 Seed extraction.

Most seeds collected are contained in cones, fruits or pods. The seeds must therefore be extracted out from their cones or fruits. *Grevillea robusta* seeds are taken out from the capsules. The capsules open when dried in the sun for 7 - 10 days. The seeds are extracted from open capsules by rubbing them against each other by hand. The extracted seeds are then dried for 3 - 4 days in the sun.

The seeds of *Acacia albida, Acacia gerrardii, Acacia polyacantha, Acacia senegal, Acacia tortilis, Acrocarpus flaxinifolia, Albizia anthelminthica, Caesalpinia decapitala, Cassia siamea, Leucaena leucocephala, Parkinsonia aculeata, Sesbania grandiflora* and *Sesbania sesban* are thrown out when the pods split open. The pods are therefore collected from the trees as soon as they change colour from green to brown and start splitting from one end. The collected pods are dried for 3 - 4 days in the sun after which they are put in sacks beaten abit and tossed around to extract the seeds. Failure to put the seeds in sacks will lead to a high loss of seeds because pods split open by explosive mechanism and throw out the seeds.

The pods of *Acacia nilotica, A. tortilis and Piliostigma thorningii* are dried for 5 - 7 days, put in a mortar and winnowed to get the seeds. The seeds are dried for 5 days before storing or sowing. In the case of *Melia volkensii*, the ripe fruits are collected, depulped using a mortar and pestle after which the seeds are washed and dried in the sun for one week. The seeds of *Balanites aegyptiaca* and *Tamarindus indica* are collected from the tree put in a large basin with water and sand, the pulp is removed by rubbing the fruits against the sand by use of hand. The seeds are then washed and dried for one week.

For *Cassia spectabilis, Delonix regia* and *Jacaranda mimosifolia* whose pods are very hard, extraction is done by opening the pods with a knife. Before opening, the pods should be dried for 5 - 7 days. The seeds are then dried for 2 - 3 days in the sun. The nut of *Croton megalocarpus* is broken using a stone or hammer to extract the seeds. The seeds are then dried for 3 - 4 days. The pods of *Prosopis juliflora* are heaped on metal sheet. The heap should be about 10 cm high. They are then covered by a layer of grass and then soil. The whole heap is then watered. *Prosopis* pods will be attacked by termites. The termites will consume the pulp and the grass leaving the seeds.

The soil will then be removed after 2 weeks and the seeds washed and then dried for 2 - 3 days. The seeds of *Melia azedarach, Newtonia hildebrandtii, Terminalia brownii, Terminalia mentalis, Terminalia pruinioides,* after being collected are directly stored.

2.6 Cleaning and sorting.

Cleaning and sorting are necessary for good germination and protection against pests and diseases. What should be removed is dirt, immature light seeds and seeds that are rotten, broken, damaged by insects or infested by diseases. They should be removed by hand sorting and if available a fan sorting machine.

2.7 Drying.

Although there are several methods of seed drying, sun drying is the most common. The seeds should not be directly exposed to naked flames. The drying process should be gradual over several days and the seed should be turned every few hours. When the seed is dry, it may be packed in clean, air and moisture tight containers such as polythene bags.

2.8 Seed testing.

Seed tests are very important to verify the seed quality, vigour and monitoring seed condition from collection through handling to storage. All collected seeds must be tested before storage or dispatch for purity percent, seed weight, moisture content and germination capacity.

Figure 2-2 Seed testing label

Accession number of seed lot	
Species name	
Type of pretreatment	
Date sown	
Date of first germination	
Date of last germination	
No. of pots sown directly	
No. of pots germinated	
Germination percentage	

2.8.1 Seed purity analysis.

This is mainly carried out on seeds that have been cleaned and sorted. This is necessary for good germination and protection against diseases. Generally tree seed samples contain impurities such as detached seed structure, leaf particles and other objects. The above analysis is conducted to determine the composition by weight of the sample being tested.

2.8.2 Direct inspection.

The exterior parts of the seeds are observed closely and carefully. The interior part is observed after the seed coat is cut with a sharp knife. The sample of seeds should be obtained from a well mixed stock of seed.

2.8.3 Seed germination.

This is the resumption of active growth in an embryo which results in its emergence from the seed and development of those structures essential in plant growth. In fact the potential germination of seeds is the most important factor of measuring seed quality. The germination test is used as an estimate of the number of seeds which can germinate at a given time. This test is useful in estimating the number of seeds that will be required for sowing.

2.9 Seed storage.

Freshly gathered seeds will germinate best, and preferably should be sown as soon as possible. However some seeds may have to be stored for some time, perhaps waiting the appropriate sowing time or for use during a lean year. The seed storage process involves maintaining the viability of a seedlot from collection time till testing or sowing time. The storage longevity of seeds is affected by their storage conditions. The two most important factors in seed storage are keeping them dry and cool. Wet/moist seeds spoil and rot in storage so they must be dried in air first. They are then stored in dry containers such as jars, boxes and bags. The seed storage containers should be kept on wooden shelves.

The collection of seeds showing a high incidence of fungal or insects attack should be avoided. All operations for collection, transport, processing etc. have to be carried out as quickly as possible to ensure seed is not damaged before it goes to storage. The seeds are normally stored at room temperature of 20^{0}C.

Some species are sown fresh due to rapid loss of viability. e.g *Azadirachta indica* (neem) while other species e.g. acacias may be stored for 3-15 years. We must always remember that the most important factors to be considered for seed storage are moisture content and temperature. There are seeds that are killed by excessive drying e.g. *Grevillea robusta, Dovyalis caffra, Azadirachta indica, Ficus benjamina* and *F. natalensis.*

When using sealed containers, the following must be remembered:-

(a) Moist (wet) seeds must not be sealed.
(b) Air-tight containers should be used for storage.
(c) The container should be clean and dry.
(d) The container should not be opened except when necessary.
(e) It is advisable to keep the container full of seed.
(f) A label on which the name of the species, collection date and place or mother trees are written should be attached to the container. (fig. 2-3).

Figure 2-3 SEED LABEL

SPECIES NAME:.....

PLACE OF COLLECTION:.....

DATE OF COLLECTION:.....

DATE EXTRACTED:.....

GERMINATION CAPACITY:.....

SEED WEIGHT:.....

TYPE OF STORAGE:.....

TYPE OF PRETREATMENT:.....

SOWING METHOD:.....

