DRYLAND AFFORESTATION MANUAL FOR KITUI PILOT FOREST PROJECT (FIELD OPERATIONS)

Manual for plantation establishment in semi-arid land

(based on the experience in Kitui Pilot Forest)

By

JACKSON MULATYA
MITSUO TAKAHASHI

P R E F A C E

The Government of Kenya has recognized that maintenance of sound environmental management is a complementary aspect of the development agenda. The pivotal role of farm forestry, conservation of genetically important forest areas and the afforestation of ASALs have been highlighted in the current sessional paper for renewed growth and economic development and in the development plan. But forest development in ASALs has continued to be constrained by many factors including lack of locally focused technical information.

We are confident that this manual will serve as a useful guide for all those engaged in tree planting and management of forest resources in ASAL. The Dryland Afforestation Manual is based on results accumulated over a period of sic years, during the implementation of the Kenya/Japan Social Forestry Training Project (SFTP) from november 26, 1986 to November 1992. So far the project has established some 300 ha of trial plantations supporting over 56 indigenous and exotic species. The manual which is the product of excellent cooperation between Kenyan and Japanese experts has been prepared by Messrs. J. Mulatya and Takahashi with the assistance of other project staff.

It is noteworthy that the manual is coming at the end of the main phase of the project. Many of the references and conclusions are based on interim observations. The authors would be pleased to have feed-backs on users' experiences with any of the recommendations provided in the manual.

The project records a special appreciation to Prof. A. Asakawa who visited the Pilot Forest Scheme annually from 1982, and provided useful technical advise and guidance to the preparation of this manual.

H. Okabe
Chief Adviser (SFTP)

Dr. J.A. Odera
Director (KEFRI)

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FIELD MANUAL

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INTRODUCTION

The Kenya/Japan Social Forestry Training Project is composed of two sub-projects: The Social Forestry Training and The Pilot Forest Schemes. The Pilot Forest Scheme has been implemented since November 1986.

The Pilot Forest Site is situated in Kwa-vonza Location/Division, Kitui District. It falls under semi-arid conditions (ASALs) of our country, ecological zone 3,4,5.

Tree establishment in these areas has been a problem largely due to site conditions, choice of right species, establishment methods and the management regimes applied. Therefore, the aims of the Pilot Forest activities are to evaluate suitable tree species for planting in the semi-arid area in Kitui District and to develop improved tree planting techniques for satisfactory survival and crop development in the area.

The Pilot Forest Scheme has been trying to address itself to solving the above constrains through trial plantation.

This manual depended on experience through establishment of about 300 of trial plantations from 1986 to 1991. This manual is for use by extension officers, voluntary groups, individual and private farmers and any other interested parties in tree planting in similar ASALs conditions.

2:0 PROJECT DESCRIPTION

2:1 Location

Pilot Forest Project is situated at Kwa-vonza Division of Kitui District, 25km West of Kitui town enroute to Nairobi. A dry seasonal river Tiva passes through it and serves as the source of nursery water (see the map).

2:2 Climatic conditions

2:2:1 Rainfall

The rainfall ranges between 500mm - 900mm per year and occurs in 2 seasons (bimodal). It is erratic and not always reliable over the years. The effective moisture for tree establishment is therefore limiting.

2:2:2 Temperature

The temperatures are usually high and range between 17 deg.C - 32 deg.C. Mean annual temperature is 23 deg.C. Evapotranspiration is high and is well above 2000mm per annum.

2:2:3 Soils and terrain

The Project site has flat areas, slightly sloping and steep eroded rocky areas. There are varied soil types, which generally consist of sandy, clay, sand loams and black cotton soils. Generally major soils are of luvisols and acrisols origin.

2:2:4 Vegetation

Natural vegetation consists of Acacia spp. Commiphora spp. Terminalia spp. in true class and Cynodon nlemfuensis in lower layer. There are other interspersed indigenous dryland species and bushes. Many among the useful species have been overexploited. The situation in some areas is worse due to prolonged human influence in form of grazing, burning, shifting cultivation or selective cutting.

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Table 1: Average monthly temperature.

