



## **A Guide to On-Farm Eucalyptus Growing in Kenya**

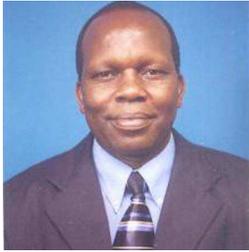


*A mature Eucalyptus plantation in Kericho District, Kenya*

**Kenya Forest Service**

**December 2009**

## Foreword

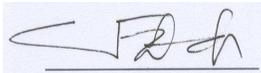


This Guide to On-Farm Eucalyptus Tree Growing in Kenya has been developed as a result of the increasing concern on the effect of the species on the hydrological cycle. There are claims that the species consumes a lot of water resulting in decrease and in some cases the drying of rivers, springs and lakes. The public has therefore been made to believe that the tree is responsible for the national drought conditions being felt and have been discouraged from further planting of the species and given a go ahead to uproot eucalypts wherever they are.

The Kenya Forest Service in consultation with the key stakeholders in the Forest Sector has developed this Guide to put facts straight about the eucalyptus tree and strive to dissipate further claims thus addressing these concerns. The document details the importance and the contribution of the species to the development of the Forestry Sector since its introduction in 1902 and the role it plays towards the National economy at large. The Guide provides available information of studies on the species on the stated areas of concern, goes ahead to outline the suitable planting sites for the species, seedling raising, and the Silvicultural practices necessary for obtaining good returns from the Eucalyptus tree. These guidelines if observed fully will minimize the conflicts associated with the growing of the species that has sparked a lot of debate. Marketing aspects of the Eucalyptus products have also been captured to demonstrate the comparative advantage of Eucalyptus enterprises.

Generally, planting of Eucalyptus is not recommended in water scarce areas, riparian areas, wetlands and marshy areas. It should also not be planted near buildings, road reserves and on boundaries. Members of the public and Eucalyptus tree growers are invited to read the document and follow the guidelines to avoid environmental conflicts arising from wrong siting of the Species. This document can be obtained from the Kenya Forest Service offices country wide.

I hope this document will assist the Eucalyptus tree growers nationally. Make good use of it.

A handwritten signature in black ink, appearing to read 'E. Koech', written over a light blue rectangular background.

Prof. Eric Koech

**Chairman, Kenya Forest Service Management Board**

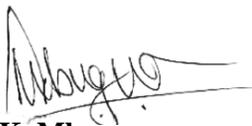
## Preface



The demand for forest related goods and services have continued to grow with increasing population. This has subjected state forests and particularly the indigenous forests to immense pressure as the national requirements for fuelwood, timber, poles and other essential forest products continues to rise. Gazetted indigenous forests have now been reserved for environmental services including soil, water and biodiversity conservation besides carbon sequestration. On the other hand, the 125,000 hectares under forest plantations can only support a small proportion of the timber industry in Kenya. Due to this, the Kenya Forest Service has had to explore other horizons for the supply of the much needed forest products. Promotion of private commercial forests in the high, medium and dry areas of the country has been found to be a viable option. These planted forests do play a critical role in conserving natural forests including the water towers in this country.

The growth of the commercial forestry sub-sector is highly dependent on the availability of fast growing planting materials whose products would have a ready market. *Eucalyptus species* have been found to have these attributes and are increasingly becoming the species of choice with most private tree growers. However, this species is also fraught with a number of challenges related to its alleged incompatibility with certain aspects of environmental conservation.

It is the mandate of the Kenya Forest Service to ensure that sustainable forest management is achieved through carefully balancing the conservation and production functions of forests. This Guide has been published as a tool to be used by extension officers to ensure that the promotion of *Eucalyptus* conforms to this ideal. It should be used to guide all aspects of establishing, managing and utilizing the species. This guide covers comprehensively procurement of planting materials, nursery management, planting, tending, silvicultural operations, pests and diseases, harvesting and marketing of the *Eucalyptus species*. It will therefore ensure that the species enhances forestry development in Kenya and that promotion of *Eucalyptus* species will not compromise the environment in any way.

A handwritten signature in black ink, appearing to read 'D.K. Mbugua', with a stylized flourish at the end.

**D.K. Mbugua**  
**Director, Kenya Forest Service**

## **Acknowledgements**

This manual is the result of a series of consultations; contributions and tireless efforts of the following KFS staff; Monica Kalenda, Samuel Ihure, Jamleck Ndambiri, Stephen Kahunyo Jane Ndeti, Evans Maneno, Jennifer Ngige, Joseph Njigoya and Felix Ngunjiri who were members of a task force that authored the document.

