Improving Tree Survival in the Drylands of Kenya

A guide for farmers and tree growers in the drylands

Akula Mwamburi and Josephine Musyoki

KEFRI Information Bulletin No. 2

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Cover photograph
Melia volkensii on a farm in Kitui District

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Foreword

Tree planting in the drylands poses challenges brought about by a combination of edaphic, ecological and socio-economic factors in these areas. Although farmers and tree growers have developed interest in tree planting as an investment activity, they are discouraged by the continuous low tree survival rate and thus are not able to reap the maximum benefits from their tree crop. Over the years, Kenya Forestry Research Institute (KEFRI) scientists through the dryland forest research programme have identified the major factors contributing to low tree survival. Through research, several mitigation measures have been developed. Farmers and tree growers need to adhere to these measures to improve tree survival and thus realize the maximum benefits from tree planting activities. This booklet presents the common factors contributing to tree mortality at all stages of tree growing. It also provides interventions that can be applied during species selection, raising seedlings in the nursery, out-planting, and tree management to enhance tree growing in the drylands.

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1 Introduction

Over 80% of Kenya's area is classified as arid or semi arid lands (ASALs). This area is characterized by low and erratic rainfall, high evapo-transpiration, shallow soils with low water holding capacity and low soil fertility. Tree growing in ASALs faces several challenges including moisture stress, termite infestation, animal damage and competition from weeds. Over the last two decades, several advances have been made through dryland forestry research to overcome these challenges. These advances include selection of appropriate tree species, and development of suitable methods for propagating, establishing and managing trees. Although farmers in the drylands are increasingly adopting tree planting, tree survival has remained low (below 30%). This low survival rate demoralizes farmers, resulting in reduced initiative to plant trees.

This booklet discusses the common factors contributing to tree mortality at all stages of tree growing in the drylands. The booklet also provides interventions that can be applied during species-site matching, nursery practices, field establishment and management of planted trees to improve tree growing in the drylands.

2 Species–site matching

One of the major problems of tree growing in the drylands is mis-match of tree species or variety to the planting site. This can lead to poor yields or even total loss of the tree crop. It is important to take into account rainfall, soil conditions, tree pests and diseases, and germplasm quality when selecting the tree species to plant.

2.1 Rainfall

Different tree species require different amounts of rainfall. It is important to find out which tree species do well with the amount of rainfall available in a given location. However, some species may do well initially but die from moisture stress in later years. This has been observed in some Eucalyptus clones.

2.2 Soils

Different tree species prefer different soil types mainly in texture, structure, depth, drainage, salinity, and fertility. *Melia volkensii*, an important timber species, for example, does best in well drained soil but poorly in black cotton soils whilst *Jatropha curcas* tolerates saline soils.

2.3 Tree pests and diseases

Consider the type of tree pests common in the area and plant trees that can withstand pest infestation. If termites are a serious problem, then it is advisable to plant termite resistant species such as *Senna siamea.*

2.4 Planting material

Planting material should be of good quality. If collecting your own seeds, the mother trees should be of desirable characteristics e.g. have good form if for timber trees, good health and vigorous growth. When buying seed or seedlings ensure that you get them from a certified seed source, such as KEFRI seed centre. Table 1 provides a summary of growth requirements for selected dryland tree species.

Table 1. Growth requirements for selected dryland tree species

Species	Rainfall amount Required (mm)	Preferred soils	Common pests/diseases	Other factors for consideration
Azadirachta indica (Mwarubaini)	300-1100	Sandy loams, sandy clays	Stem borer	Tolerates saline soils
Casuarina equisetifolia (Mvinje)	300-1500	Sandy soils	Fungal diseases, insect attack on seeds	Tolerates saline soils
Croton megalocarpus (Croton)	600-1000	Loamy soils	Defoliators	Can tolerate hardpans, rocky areas
Dovyalis caffra (Kei apple)	600-1000	Deep and well drained loamy to clay soils		Tolerates dry spells
Eucalyptus camaldulensis	450-1100	Loam and sandy loams, alluvial soils	Eucalyptus psyllid	Relatively drought and termite resistant
Jatropha curcas	450-1100	Well-drained soils	Defoliators and leaf spot	Adaptable to dryland conditions, including poor, stony and saline soils
Leucaena leucocephala	450-1100	Loamy soils	Leucaena psyllid	Good for fodder
Melia volkensii (Mukau)	450-1100	Loam and sandy loams, alluvial soils	Damping off, stem canker	Avoid sites with black cotton soils and areas prone to flooding
Senna siamea	450-900	Sandy to sandy loam soils	Damping off, powdery mildew, die-back	Termite resistant, not browsed by animals, drought tolerant