Deg. C

Month	Minimum	Average Max
Jan	23.1	30.2
Feb	24.0	31.5
Mar	24.4	31.5
Apr	23.9	29.4
May	23.4	28.6
Jun	21.5	27.5
Jul	20.9	26.3
Aug	21.0	26.4
Sep	22.8	29.2
Oct	23.7	30.0
Nov	23.3	28.7
Dec	23.1	29.4
Average	22.9	29.1

Observed at Tiva Nursery, from January 1989 to December 1991

Table 2: Monthly Rainfall.

Month	Rf. (mm)
Jan	60.2
Fab	22.2
Mar	108.9
Apr	200.6
May	39.4
Jun	0.9
Jul	2.4
Aug	1.6
Sep	11.4
Oct	78.4
Nov	266.7
Dec	145.4
Total	938.1

Observed at Tiva from January 1988 to December 1991.

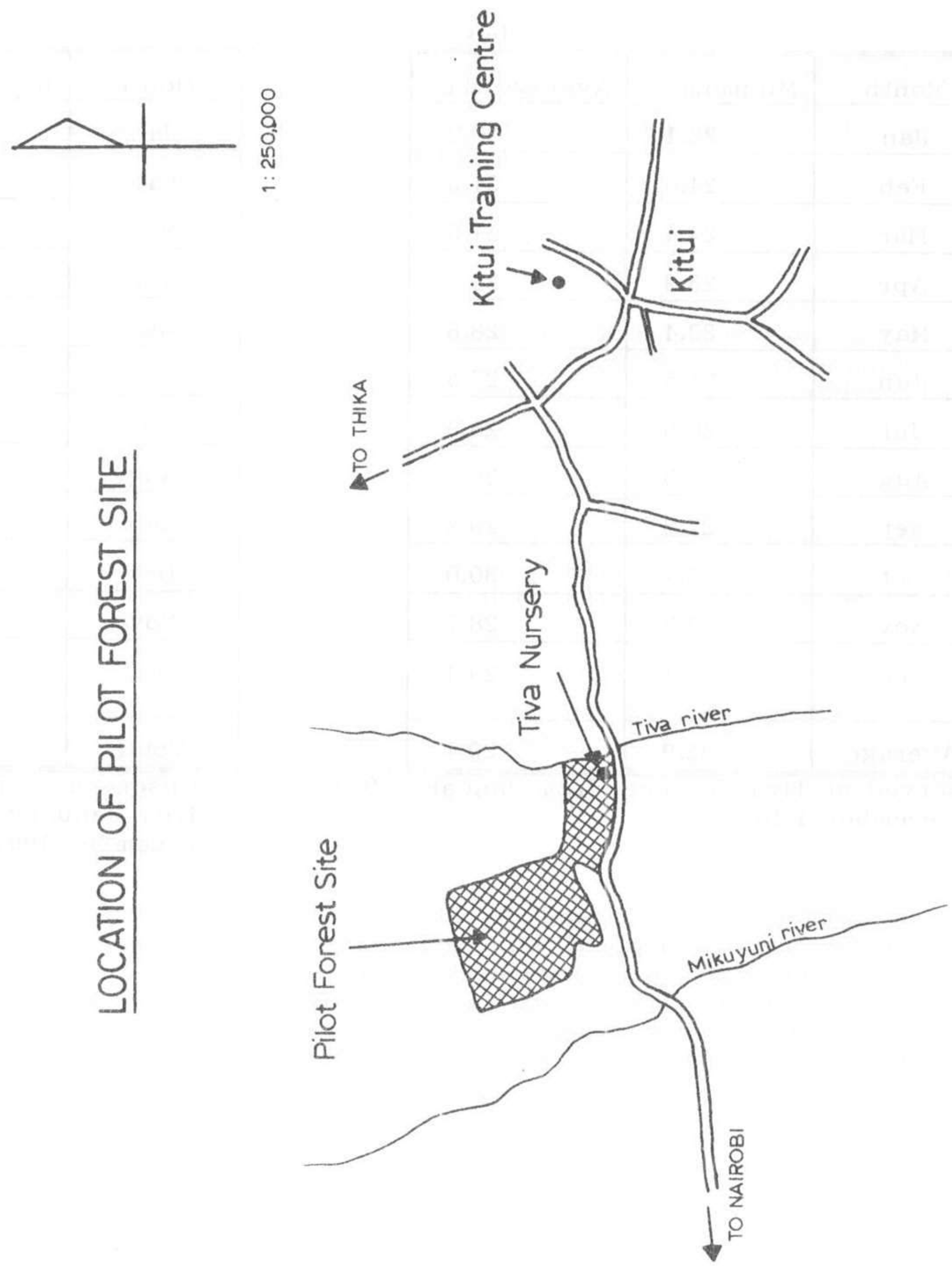


FIGURE 1: LOCATION OF PILOT FOREST

3:0 SPECIES SELECTION

The choice of the right species is one of the major factors that determine the success of the ASALs planting projects. In these marginal areas species selection should conform to the following:

- Select species or provenance from similar ecozones.
- Select well-performing indigenous species and then introduce the others on trial basis.
- Local and social needs also act as a guide to which species are to be selected to meet the people's needs.
- Conservation and re-introduction of over-exploited species.

Experience and work done in the Kitui Social Forestry Project indicate that all the above selection criteria are necessary in order to come up with a comprehensive list of socially and ecologically adaptable and preferable species for Social Forestry needs.

As many as 51 species have been tried in the Project and the following species appear to be promising so far (see Table 3, 4).

Table 3: Promising species among the tested (12 species)

Acacia gerrardii	A. nilotica	A. polyacantha
Cassia siamea	C. spectabilis	Croton megalocarpus
Dalbergia melanoxylon	Eucalyptus camaldulensis	Gmelina arborea
Grevillea robusta	Prosopis juliflora	Tamarindus indica

Table 4: Species tested (39 species)

Acacia abyssinica	A. albida	A. auriculiformis
A. hapophylla	A. holosericea	A. pendulla
A. plectorcarpa	A. salicina	A. senegal
A. stenophylla	A. tortillis	A. xanthophloea
Acrocarpus flaxinifolius	Albizia amara	A. anthelmintica
Azadirachta indica	Balanites aegyptiaca	Bauhinia thorningii
Caesalpinia decapitulata	Callitris robusta	Casuarina equisetifolia
Delonix regia	Eucalyptus citriodora	E. paniculata
E. tereticornis	Leucaena leucocephala	Melia azedarach
M. volkensii	Moringa stenopetala	Newtonia hiderbrandtii