2.10 Seed pretreatment.

Seed pretreatment is recommended for several types of dormant seed to help ensure rapid germination of a maximum number of seeds sown in the nursery. Some seeds will germinate naturally only after a prolonged period; of perhaps two to four weeks in the nursery after they have been exposed to specific moisture, temperature, or light conditions necessary for that species or when the seed coat has rotted. Such seeds are said to be dormant and a number of pretreatment measures can be taken to break their dormancy so as hasten germination. Seeds also become dormant during a period of storage and some pretreatment is necessary to activate the germination process before they are ready for sowing.

2.10.1 Nipping.

Nipping is the treatment involving cutting the seed coat to enable moisture to enter the inside of the seeds. This treatment can be done with nail clippers, fine pliers, knives or a needle. A small scar at the end of the seed indicates the point to nip. One should be careful not to damage the radicle. Sometimes a hot wire is also used in nipping for some species.
Nipping may be used to pretreat the following species:
*Acacia albida, Acacia brevispica, Acacia mellifera, *Acacia nilotica, Acacia polyacantha, Acacia senegal, *Acacia tortilis, Acacia xanthophloea, Acrocarpus fraxinifolia, Albizia anthelmintica, Albizia gummifera, *Bauhinia thorningii, Cassia siamea, Cassia spectabilis, Leucaena leucocephala* and *Melia volkensii.*

Use of knife

Use of needle

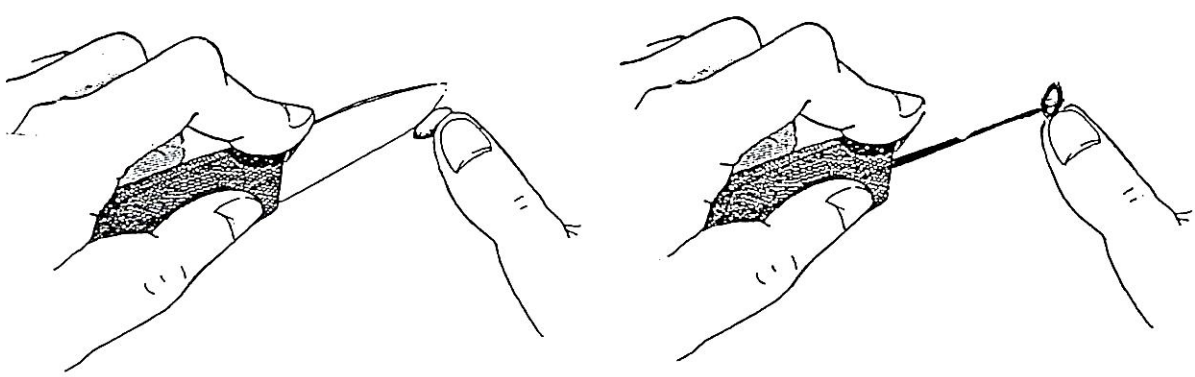

Figure 2-4

* Pretreatment by hot wire

2.10.2 Soaking in boiled water.

This is a frequently used technique whereby the seeds are immersed in boiled water 4 - 10 times their volume, then the heat source is immediately removed and the soaked seeds are left in water to cool gradually for 12 - 24 hrs. The method is widely used but it can give erratic results. The optimum soaking time varies between species. This method appears to give better results for *Acacia spp.* The hot water softens the seed coat making it more permeable to water. The following species may be pretreated using this method. *Acacia senegal, Acacia polyacantha, Leucaena leucocephala, Acacia mearnsii, Delonix regia.*

2.10.3 Soaking in hot water.

The soaking of seeds in water within a range of $60^{0}C$ -$90^{0}C$ is often as effective as soaking at $100^{0}C$ (boiling water) but there is less chance of damage at the lower temperatures. This method is normally applied for the seeds with hard coats or testa e.g. *Acacia gerrardii, A. mearnsii, A. mellifera, A. xanthophloea, Cassia siamea, Cassia spectabilis, Delonix regia, Leucaena leucocephala, Prosopis juliflora* and *Tamarindus indica.*

2.10.4 Soaking in cold/warm water.

Soaking of seeds in water below or about $40^{0}C$ is effective in promoting germination only in those seeds which already have a permeable seed coat. In some instances most seeds tend to develop impermeability as they mature or in subsequent storage e.g. *Acacia senegal.* The following species may be pretreated using cold or warm water:
Newtonia hildebrandtii, Tipuana tipu and *Ziziphus mauritania.*

2.10.5 Fresh seeds only.

As it was mentioned earlier some species will not germinate after being stored for some time. These species should be sown very soon after collection e.g. *Azadirachta indica, Kigelia africana, Salvadora persica, Warbugia ugandensis.*

2.10.6 No treatment required.

Casuarina equisetifolia, Croton megalocarpus, Dalbergia melanoxylon, Eucalyptus spp, Grevillea robusta, Jacaranda mimosifolia, Melia azedarach.

Table 1. Pre-sowing treatments applicable to various tree species:

SPECIES	PRETREATMENT	GERMINATION (%)
1.Acacia abyssinica	80°C for 15 minutes	78
2.Acacia albida	80°C for 3 minutes	39
3.Acacia gerrardii	Cold water 12 hrs.	75
4. Acacia holoicilica	80°C for 7 minutes	86
5. Acacia mearnsii	80°C for 7 minutes	69
6. Acacia nilotica	Nipping	50
7. Acacia polyacantha	80°C until water cools	77
8. Acacia tortilis	Nipping	73
9. Acrocarpus flaxinifolia	Nipping	60
10. Azadirachta indica	None	95
11. Bombax rhodoghaphalon	80°C for 2 minutes	57
12. Caesalphinia decapetala	60°C for 3 minutes	75
13. Cassia siamea	60°C for 20 minutes	92
14. Cassia spectabilis	80°C for 10 minutes	68
15. Casuarina equisetifolia	None	90
16. Croton megalocarpus	None	99
17. Eucalyptus spp.	None	90
18. Jacaranda mimosefolia	None	69
19. Leucaena leucocephala	60° for 15 min.	96
20. Melia volkensii	Nipping	27
21. Parkinsonia aculeata	80°C for 3 minutes	86
22. Phoenix reclinata	60°C for 15 minutes	18
23. Prosopis julilfora	80°C for 15 minutes.	84
24. Sesbania grandiflora	Cold water 12 hrs.	74
25. Sesbania sesban	None	86
26. Tamarindus indica	60°C for 3 minutes	95
27. Terminalia brownii	Nipping	39
28. Terminalia catappa	60°C for 3 minutes	90
29. Terminalia mentalis	80°C for 15 minutes	49
30. Terminalia prunioides	Nipping	5
31. Terminalia spinosa	80°C for 3 minutes	13

3.0 NURSERY TECHNIQUES.

The success of seedling production in the nursery not only depends on efficient management of resources but also availability of the resources in good quantity and quality.