3 Nursery practices

To ensure good survival of trees in the harsh ASALs environment, it is important to plant healthy and vigorously growing seedlings. The methods used to raise seedlings in the nursery have a bearing on production of such high quality seedlings. Some of the critical factors and practices to consider when producing seedlings include the following:

3.1 Soil mixture

The type of soil mixture used in the nursery can affect tree survival in the field. Good soil mixture should provide proper aeration and drainage to ensure adequate root development of the seedling. This ensures rapid adaptation of the seedling when it is planted out in the field. The most suitable soil mixture for potting consists of forest soil, manure and sand at a ratio of 4:1:1. Where forest soil is unavailable, soil from a fertile part of the 'shamba' may be used. Seedlings grown in clay soils have poor root development which affects their rapid anchorage in the field. Potting soil should never be collected near or on termite hills to avoid termite attack on developing seedlings.

3.2 Size of seedling containers

The seedling containers should be of the right size depending on the size of the seedling or nature of the species to be grown. For the drylands, the minimum polyethylene tube size for most species should be 10 cm wide and 15 cm long. Smaller polyethylene tubes (8 cm wide or less), while convenient for transportation, can result in poor root development hence weak seedlings which have low chances of surviving in the field.

3.3 Root pruning

Prune the roots of seedlings (Figure 1) to stop them from penetrating the ground. Once the roots develop into the ground, cutting them during transplanting weakens the seedlings, making them unable to adjust fast to field conditions. If buying seedlings, make sure they have been root pruned.

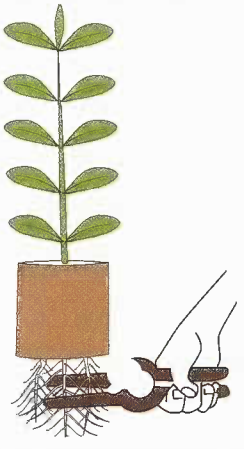

Figure 1: Root pruning

3.4 *Managing* pests and diseases in the nursery

Diseases and pests at nursery level affect tree survival in two ways:

- Diseased seedlings (Plate 1) and those infested by pests are weak and therefore do not adapt easily to a new environment.
- Some pathogens and diseases may be translocated with seemingly healthy seedlings to the field.

These seedlings may not withstand the same pests or pathogens as they did in the nursery owing to increased stress in the field, hence causing high death rates.

It is therefore necessary to control pests and diseases in the nursery by maintaining hygienic conditions. Ensure acquired seedlings are healthy and free from pests.

You can also spray insecticides/ fungicides on the seedlings before planting.

Plate 1: Diseased seedlings of *Eucalyptus camaldulensis*

3.5 Hardening up

Hardening up is needed to prepare the seedlings to withstand the shock caused by possible harsh field conditions. Seedlings are hardened up in several ways such as through gradual removal of shade, increased frequency of root pruning, and reduced watering. If seedlings are from an external source, ensure that they have been hardened up. Characteristics of properly hardened up seedlings are stout stems and fewer but stronger leaves (Plate 2).

Plate 2: Hardened seedling of *M. volkensii* (left) has greyish stout stems. Unhardened seedling (right) is green and weak.

3.6 Transporting seedlings

Water your seedlings immediately before transporting them to the planting site to protect them against drying up. Pack the seedlings carefully in boxes, bags, crates or baskets without piling them on top of each other to reduce damage during transportation (Plate 3). Some species such as *Melia volkensii* need great care during transportation because the young branches are very fragile. Move the seedlings to the field when the planting site is ready and plant them immediately. Take care when transporting seedlings between the nursery and the planting site to avoid over disturbing the seedlings. This will help reduce planting shock. Avoid unnecessary loading, off-loading and storing of seedlings. Water the seedlings on arrival at the planting site and keep them under the shade.

Plate 3: Well packed seedlings ready for transportation

4 Field establishment

4.1 Site selection

The site where trees are planted will determine their growth and survival. When selecting the site, it is important to consider the following factors:

- Animal damage: Browsing is responsible for most tree mortality, after moisture stress Therefore, the site selected must be easy to protect from animals, especially browsers.
- Soil drainage: Avoid sites prone to flooding and water logging especially for species such as *Melia volkensii.*
- Soil type: Match the soil type with the tree species (Table 1). Unsuitable soils can lead to poor tree survival (Plate 4).
- Water harvesting: Sites where it is easy to construct water harvesting structures are better.
- Future development plans of the site: It is not economical to uproot immature trees later to pave way for another development activity.