Parkinsonia aculeata	Philiostigma thorningii	Schinus molle
Sesbania sesban	Terminalia brownii	T. catapa
T. mentalis	T. pruinoides	T. spinosa

4:0 SEEDLINGS TO BE PLANTED

Timely production of seedlings is very vital for any tree planting programme to succeed. This coupled with selection of right dryland species increases the chances of a planting programme success.

Seedlings must also be hardened up well before outplanting. The research work done at the Project area through species trial and the field experience gained during extension exposure of preferred tree species on farmland, have provided a broad base for different seedling production.

The process of hardening up (time to start and duration, watering intensity and frequency reductions), other nursery techniques necessary to produce healthy and hardy seedlings, are referred to "Nursery Manual for Tiva Nursery".

5:0 OPERATIONAL PLAN

Operational plan is a frame work for any sound afforestation programme. It is a guide to various components leading to the actual planting exercise. Basically it involves targets of various components that have to be achieved. These may include:- The species required, total area to be covered, number of compartments, number of seedlings per species, types of planting methods, budget and the time estimation.

Infrastructures like roads, paths, firebreaks, etc. are designed. For their constructions time of implementation should be indicated.

The most important one is manpower, silvicultural activities will be done mostly by many hands. Therefore, the planning of manpower should be made in detail in each work of afforestation.

The annual programme for the above mentioned items is necessary to give a breakdown with reference to time of year when each of the activities may be undertaken.

6:0 PLANTING SITE SURVEY

Planting sites should be surveyed to select appropriate species and to determine the method of site preparation, planting, etc.

6:1:1 On-foot survey

You need physically to cruise around the area you intend to plant. By doing so, you get an indication as to the amount of work required especially during land preparation. Assess type of vegetation and trees and any usefulness to be left behind, choice of species shade tolerant or intolerant.