3.1 Facilities required.

(1) Storage for keeping the nursery tools safely and in good condition.
(2) Fencing around the nursery to keep livestock away.
(3) Water tank or drums for water storage.
(4) Offices.
(5) Green house.
(6) Potting shed.
(7) Capentary workshop.
(8) Seed store.

3.2 Tools.

The following tools should always be available for use at any given time. It is the responsibility of the nursery manager to find out how many of each will be required during the season and therefore be acquired in time. This work may be done in December and early January. Tools include: Rakes, Jembes, Slashers, Watering cans, Wheelbarrows, Pruning Knives, Sharpening files, Soil sieves, Shovels, Pangas, Jerrycans, etc.

3.3 Time to start Nursery work.

The time to start work at the nursery is dependent on the time to plant seedlings. There must be enough time for the seedlings to grow to plantable size, secondly, availability of labour should be considered since initial labour input for bed construction, soil collection, procurement of tools and materials, etc. is alot much higher than daily operation. It is important that work is started in late December or early January for some of the slow-growing species to reach plantable size by the onset of rains in November.
(Appendix 2).

3.4 Soil mixing and preparation for sowing.

In the preparation of the soil mixture it should take into consideration the fact that this is a semi-arid area and that the soil in the field is usually poor in nutrients. As much as possible, the seedlings growing in the nursery should meet the soil conditions that are the same or close to what they will experience in the field.

The soils should be collected from a forest area. The soil must have good physical structure and humus content. The surface layer consisting of grass, sticks, roots is removed to a depth of 10cm; the depth at which soil is collected. It is important that the soil is collected 2 - 3 months prior to potting so that the organic matter can decay and the seeds of weeds germinate and can be removed easily, and soil must be sieved before mixing to remove stones, branches, roots and other unnecessary matters. However if it is late, sieving should be recommended immediately after collection of soil. The soil is mixed with cow manure in the ratio of 4 parts of soil to one part manure. (Figure 3-1). The manure may be purchased from neighbouring farms.

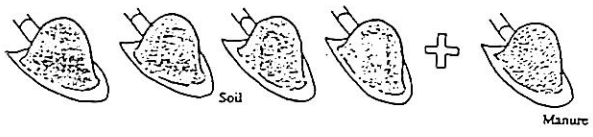

Figure 3-1: Soil mixing ratio

3.5 Potting media quantity calculations.

A nursery manager should be in a position to know the quantity of soil and manure that he may require to raise a given number of seedlings. The quantity of two mainly depends on the pot size, mixing ratio, number of seedlings required and survival ratio. For the Tiva tree nursery, the mixture is 80% top soil, 20% manure, survival ratio is 70% and pot size is 4" x 7". Soil mixture can be computed as follows:-

$$\text{Total soil quantity } (m^3) = \frac{A \times B \times C}{D}$$

Where A = capacity of pot
B = Mixing ratio
C = No. of seedlings required
D = Survival ratio.

3.6 Potting.

Potting is done in polythene tubes (normally 4"x7") clear or black in colour. It is important that they are open at the bottom to facilitate root development and movement of water. The pots should be filled in such a way that 3/4 of the lower bottom of the pot is compacted to ensure that the pot does not bend and spill the contents when it is being carried. The top is not compacted so much because compaction will not only make seed sowing difficult but also lead to localized resistance to root penetration (fig. 3-2). The pots are filled to the brim because the level of the soil goes down after watering. The soil mixture should be moist but not wet when preparing. A little water may be added to make it moist for easy potting. Potting under shade ensures that the soil does not loose moisture fast. The working efficiency is also higher under shade considering the high temperatures at Tiva.

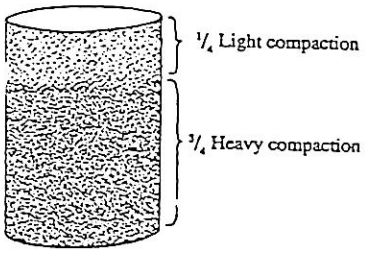

Figure 3-2: Compaction of soil in the pot

3.7 Seed sowing schedule.

The time for sowing a specific type of seed depends very much on the time it takes to attain plantable size. It is important that the seeds are sown in time as to attain plantable size (30 - 50 cm) by early November.

The following table shows the sowing schedule for Tiva nursery (Table 2).

Table 2: SOWING SCHEDULE (TIVA NURSERY)

No.of months before planting date	Species
18 months	Acacia plectocarpa(No. 16182)
16 months	Albizia anthelmintica Cupressus pyramidalis Newtonia hildebrandtii
12 months	Terminalia prunioides
11 months before	Acacia pendula (No. 11225) Albizia amara Azadirachta indica Bauhinia thorngii Terminalia brownii
10 months before	Acacia holoicilica Acacia tortilis Cassia spectabilis Balanites aegyptiaca Gmelina arborea
9 months before	Acacia gerrardii Acacia juliflora Acacia pendula (No. 11223) Acrocarpus fraxinifolia Dalbergia melanoxylon Delonix regia Grevillea robusta Melia azedarach Tamarindus indica Terminalia mentalis
8 months before	Acacia harpophylla (No. 15100) Acacia pendula (No. 10426) Acacia salicina (No. 16293) Caesalpinia decapetala Croton megalocarpus Cassia siamea Eucalyptus brevifolia Parkinsonia aculeata Terminalia catappa Terminalia spinosa
7 months before	Acacia albida Acacia nilotica Acacia polyacantha Acacia salicina (No. 15465) Acacia xanthophloea Casuarina equisetifolia Mellia volkensii Prosopis juliflora Sesbania grandiflora
6 months before	Acacia senegal Dovyalis caffra Eucalyptus paniculata
5 months before	Eucalyptus camaldulensis Eucalyptus tereticornis Schinus molle
4 months before	Acacia abyssinica Sesbania sesban Leucaena leucocephala

*Tiva pilot Forest Site planting season November every year

3.8 Sowing.

Use of potted seedlings for re-afforestation is a very expensive venture as compared to the use of bare-root seedlings. This is due to the cost of pots, pot filling, transportation of pots and arrangement. However in order to attain a high survival percentage in the field, there is not much choice but to produce seedlings in pots.

3.8.1 Direct sowing.

This is done for medium to large sized seeds. The following table shows some of the species that can be sown directly.