Plate 4: Low survival of trees due to poor soils and low soil moisture

4.2 Land preparation

Prepare the land before the rains (during the dry season) to enable early planting. Land preparation, which mainly involves land clearing and pitting, improves tree survival in the drylands when properly done.

4.2.1 Land clearing

There are different methods for land clearing depending on the circumstances in which they are used. The land clearing methods include complete cultivation, strip clearing, and spot clearing.

- Complete cultivation involves complete ploughing and/ or clear weeding of the planting site. This results in higher tree survival than with land slashing as it increases infiltration of the rainwater which becomes available to trees for a longer period. The trees also do not suffer early competition from weeds. This is usually done where trees are to be planted among crops (Figure 2) or in plantations.
- Strip clearing involves removing vegetation in strips and planting trees along the cleared strips. It is preferred where labour or machinery is limiting, on steep slopes, and where competing vegetation is slow to re-establish. It also improves biodiversity conservation.
- Spot clearing is done at the spot where the trees are to be planted, in the same way as done for enrichment planting in indigenous forests.

Figure 2: Intercropping of trees and crops

4.2.2 Pitting

It is important to prepare appropriate planting holes (at least 45 cm square and 45 cm deep) that can trap enough water to sustain the tree during initial growth. The more denuded the soils, the bigger the holes. Square holes are better than round ones since the square holes allow the seedling to anchor faster. Avoid smoothening the sides of the planting hole as this reduces the ability of the tree roots to penetrate into the soil. Re-fill the planting hole with the original soil just before the rains begin. For *Melia volkensii,* fill the hole completely with soil to avoid water logging.

4.3 Planting

Figure 3: Planting a tree seedling

The best time to plant tree seedlings is immediately the rainy season begins. The earlier the planting the better the tree survival, as this exposes the planted trees to the maximum rainy days possible before the dry season starts. There should be enough moisture on the ground before you plant. Make a hole the size of the seedling container in the middle of the planting pit using a jembe or a machete (Figure 3). Squeeze the seedling container on the side to loosen the potting soil, and then remove the seedling container carefully while retaining the ball of soil around the roots. Lower the seedling into the pit to the root collar level and then compact the surface around the seedling first by hand and then by foot. Watering once but adequately immediately after planting ensures good bonding of soil particles with the roots where feasible.

4.4 Water harvesting

Water harvesting and conservation structures are very important contributors to tree survival but are often ignored. Techniques that have proved very useful for dryland tree planting include water retention ditches such as cut-off drains, micro-catchments, and bottle watering.

Plate 5: Trees planted along water retention ditches

- Water retention ditches: These are structures dug to divert and retain water that would otherwise be lost as run-off, and directed to the farms. Trees planted along these structures survive better (Plate 5).
- Micro-catchments: Micro-catchments are rainwater harvesting structures that collect rainfall runoff and direct it to the planting hole. Water thus harvested is made available to the tree long after the rains have stopped. There are different types of micro-catchments: V-shaped, W-shaped, circular, and semi-circular.
- Bottle watering: This is a technique of watering a tree seedling in the field. It involves

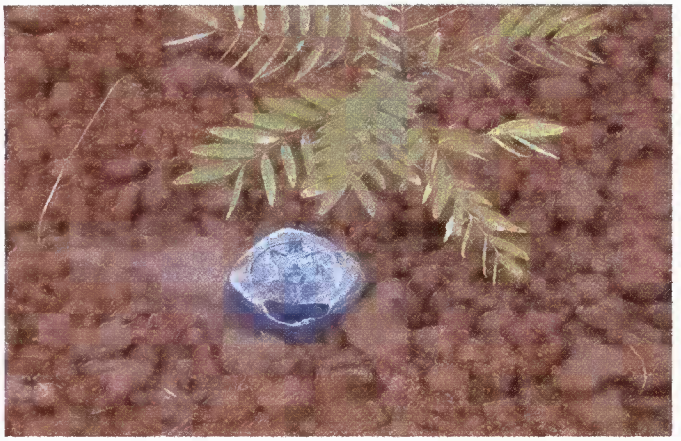

Plate 6: Bottle watering of *Senna siamea*

making a tiny hole in the bottom corner of a 3-5 litre plastic bottle and inserting it full length near the tree seedling (Plate 6). The technique reduces water loss through evapo- transpiration and reduces the frequency of watering. A 3-litre bottle can last for a week.