It also helps you to assess and evaluate on the site whether it is rocky, sandy, sloppy, murrummy or otherwise and then re-adjust the planning accordingly which helps to decide species.

6:1:2 Campus survey

Once the on-foot survey is completed and some tentative ascertainment made, campus survey is employed. This enables planners to determine the exact area of the selected sites. It also enables mapping such areas on paper planning prior to implementation. Campus survey is again used in plots and blocks demarcations. You could have pre-decided area on a map then demarcate on the ground or if fixed area then do the above.

6:2 Land demarcation

After surveying the site and actual areas established, demarcation according to the area to be covered and by each species is done. Big areas are sub-divided into blocks, plots according to a particular planting method. Land demarcation may also follow the type of soils and the type of the species to be planted; e.g. Cassia siamea does better on murrum/shallow soils than other species thus demarcating such areas for that particular species.

7:0 LAND PREPARATION/CLEARING

The survival of planted species is mainly determined by the mode of land preparation among other factors. Good land preparation especially on difficult sites is essential. This may improve soil moisture and reduce weed competition. For good land preparation methods consider the following operations:-

Clearing of the vegetation on the planting site by:

i) Strip clearing or line clearing when doing enrichment planting.

ii) Small area clearing especially in the medium bush areas, thus leaving bug trees.

iii) Spot weeding in pasture land/grassland areas.

The Pilot Forest Project experience in Kitui where enrichment planting is practised shows that -

Strip clearing of upto 2-4 m wide according to the height of existing vegetation. However, 4m wide strip clearing is desirable.

Never fell big trees of higher economical importance to plant uncertain ones but whenever the planted ones establish themselves well then trim the existing trees or cut their shading branches off.

Land clearing should be done in good time to allow other activities (pitting, hole digging) to be done before planting.

Consider species, land preparation/clearing, which will be planted, since there are species which could be used for under planting and those preferring open canopy planting according to relative light illumination experiment carried out in the pilot forest strip plantings.

8:0 LABOUR BUDGETING

Labour budgeting is very important in that it enables land preparation in time. In rural areas, heavy machinery are lacking for most of the time and hence low input (in terms of machines) types of afforestation programmes are needed. Manual labour dominates and therefore proper labour allocation is necessary. Individual labour could also be budgeted for small scale planting projects by allotting some of the farm time to tree planting (e.g. 1 hr).

As it has been noticed, that people could be used to plant and tend for forest crop with minimum incentive e.g. firewood, grass and transport. Only requires to organize groups. "Harambee moto" can be used to afforestate hills through national tree planting days by use of administration. Could also establish peoples' plantation where they could in future harvest the produce on either individual land or communal lands.

9:0 SPACING AND STAKING

Once strips or open spots are prepared spacing by staking of planting holes is carried out. However straight lines and well organized spacing is not always necessary but spacing should bo considered seriously. The stocking density per hectare is determined by end use product and the amount of the land available. And spacing is also determined by the amount of rainfall that falls within a region. Wider spacing in more arid conditions e.g. 5m x 5m may be recommended. Spacing too may depend on the density of the existing (natural) vegetation survival percentage at maturity and soil fertility. For sparse vegetation areas, closer spacings may be recommended.

In Tiva Pilot Forest Project it has been shown that stocking density of 833 trees/ha (3m x 4m) or 1000 trees/ha (3.0m x 3.3m) are most appropriate under enrichment planting. In case of single line planting 3.0m spacing is used for both poles and firewood purposes. Digging exercise starts once staking is completed according to specified planting methods.

10:0 PITTING/HOLE DIGGING

Hole digging should start immediately after staking. If the planting programme covers a big area and only limited labour is available, you should start pitting. The Kitui Pilot Forest situation is such that pitting starts around June.

There are different hole sizes tried in the project and each one of them has different labour requirements. These include: 25cm x 25cm, 45cm x 45cm, 65cm x 65cm requiring one man one day to dig 50, 20 and 10 holes respectively. For mass afforestation programme and considering labour availability it has been found that 45cm x 45cm and 65cm x 65cm are good enough in the Pilot Forest Project at Kitui.