Table 3. Species that are directly sown

1. Acacia abyssinica
2. Acacia hypophylla No. 15100
3. Acacia juliflora No. 14890
4. Acacia nilotica
5. Acacia pendula No. 11225
6. Acacia plectocarpa No. 16182
7. Acacia polyacantha
8. Acacia pruinoicarpa No. 7889
9. Acacia salicina No. 15465
10. Acacia salicina No. 16293
11. Acacia stenophylla
12. Acacia tortilis
13. Acacia torulosa No. 47490
14. Acacia tunida No. 17181
15. Acrocarpus fraxinifolia
16. Albizia amara
17. Albizia anthelmintica
18. Azadirachta indica

19. Caesalpinia decapetala
20. Cassia siamea
21. Cassia spectabilis
22. Carica papaya
23. Croton megalocarpus
24. Delonix regia
25. Gmelina arborea
26. Grevillea robusta
27. Melia azedarach
28. Newtonia hildebrandtii
29. Parkinsonia aculeata
30. Sesbania grandiflora
31. Tamarindus indica
32. Terminalia brownii
33. Terminalia catappa

3.8.2 Sowing into special transplant beds.

For medium sized seeds which are difficult to germinate sowing is done on seed beds or transplant beds and later pricked out into pots or empty pots of directly sown seeds. The following table shows some of the species that are sown in transplant beds.

Table 4. Species that are sown in seed beds

1. Acacia gerrardii
2. Acacia polyacantha
3. Cassia siamea
4. Cassia spectabilis
5. Casuarina equisetifolia
6. Croton megalocarpus
7. Cupressus pyramidalis
8. Dovyalis caffra
9. Grevillea robusta
10. Jacaranda mimosifolia
11. Leucaena leucocephala
12. Schinus molle
13. Sesbania grandiflora
14. Sesbania sesban
15. Tamarindus indica
16. Terminalia mentalis
17. Terminalia prunioides
18. Terminalia spinosa

3.8.3 Sowing in seed boxes.

This is done for very fine and light seeds. Their seeds are small and therefore before sowing the seeds should be mixed with fine dry sand. The mixture is then broadcasted on the bed. This ensures uniform distribution of seeds. The seed boxes are kept in a green house and after germination the seedlings are pricked out into pots in the nursery. The table below shows some of the species raised in seed boxes.

Table 5 Species that are sown in seed boxes

1. Acacia abyssinica
2. Acacia holoicilica
3. Acacia juliflora No. 14890
4. Acacia pendula No. 10426
5. Acacia pendula No. 11223
6. Allocasuarina sp (caprestri)
7. Casuarina equisetifolia
8. Callitris robusta
9. Dalbergia melanoxylon
10. Dovyalis caffra
11. Eucalyptus brevifolia
12. Eucalyptus tereticornis
13. Eucalyptus paniculata
14. Melia volkensii
15. Prosopis juliflora
16. Terminalia spinosa

Note: Sowing depth is a very important aspect to be considered when sowing seeds. This is because when seeds are sown too deep in the soil they take a longer time before emerging from the soil, and they may produce uneven seedlings. Uniform sowing is therefore important for production of uniform sized seedlings.

3.9 Pricking out.

Seeds sown in boxes and seed beds once germinated have to be transferred into pots a process known as pricking out. Seedlings should be pricked out at the cotyledon or first leaf stage. When pricking out, the tender seedlings should be held with alot of care preferably by the leaves not the collar or stem. Before seedlings are pricked out they must be well watered. This also applies to after pricking out. It is important that pricking out is done under shade. Only healthy seedlings which have been uprooted from the seed-bed awaiting pricking into the pots should be kept in a tin or any other maturation container.