- Stone method: When planting seedlings, you can arrange small stones vertically next to the seedlings. However, the stones should not touch the seedlings.

The stones direct the flow of water to the lower soil levels to be conserved and used gradually by the growing tree.

5 Managing planted trees

5.1 Protection from animals

Damage by both domestic and wild animals is a major drawback to tree planting in the drylands. While mortality caused by water stress is gradual and hence can be controlled with time, mortality resulting from animal damage can be rapid and severe. Plan your protection measures, therefore, before planting. Some common methods include complete plot fencing and individual tree protection.

5.1.1 Complete plot fencing

If you have many trees it may be cost effective to fence the entire plot. You can use chain link or barbed wire. Chain link fencing is expensive but very effective for control of all types of animals while barbed wire fence is moderately expensive but may not be able to control small animals such as young goats and dik diks. A barbed wire fence when reinforced with thorny branches can be quite effective for both large and small animals. You can further reduce the cost of fencing by relocating the fence to a second location after the trees are big enough.

Plate 7: Individual tree protection

5.1.2 Individual tree protection

Individual trees are protected (Plate 7) mostly when trees are planted near the homestead. Though effective, it is labour intensive and hence practical when trees are few.

5.2 Protection from termites

Termites attack is also a major field problem in tree planting. Termite damage is more severe when the trees are stressed. There are several methods for termite control. These include:

- Planting tree species that are less prone to termite attack such as *Melia volkensii* and *Senna siamea*. Species prone to termite infestation such as *Grevillea robusta* are not recomended for planting in heavily infested sites (Plate 8).

Plate 8: *Grevillea robusta* infested with termites

- Using chemicals such as ConfidorT and Marshal Suscon T.
- Using ash and chicken manure which control termite attack especially when the trees are young.
- Smearing old engine oil on big trees.

5.3 Weeding

Weed the young trees as frequently as is necessary but before the soil's water supply dries up, that is, immediately after the rains. It can either be complete weeding or spot weeding (Plate 9). Weeding increases tree survival by:

- Reducing competition for moisture and nutrients
- Increasing water infiltration into the soil
- Reducing alternative host and hiding ground for pests.

Plate 9: Completely weeded *Melia volkensii* trees (left) and spot weeded Melia of the same age (right)

6 Where to get help

Trees take a longer time to mature and are more permanent compared to crops. Mistakes in the planting of trees are more difficult to correct. Before planting trees especially on a large scale, ask the experts nearest to you for help. These include staff of KEFRI through its Regional Centres and Sub-centres or Kenya Forest Service offices.

Annex 1: Checklist for planting in the drylands

- Seedlings are of correct species for the site
- Seedlings are strong and of the correct height (at least 30 cm)
- Seedlings are adequately hardened up
- The identified planting site is not water logged during the wet season
- The site is cleared (cultivated if possible)
- The plot is adequately protected against small and large animals
- Micro-catchments are constructed
- The pits have been prepared during the dry season
- The seedlings have not been excessively disturbed during transportation
- Planting is done early enough to ensure the trees get established during the rainy season
- The planting hole is a adequately filled with soil to ensure there will be no water *logging* (*Melia volkensii* only)
- The tree plot is weeded at appropriate intervals
- Termite control mechanisms are in place

Glossary

Bottle watering – a technique of watering a tree where a water fillied bottle is placed upside down with its neck into the soil next to the tree. Water gets released slowly and directly besides the roots, so it is available to the plant for a longer time.

Germplasm – the genetic material that forms the physical basis of inheritance and which is transmitted from one generation to the next

Hardening up – preparing tree seedlings for planting out by gradual reduction of water, shade and shelter intensity just before out planting in readiness for the harsh field condition

Hard pan – a compacted horizontal soil layer that restricts growth of roots as well as air and water movement

Pathogen – an organism such as virus, bacterium or fungus that causes diseases in plants

Pitting – digging of holes in a planting site

Root pruning – cutting back the roots of tree seedlings to prepare them for future transplanting by encouraging the growth of a fibrous lateral root system in the pot or bed

Salinity – the saltiness of the soil

For more information, please contact:

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