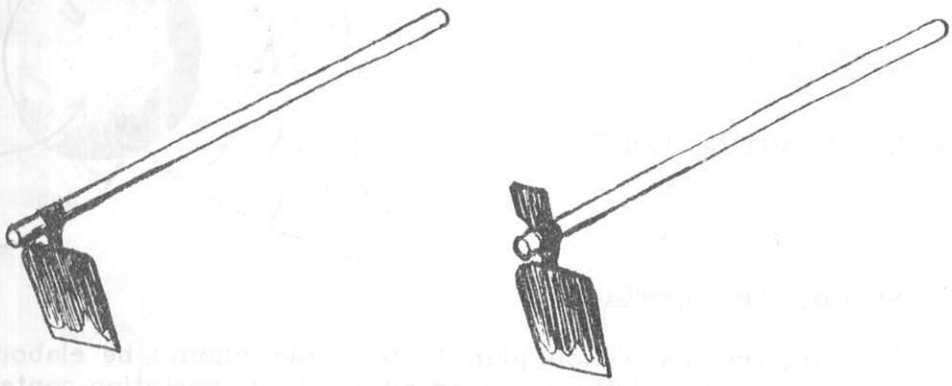
10:1 Constraints to hole digging

Where the soil is soft (sandy-sandy loan) hole digging is easier during the rains but becomes difficult in muddy clay soils. You may find that it is easier to dig clay soils during dry season than when it is wet. Murrum soils may be better dug during rainy season. When you plan to dig some areas during the rainy season (Kitui condition) then it is better dug soon after April-May rains in order to save on labour and time factor.

10:2 Digging tools

The kind of digging tools matters alot. Some tools make work easier; e.g. Mattock jembes are better when working on hard - murrum soils.

Jembes without head/comb are easier to use especially when the holes get deeper. The mud holds less space in combless jembes than in combed ones.



Jembe without head/comb better than Jembe with head/comb

Figure 2: JEMBE

Forked jembes are suitable for rocky sites. Sharpened pangas will always make clearing work easy so make proper arrangements and procurement of sharpening devices.

11:0 PLANTING OPERATIONS

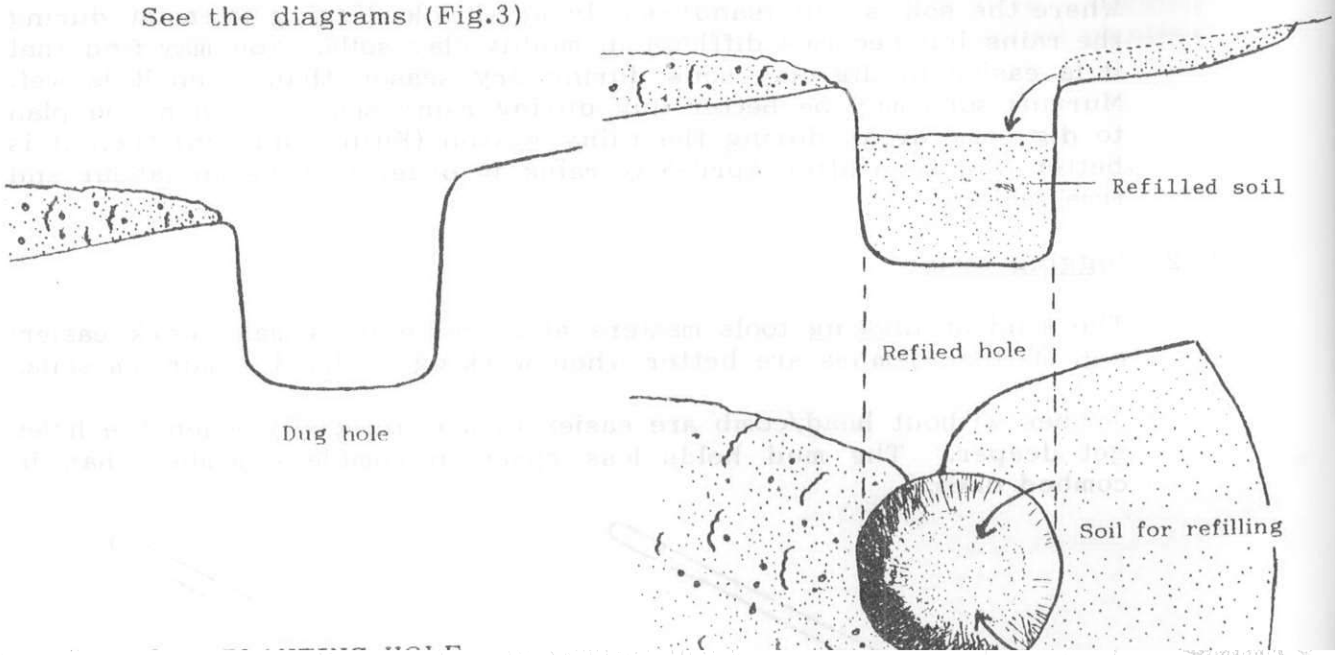
This is the most critical part in any afforestation programme. Here all means (labour, tools and materials) are mobilized towards actual putting of the seedlings into the ground. It will include:-