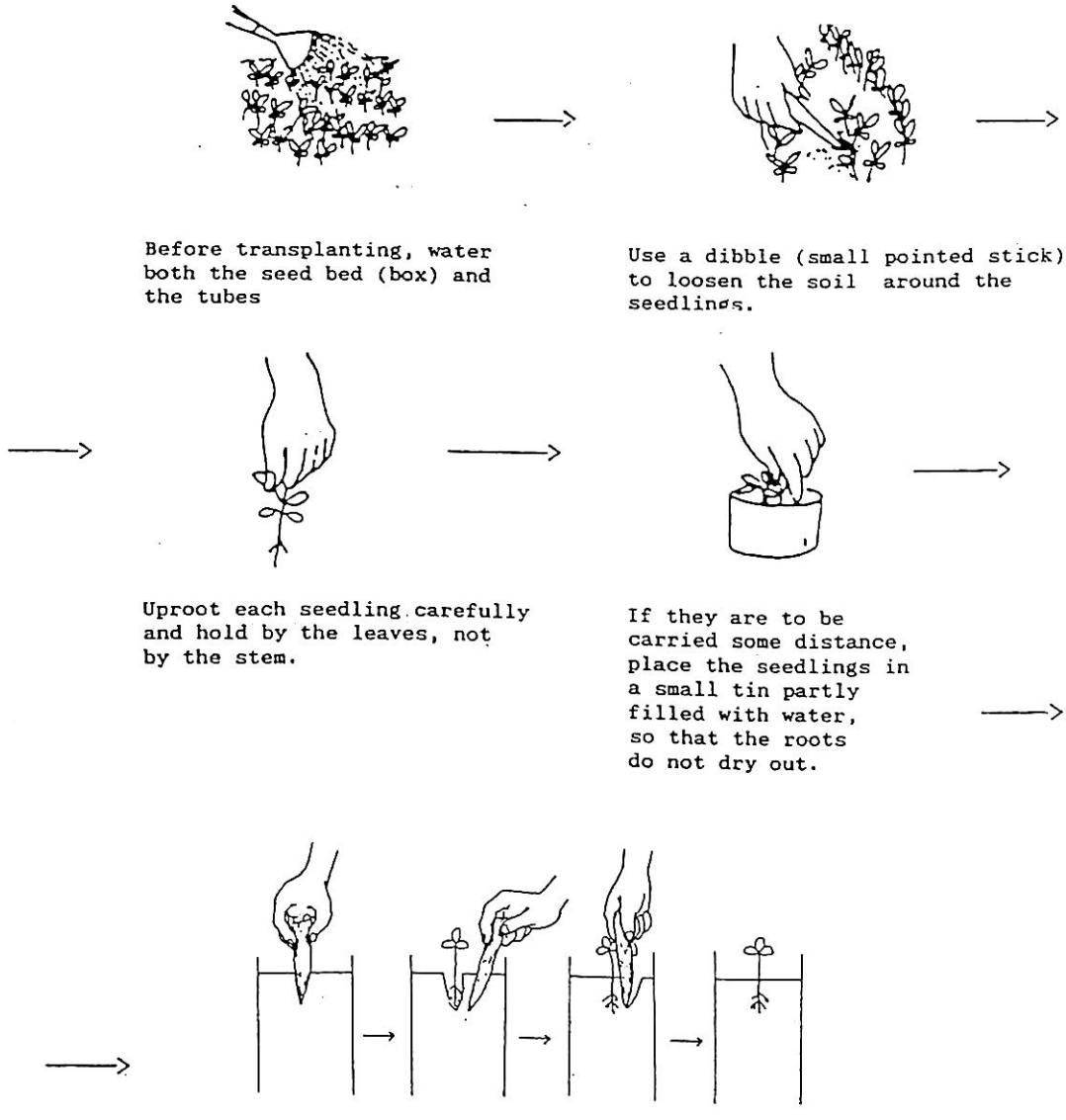

Figure 3-3: Pricking out

3.10 Seedling care and maintenance.

3.10.1 Shading.

It is necessary to control or minimize evaporation by protecting the nursery bed from direct sun. After pricking out the seedlings should be kept in full shade for 2 - 3 weeks. The shading material used may be grass net made locally. Some of the species that require shade are *Cassia siamea*, *Casuarina equisetifolia* while *Acacia polyacantha*, *Tamarindus indica*, *Prosopis juliflora* and *Croton megalocarpus* may not require shade.

3.10.2 Watering.

The seedlings should be watered twice each day, early in the morning and late in the afternoon when sunshine is not too strong. 30 l/1,000 seedlings is used. They should never be watered at mid-day. In the rainy season watering should be done once a day or none at all but the nursery headman should watch whether the stock is not under stress. During watering the intention is to keep the soil highly moist but never sodden or dry. Note, however that both over-watering and under-watering are bad for the seedlings. Over-watering may lead to root rot as a result of waterlogging and may also encourage prolification of damping off fungi, while under-watering will result in poor root development since the water will moisten only the surface layer of the soil.

The nursery beds/pots should not be watered using a hosepipe because strong jets of water are likely to wash away the soil and/or damage the seedlings. The water should be evenly distributed over the nursery using a watering can or an old tin with holes drilled at the bottom. Alternatively, a leafy branch can be used. Dip the branch into water and sprinkle the water onto the bed or pour the water down the branch onto the soil.

3.10.3 Weeding.

Weeds are a threat to healthy development of seedlings and must therefore be controlled. This is because they compete with seedlings for water, nutrients and light. Rouging i.e. the gentle pulling out of the unwanted growth is usually an appropriate method of weed control.

3.10.4 Secondary weeding.

This is a practice aimed not only in controlling the weeds but also in improving aeration and water percolation. Roots can penetrate easily into the soil which facilitates absorption of nutrients. Experience has shown that repeated watering of seedlings in pots compacts the soil thereby deteriorating the physical properties of the soil. This therefore makes cultivation an indispensable exercise. Convenient tools for the operation are spatulas, dibblers etc.

3.10.5 Root pruning.

When seedlings have reached a certain size, their roots become longer than the depth of the pots. If the roots are left without pruning, they penetrate into the ground and develop a root system.

It is important that strong roots are not allowed to develop because once they are cut the seedlings are likely to be weakened. Hence periodical root pruning is required before the root system is formed in the ground. This is done after every 2 - 3 weeks. It is advisable that the nursery stock is watered before and after root pruning. The watering after pruning helps the plant withstand moisture stress.

Figure 3-4: Root pruning

3.10.6 Cleaning around the beds.

Weeds emerge not only in the pots, but also around the beds. These weeds attract crickets, caterpillars and other insects which feed on seedlings and also give them a place to hide. Remove all the weeds around the beds with jembes and do not leave any rubbish around.

3.11 Hardening up.

If seedlings are over-watered and partially shaded up to the time they are out planted to the field, the resulting survival will be low. This is because the act of planting is a shock to the seedlings especially when planting in ASAL conditions. Seedlings in the nursery are usually weak and succulent. They wilt and die in a short time when exposed to the intense sunlight. Seedlings should therefore be prepared gradually for the field conditions.

One month before the end of the season, watering frequency is reduced to once a day and its intensity is reduced from 30 litres to 20 litres/1000 seedlings. Stock is however not allowed to seriously wither but it is the intention to stop soft and succulent growth. The seedlings are separated and rearranged in rows of threes so that they get fully exposed to sunlight.

4.0 STUMP SEEDLINGS.

4.1 Introduction.

It is a great problem to transport potted seedlings from the nursery to the planting site even if the nursery is located near the latter. In case of species with high sproutability, stumps will solve this problem. For a number of species, stumps can be stored in a frame prepared in the ground even for several months. This may be favourable in nursery practices from different viewpoints eg. cost of production, labour requirements and transportation.

4.2 Definition.

Stumps are seedlings that have been grown in the nursery bed and prepared as shown in Fig. 4.1 by trimming both top and tap root.

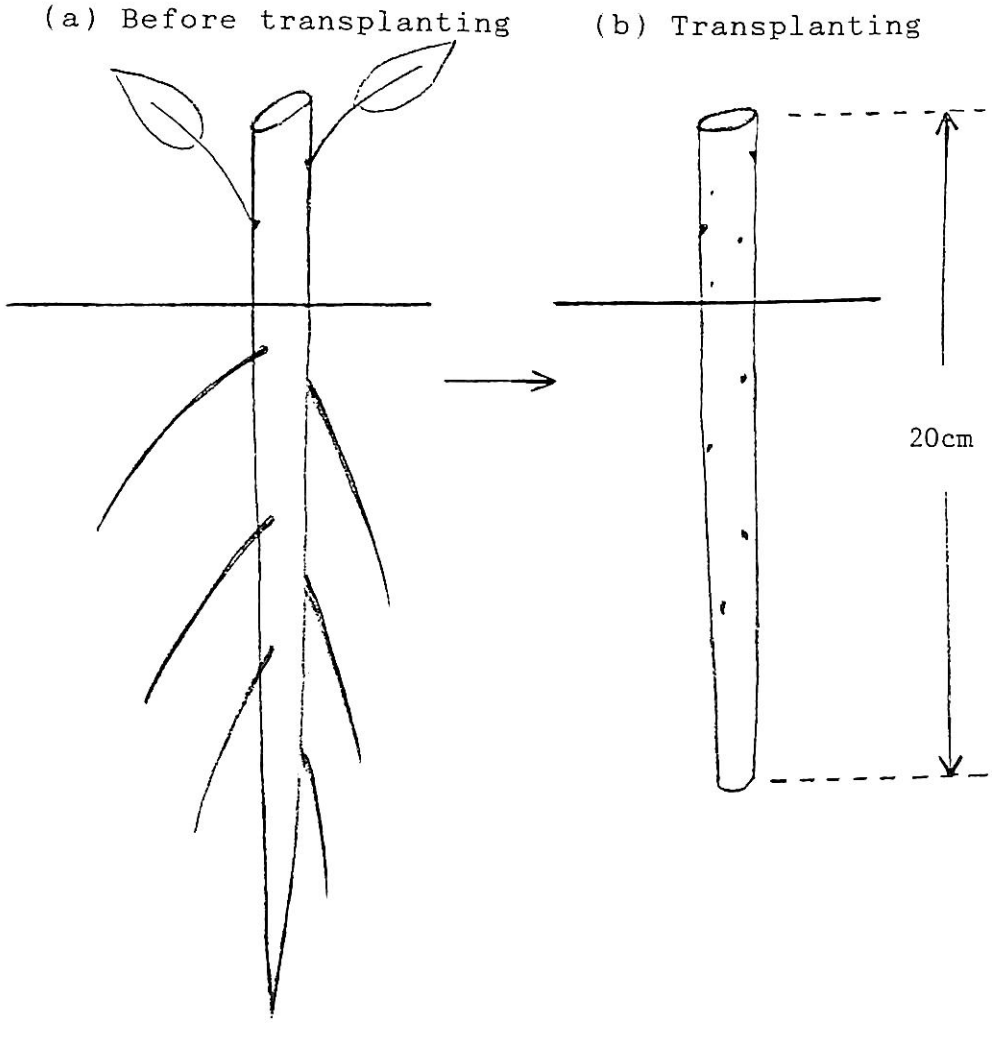

Fig. 4.1:
General appearance and approximate dimensions of a stump.

4.3 Production and handling.

General appearance and approximate dimensions of a stump is shown in fig. 4.1. The stump usually begin to grow their roots well before they leaf out, which is a great advantage in dry areas. Stumps are usually transported bare and will survive for more than a week if shaded and kept moist with wet hessian, straw or other material. Hundreds of stumps can thus be transported in relatively small box or crate. It is important to note that stumps can survive harsh growing conditions because of their "head start".

4.4 Species that can be outplanted by stumps

1. Albizia lebbeck
2. Azadirachta indica
3. Cassia siamea
4. Chlorophora excelsa
5. Commiphora africana
6. Conocarpus lancifolius
7. Dichrostachys cinerea
8. Euphorbia balsamifera
9. Gmelina arborea
10. Khaya senegalensis
11. Moringa oleifera
12. Prosopis juliflora
13. Tamarindus indica
14. Tamarix senegalensis
15. Ziziphus mauritania

5.0 NURSERY PROTECTION.

5.1 Introduction.

Seedlings are delicate and susceptible to attacks by various pests and diseases as well as some meteorological conditions. Damages by such pests and diseases seriously weaken or sometimes even kill the seedlings unless they are properly protected before the attacks or treated after the attacks without any delay. It is therefore important for nursery workers to have knowledge on anticipated pests/diseases and protection /control methods against them.

5.2 Damage and disasters in the nursery.

There are many factors that affect tree seedlings in the nurseries. They may be categorized into three:-

5.2.1 Physical factors.

These are drought, high temperature, strong winds, etc. Most of these can be prevented by physical countermeasures e.g. frequent watering, shading and windbreaks.

5.2.2 Human factors.

Disasters caused by man are such as trespass in the nursery and robbery of seedlings. These are more social than technical and therefore control measures cannot be specified.

5.2.3 Biotic factors.

Some mammals, birds, insects and fungi also damage or attack tree seedlings. Only these factors have been dealt with below.

5.3 Biotic damages by pests and control measures.

5.3.1 Insects.

Most insects and pests breed and hide under rubbish and weeds. The nursery should at all times be clean by sweeping all rubbish away. All weeds should be regularly uprooted and swept away. This cleaning will reduce the breeding grounds and number of the insect pests. In case of any attacks, protective measures such as chemical application or manual removal should be carried out as soon as possible.

5.3.1.1 Defoliators (leaf eaters).

Various groups of insects such as caterpillars, grubs, crickets, grasshoppers, locusts, etc. are defoliators. They eat a part of or the whole leaves and retard the photosynthetic ability of the seedlings.

Control.

Spraying of sumithion or parathion is effective especially for larvae in their early stages.

5.3.1.2 Stem cutters.

Cutworms are the caterpillar type larvae of various nocturnal moths. They cut stems of seedlings usually at night. This may lead to immediate death of the seedlings.

Control.

It is not easy to deal with cutworms once they have started to attack. However, some measure such as spraying chemicals e.g. Aldrin and Diazinon could be effective (poisoned bait), or sprinkling of Gammoxane into the soil could also be used when pots are being filled, which will reduce the incidence of loss by these pests.

5.3.1.3 Sap suckers.

Small insects such as woody aphids and bugs suck sap from seedlings. These insects sometimes transmit diseases to the leaves of seedlings through their saliva. In case the attack is serious, the whole seedling is damaged and dies. Sometimes unusual structures called galls, are formed on the leaves or stems, which are also caused by insects.

Control.

The most effective measure is use of chemicals.

5.3.1.4 Termites.

More than 2,000 species of termites are distributed mainly in the tropics. Common termites seen in semi-arid areas rest in the ground or dead wood and infest seedlings through the tunnels in the soil surface. They eat roots and stems of seedlings of many tree species. *Eucalyptus* spp are particularly susceptible to termite attacked.

Control

Termites can be controlled by several methods:

(a) Using ash in the soil mixture

(b) Putting a thin layer of ash 2 - 3 cm thick on the bed where the pots will be placed. However the effectiveness of the ash cannot last long. Periodical application is recommended.

(c) Using chemicals such as Deldrin and Aldrin

(d) Digging out queens of nearby colonies (termite hills). Extermination of all termites in the colonies by chemicals is more effective.

(e) If milk packs are used as pots, wash the packs with soapy water or solution of insecticide before use otherwise termites may be attracted.

5.3.2 Fungal diseases.

Although there are various diseases which attack seedlings in the nursery, only damping off and Botrytis wilt are described here since they are the most common fungal diseases in the country.

5.3.2.1 Damping off diseases and seedling blight.

In such diseases, most prevalent on seedlings and cuttings, the roots and the stem base are infected by a necrotrophic pathogenic fungus which usually enter through wounds or through the very thin cuticles which seedlings possess when grown under damp, poorly lit conditions. The pathogens are quite unspecialized; most of them are active producers of pectolytic enzymes and cause local death and collapse of the infected tissues. The plant then topples over and is further invaded by the pathogen.