11:1 Hole refilling

With the onset of rains, hole refilling is done to three quarters full to provide loosened soil which enables quick moisture build up.

Usually the top (fertile) soil around the upper half of the hole is put into the hole. This makes a soft soil mattress for seedling anchorage. Some sloping trenches may be made to these holes to allow more water run off to them. A sort of microcatchment is formed as shown below:-

See the diagrams (Fig.3)



11:3 Actual planting

The planting party should be divided according to the tasks involved.

i) Seedling transportation team, for placing individual seedlings against the hole side.

ii) Hole making team, each with a jembe (hoe) for making depression in the already refilled hole for inserting the seedling.

iii) The actual planting team, which removes polythene bags, inserts the seedling in the hole, covers it with soil and finally compacts the soil to anchor it.

This type of organization is good for large planting programmes and enables completion of planting in time and in orderly manner, see the diagrammatic representation (Fig.3).

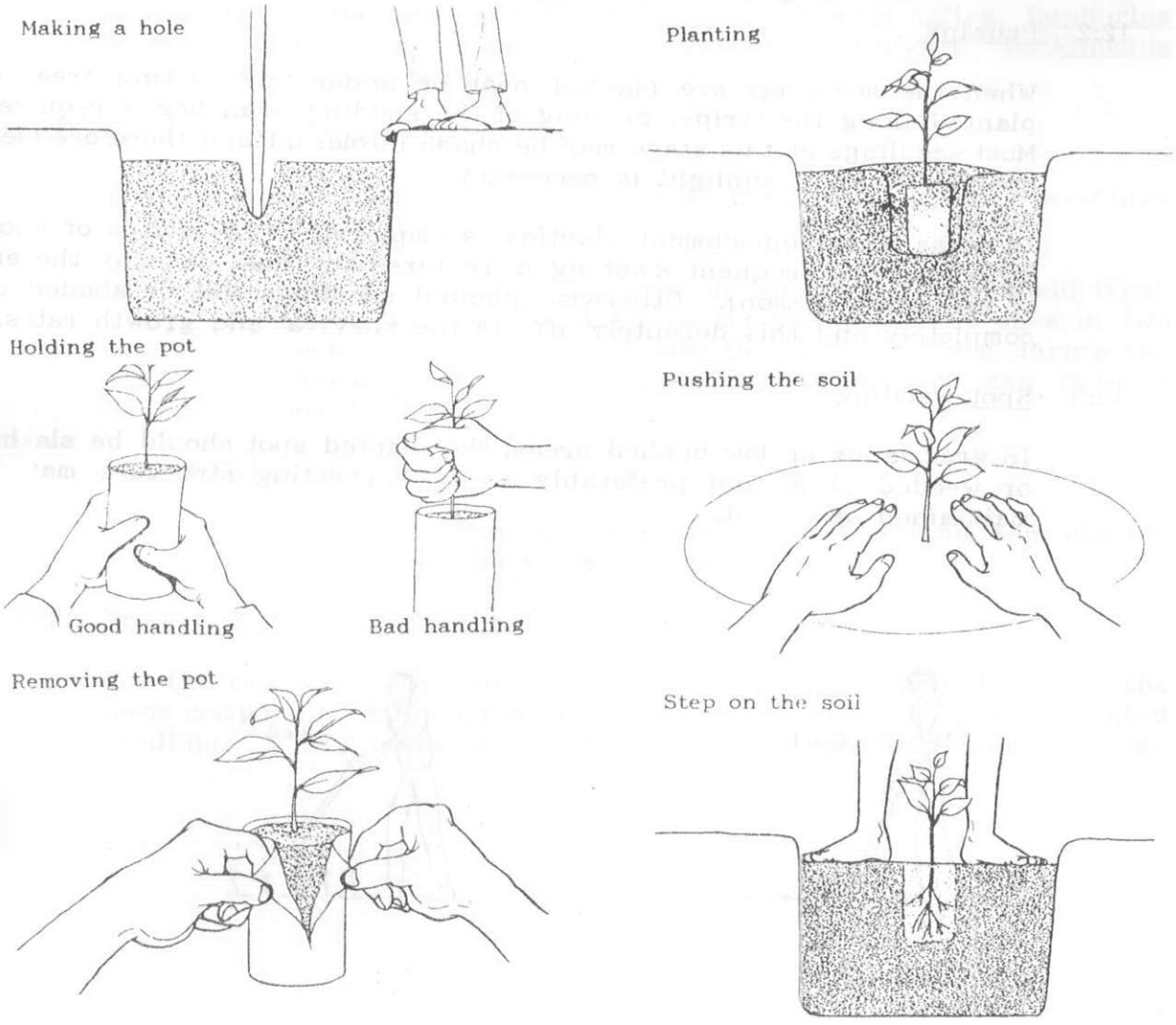


Figure 4: PLANTATION METHODS

13:0 PROTECTION

Planted seedlings should be protected against destruction by animals. In case of large planted areas, fencing is most appropriate. These could use traditional way of fencing which uses cut branches arranged into enclosures. The most permanent way of fencing is by use of live fencing and where funds are available barbed wire (especially on very important areas) could be used.