Conditions favourable for the spreading of damping off are:-

(a) high sowing density.
(b) overwatering.
(c) using soil with under-composed material.
(d) using soil affected by damping off.

Control.

- Use optimum sowing density in seed bed
- Use appropriate quantity of water
- Do not damage the bark of seedlings
- Do not use alkaline soils

6.0 NURSERY MANAGEMENT AND THE ROLE OF NURSERY FOREMAN.

6.1 Introduction.

In the foregoing chapters, nursery techniques have been introduced. It is however important to note that though it is exceptionally important that technical aspects are adhered to, the managerial aspects have a big role to play in the success of these activities. Management includes a wide range of activities; planning of the operations, procurement of tools and other materials, labour arrangements, supervising the work, recording the activities, etc. The person responsible for all these is the nursery foreman.

6.2 Nursery management.

Planning of nursery work: In planning nursery work, the following must be undertaken:

(1) Selection of species. Selection of species to be raised in the nursery should be done in conjunction with technical staff from other sections, such as those in extension and plantation establishment as well as farmers. This should be done preferably in December before the start of sowing period.

(2) Scale of operation. Since the scale of operation is highly dependent on availability of funds and labour, the number of seedlings to be raised has to be based on available funds.

(3) Materials. Lists of the necessary tools should be made early in time (Dec-Jan).

(4) Annual operation plan. An annual working schedule (nursery calendar) should be prepared by December. Room should however be left for any changes that may come up with time depending on unforeseen circumstances.

Before starting the operation.

Before nursery work starts, the following should be done:

(1) Assignment of staff: the nursery manager should assign the nursery foreman, storekeeper, etc.

(2) Condition of work: The foreman should be able to assign the work force.

(3) Technical guidance: All people supposed to work in the nursery should be given the necessary technical guidance by the foreman.

Daily operation.

This is supervised by the foreman. This includes:

(1) Assignment of days' work: The foreman assigns the tasks of the day to workers.

(2) Supervising the jobs: The foreman should supervise the jobs and give the necessary instructions.

(3) Technical consultation: If any technical or other problems are encountered, consultation should be made with the nursery manager or any other senior technical staff available.

(4) Record and record keeping: The foreman should make all necessary records of the nursery activities.

6.3 Nursery foreman.

The nursery foreman should have the following characteristics:-

(1) Writing: Since record keeping is one of the most important jobs in the nursery, he/she should be able to write.

(2) Training: He/she should be trained properly on nursery techniques and management beforehand.

(3) Personality: He/she should be able to keep good relations with other people and be able to lead them.

(4) Honesty: He/she should be a very honest and strict person because there are many valuable things in the nursery.

7.0 NURSERY RECORDS AND RECORD KEEPING.

7.1 Introduction.

Recording all work and progress in a nursery is essential for nursery management. Well maintained nursery records also help improve techniques and rationalize the activities works and can also be used as a basis for the following season's operations. To keep and accumulate the records is also important. Accumulated data may also reveal some new findings and knowledge.

7.2 Nursery records.

7.2.1 Nursery diary.

This is the most important record book. All operations and observations of the day should be recorded in this book in details. The diary should be filled out in the morning after allocation of duties and in the evening before leaving for home.

Date	Work done	Remarks
10/1/91	200 seedlings of T. prunioides pricked out.	Collection of forest soil 4 people. Sowing Acacia holoicilica.

Figure 6-1 Nursery diary

7.2.2 Nursery register.

This is the record on individual nursery bed basis. All the main nursery operations should be recorded on board.

Species	Eucalyptus camaldulensis	Bed No.1
Provenance/source	Tree seed centre	
Date sown	8/4/89	
Germination date	22/4-6/5/89	
Pricking out	15/5/89	
Root pruning	3/8,10-9, 11/10	
Remarks		

Figure 6-2 Nursery register

7.2.3 Nursery delivery record.

This is a record showing how the seedlings were distributed. Names of people who received the seedlings, their locations, the species names and numbers (appendix 5).

7.2.4 Muster roll.

This is where the daily attendance of all workers is recorded. It should be done twice in a day. Early in the morning and late in the afternoon. This is a confidential book and therefore it should be kept safely.

7.2.5 Visitors book.

This is not an essential record of the nursery operations. However, whenever there are some visitors, they should be asked to sign and also make comments about the nursery.

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Appendix 1: List of species, time of flowering, collection and places of collection at Tiva Nursery.

No. Species	Time of flowering	Time of collection	Place of collection
1. Acacia holoicilica	February	July	*B.L.I. Kitui
2. Acacia nilotica	February	September	Kaveta
3. Acacia polyacatha	January	June	Kaveta
4. Albizia amara	February	June	Tiva site
5. Albizia anthelmintica	August	October	Tiva site
6. Caesalphinia decapetala	January	April	Tiva site
7. Callitris robusta	June	January	Kavonge , Ilooi
8. Cassia siamea	June	August	Kaveta, Kabati, Matinyani, Kavisuni
9. Cassia spectabilis	January	July	Kaveta, Matinyani
10. Casuarina equisetifolia	July	January	B.L.I.
11. Croton megalocarpus	January	March	Kaveta, Tungutu, Matinyani
12. Delonix regia	January	July	Kaveta
13. Dovyalis caffra	July	February	Kaveta, Kitui High Sch.
14. Eucalyptus camaldulens	June	February	Kaveta
15. Ficus capense	June	February	Kaveta
16. Grevillea robusta	January	March	Kaveta, Matinyani
17. Jacaranda mimosifolia	September	Dececember	B.L.I. Kitui
18. Lawsonia inermis	January	May	Kitui High Scho.
19. Leucaena leucocephala	January	April	Matinyani, Kaveta
20. Mellia azedarach	January	April	Kaveta, Matinyani
21. Mellia volkensii	October	February	Yatta B2 Kwa Vonza Kavisuni
22. Prosopis juliflora	August	February	Kyuso
23. Sesbania grandiflora	April	August	Matinyani, Syongila
24. Sesbania sesban	May	October	Tiva site
25. Tamarindus indica	January	August	Ithookwe Kitui East, Zombe
26. Tecoma stans	May	November	Isaagwa
27. Terminalia brownii	August	December	Kabati, Isaagwa
28. Terminalia mentalis	December	March	Kaveta, Mulango
29. Terminalia prunioides	January	May	Kitui East, Zombe
30. Thevetia peruviana	January	April	Kaveta

* B.L.I. - Better Living Institute (Ministry of Agriculture).