The Project recommends live hedge fencing. When it comes to individual trees, cut twigs are woven around the seedling and usually pastured with thorny branches. (see the illustrated diagrams overleaf).

The common live fencing species found and tried around rural homesteads of the project area are Dovyalis/Alberia caffra, Euphorbia terrucali, Caesalpinia decapitulata, Prosopis juliflora, Parkinsonia aculeata and Acacia mellifera.

13:1 Protection against termites

There are many simple and local methods used for protecting seedlings against termites and these include:-

(a) Ash: This is commonly used both at the nursery and field level. Ash is usually sprinkled on the nursery beds once in two weeks. It's also poured into the planting holes during the planting time. It has been established that ash reduces termite attack.

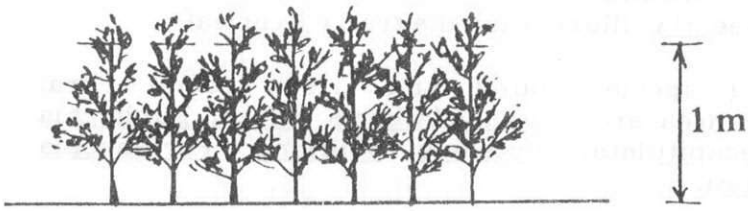
(b) Chicken droppings

When dissolved in water and poured around the planted seedling, it checks termite attach.

13:2 Protection against drought

For the most economical or aesthetic trees usually planted around the home compounds, watering is done with bottle and can sustain planted seedling. 1 litre bottle is inserted around the seedling twice a week.

Trees in fence line are planted. At this stage they need protection,



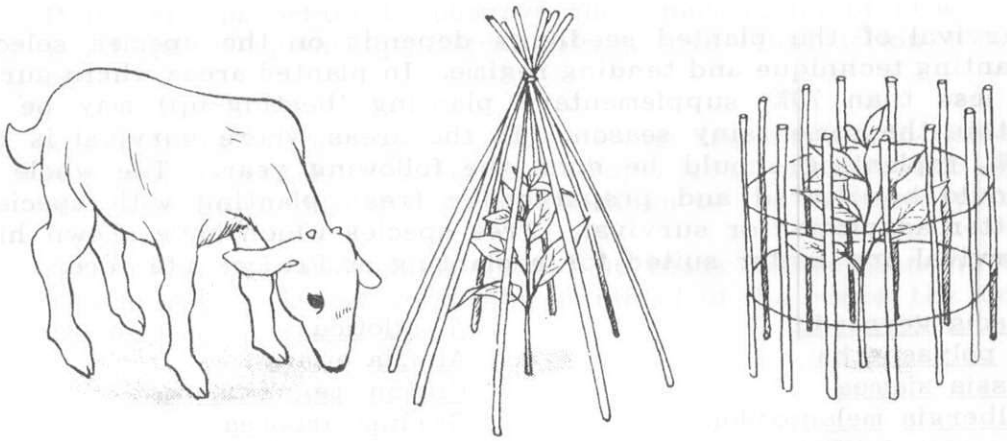
Ready for pruning. Cut all branches above desired height. Use branches to plug holes between plants.

After pruning, further growth will fill in remaining voids.

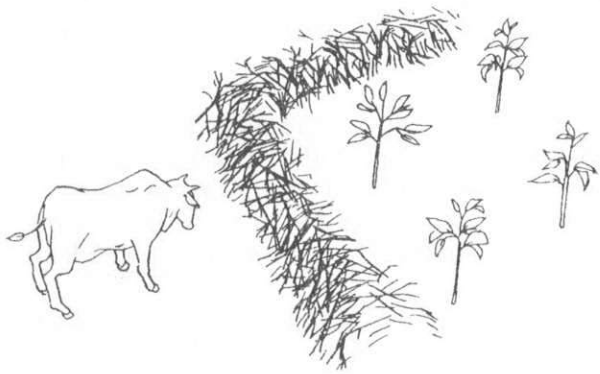
From this stage, hedge only needs periodic trimming.

Figure 6: LIVE FENCE

Fencing around individual trees



Fencing around trees



Individual tree protection

Figure 7: SEEDLING PROTECTION

14:0 SUPPLEMENTARY PLANTING AND REPLANTING

Survival of the planted seedlings depends on the species selection, planting technique and tending regime. In planted areas where survival is less than 70%, supplementary planting (beating-up) may be done within the same rainy season. In the areas where survival is below 30%, replanting should be done the following year. The whole area should be cleared and prepared for fresh planting with species of better adaptation or survival. Tree species which have shown higher survival and better suited for replanting at Project site are:

Acacia gerrardii
A. polyacantha
Cassia siamea
Dalbergia melanoxylon
Prosopis juliflora
A. nilotica
Albizia amara
Croton megalocarpus
Gmelina arborea
Tamarindus indica

15:0 INFRASTRUCTURE

It is very important to observe the construction of other structures which go with planting programme e.g. road construction, stores and so on.

15:1 Accessibility to the planting sites is very important and therefore good road construction is essential. Proper road construction will enable easy and quick distribution of seedlings to the intended planting site.

Both large and small roads should be ready before planting time. The management goals determine the standard of the roads, the location and the mode of construction.

15:2 Standard road construction

The amount of traffic size and the type of vehicles to be used during planting operation determine standard of the roads. Soils and terrain also affect the grade of the roads. Soils and terrain also affect the grade of the roads. Soils and terrain also affect the grade of the roads. For good roads, machineries like bulldozer, grader, loader/shovel and lorry are required.

Bulldozer helps in bush clearing and breaking up ground. Road grading then follows usually allowing for sloping sides to drainage systems. The roads should be murrumed especially around difficult soils. Lorry and loader are used to carry murrum soils and then compacted by bulldozer. Whenever necessary culverts should be used.

Small roads accessibility to compartments can be made by use of manual labour or clearing by bulldozer and maintained manually. These roads are sometimes used as survey lines. They could as well be used as firebreaks.

15:3 Maintenance

Maintenance of roads, equipment is very important and should always be observed. Maintenance of working tools should be maintained throughout.

15:4 Stores

Good storage of equipment, tools, data files and stationeries should be kept well.

15:5 Firebreaks

In the areas where floor vegetation is flammable during dry season, it is desirable to construct firebreaks along ridges or by making use of various terrains so as to partition the plantation. In some cases reduce the firerisk by controlled grazing or early burning.

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