Appendix 2

ANNUAL WORK PLAN FOR TIVA NURSERY

Time of the year	Activities to be undertaken	Remarks
December	Collection of forest soil and manure. Maintenace of seed beds. Potting to start. Sowing of *Albizia anthelmintica Terminalia prunioides.* Collect the seeds of *Jacaranda mimosifolia and Terminalia brownii.*	
January	Potting to continue, pricking out, Sowing of *Acacia holoicilica, Balanites aegyptiaca, Bauhinia thorngii and Terminalia brownii.* Collect the seeds of *Calitris robusta , Casuarina equisetifolia.* Other routine activities to continue.	
February	Potting to continue, pricking out some of the species sown in January to be carried out. Sowing of *Acacia tortilis, Dalbergia melanoxylon, Gmelina arborea* and *Terminal brownii.* Collect the seeds to *Dovyalis caffra, Eucalyptus camaldulensis, Ficus capensis, Melia volkensii* and *Prosopis julifora.* Other routine activities to continue.	
March	Sowing of *Acacia albida, Acacia gerrardii, Acrocarpus flaxinifolia, Azadirachta indica, Cassia siamea, Cassia spectabilis, Casuarina equisetifolia, Delonix regia, Grevillea robusta, Jacaranda mimosifolia, Melia azedarach, Parkinsonia aculeata, Prosopis juliflora, Tamarindus indica, Terminalia mentalis* and *Terminalia spinosa.* Collect the seeds of *Azadirachta indica, Croton megalo carpus, Grevillea robusta* and *Terminalia mentalis.* Other routine activities to continue.	
April	Sowing of *Acacia niloitica, A. harpophylla, A. polyacantha, A. xanthophloea, Caesalphinia decapetala, Croton megalocarpus, Melia volkensii* and *Terminalia catappa.* Collect the seeds of *Caesalpinia decapetala, Leucaena leucocephala, Melia azedarach* and *Thevetia peruviana.* Other routine activities to continue.	
May	Sowing of *Acacia senegal, Dovyalis caffra* and *Eucalyptus paniculata.* Collect the seeds of *Lawsonia inermis and Terminalia prunioides.* Other routine activities to continue.	

Continued from previous page

Time of the year	Activities to be undertaken	Remarks
June	Sowing of *Eucalyptus camaldulensis, E. tereticornis* and *Schinus molle*. Collect the seeds of *Acacia polyacantha and Albizia amara*. Other routine activities to continue.	
July	Sowing of *Acacia abyssinicaLeucaena leucocephala, Sesbania grandiflora* and *Sesbania sesban*. Collect the seeds of *Cassia spectabilis* and *Delonix regia*. Other routine activities to continue.	
August	Collect the seeds of *Cassia siamea* and *Sesbania grandiflora*. Other routine activities to continue.	
September	Collect the seeds of *Acacia nilotica*. Other routine activities to continue.	
October	Hardening up to start. Collect the seeds of *Albizia anthelmintica, Sesbania sesban*.	
November	Hardening up to continue prepare the seedlings for distribution to various sections. Seedlings to be distributed out once the rains start. Collect the seeds of *Tecoma stans*. Make an inventory of the tools and materials that may be required in the next season.	

Appendix 3:

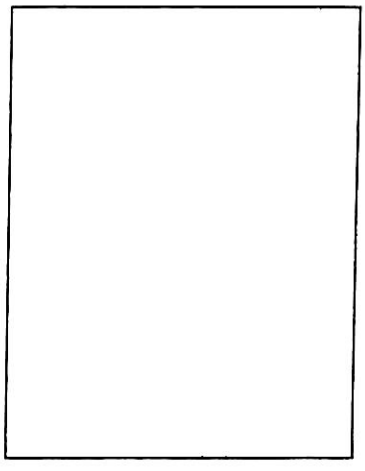
LOCAL NAMES OF SPECIES GROWN AT TIVA.

BOTANICAL NAME	LOCAL NAME (Kamba)
1. Acacia albida	-
2. Acacia gerrardii	Muthii/Munina
3. Acacia mellifera	Muthiia
4. Acacia nilotica	Musemei/Kisemei
5. Acacia polyacantha	Musewa
6. Acacia senegal	Mung'ole
7. Acacia seyal	Mweea
8. Acacia tortilis	Mwaa
9. Acacia brevispica	Mukuswi
10. Albizia anthelmintica	Mwoa/Kyoa
11. Albizia amara	Kyuundua
12. Albizia gummifera	-
13. Albizia lebbeck	-
14. Azadirachta indica	Mwaluvaini
15. Balanites aegyptiaca	Mulului
16. Cassia siamea	Ikengeka
17. Cassia spectabilis	Ikengeka
18. Casuarina equisetifolia	-
19. Croton Megalocarpus	Muthumula
20. Cordia abyssinica	-
21. Comiphora spp	Ikuu/Kitungu
22. Dalbergia melanoxylon	Muvingo
23. Delonix regia	-
24. Dombeya spp	-
25. Dovyalis caffra	Kayava
26. Eucalyptus camaldulensis	Musanduku
27. Eurphorbia tirucalli	Ndau
28. Erythrina abyssinica	Kivuti
29. Grevillea robusta	-
30. Kigelia africana	Kiatine
31. Leucaena leucocephala	-
32. Melia volkensii	Mukau
33. Melia azedarach	Kamukau
34. Parkinsonia aculeata	Musoka
35. Piliostigma thornningii	Mukolokolo
36. Salvodora persica	Mukayau
37. Tamarindus indica	Muthumula
38. Terminalia brownii	Muuku/Kyuuku
39. Terminalia mentalis	Mwavuli
40. Terminalia prunioides	Mutoo
41. Terminalia spinosa	Mutala
42. Warburgia ugandensis	Muthiga
43. Ziziphus macronata	Muae

Appendix 4

Mother tree identification report

Sketch map



Collection No:.....

Species:.....

District:.....

Location:.....

Sub-location:.....

Provenance:.....

Lat:..... Long:.....Elev.....m

Topography: Flat/Hilly

Rainfall mean annual.....mm

Wet months:.....dry months.....

Temperature mean annual.....°C

Mean max .....°C, Mean min.....°C

Stand: Natural ,open, Thin/dense
Young/Mid-aged/old

If from selected trees numbers:.....

Height:.....m. Diameter .....cm. Crown shape.....

Associated trees:.....

Form: Boles: Single/multiple Straight/fair/poor

Crowns: Flat/narrow/heavy

Seed crop: Light/medium/heavy

Remarks:.....

.....

.....

Date:..... .....
Officer in charge

Appendix 5: Seedlings distribution report.

TIVA TREE NURSERY

Date	Section	Species	Quantity	Remarks