Further contributions came from a number of other colleagues from within and outside KFS. We take this opportunity to thank them all for taking time to critique the draft guide and giving valuable input towards this effort.

We recognize the invaluable contributions of Prof. Eric Koech - Chairman Kenya Forest Service Board, Mr. D.K. Mbugua - Director KFS, Dr Chikamai - Director KEFRI and the Director NEMA. In addition, our appreciation goes to E. N. Mugo – Senior Deputy Director, E. Omollo – Deputy Director, Forest Conservation and Management, B. Kanyi, R. Mworia, C. Ng’oriareng, Z. Toroitich and Nafasi Mfahaya all officers of KFS who in one way or the other contributed to the technical content, editing and overall quality of this guidebook.

Special thanks go to Lucy Wangeci for valuable support services accorded to the task force during the preparation of the document.

## **ACRONYMS**

DAP	Di-Ammonium Phosphate
EGC	Eucalyptus Grandis Clone
FAO	Food and Agricultural Organization of the United Nations
GDP	Gross Domestic Product
Ha	Hactares
KEFRI	Kenya Forestry Research Institute
KEPHIS	Kenya Plant Health and Inspectorate Service
KFS	Kenya Forest Service
KPLC	Kenya Power and Lighting Company
MENR	Ministry of Environment and Natural Resources
MFW	Ministry of Forestry and Wildlife
NEMA	National Environment Management Authority
NPV	Net Present Value
NRB	Nairobi
PIP	Plant Import Permit
SPP	Species
TBP	Tree Biotechnology Project

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## Executive Summary

Since their introduction into Kenya in 1902, *Eucalyptus species* remain superior in terms of fast growth, multiple uses, and suitability to small scale farmers and overall support to key sectors of the economy such as manufacturing, construction and energy. The contribution of *Eucalyptus spp.* to the national economy is estimated at a value exceeding Ksh 1.6 billion excluding non-traded domestic and small scale enterprises. Due to this, the Government has moved a step further to support the introduction of high-yielding, shorter-rotation varieties through biotechnology. There are a number of notable *Eucalyptus spp.* distributed in different climatic conditions all over Kenya. They include; *E. grandis*, *E. saligna*, *E. globulus*, *E. regnans*, *E. paniculata*, *E. maculata*, *E. camaldulensis*, *E. citriodora*, *E. tereticornis*, *E. urophylla* and *E. hybrids*. Latest statistics records area under *Eucalyptus spp.* in the country at about 100,000 hectares.

Of late there has been a lot of controversy over the effect of *Eucalyptus spp.* on the hydrological patterns. It is claimed that their presence on the landscape is causing the drying up of water sources, rivers and springs. Scientific studies have however established that *Eucalyptus spp* exhibit high efficiency in water use for biomass accumulation. *Eucalyptus spp* require 785 litres of water to produce 1 Kg of biomass compared to cotton / coffee / bananas which require 3,200 litres, sunflower 2,400 litres, and maize, potato and sorghum 1,000 litres. The effects of Eucalyptus on the water budget will depend on a number of factors such as rainfall, soil type and site which if not taken care of will justify the public concerns.

From an informed platform, eucalypts have a market niche which gives them a competitive edge over other tree species and contributes to the growth of national economy. Different *Eucalyptus spp.* are suited for different agro-ecological zones and instead of wholesale condemnation of the species without offering alternatives, farmers need to be guided on areas where to plant and where not to plant them, matching propagules with management objectives, necessary site preparations and the relevant silvicultural practices. There are areas where the species should not be grown. These areas are; wetlands and marshy areas, riparian areas, around lakes, ponds, swamps, estuary, sea shores and any other body of standing water, irrigated farm lands and areas with less than 400mm of rainfall. The best areas to plant *Eucalyptus spp* include; marginal lands degraded through soil erosion and loss of soil fertility, planting as shelter belts and wind breaks on large scale farms, on areas with saline soils, water logged areas for purposes of draining the area for agricultural production and on farm lands as plantations or woodlots.

The yield and environmental impact of *Eucalyptus spp* is greatly influenced by a number of factors such as species choice, site matching and preparation, sourcing of the propagules, nursery management, management objectives, silvicultural practices, incidences of pests and diseases and the whole host of economic returns down the value chain. If the prescriptions contained within this guide are observed then the negative environmental impacts will be minimized.

## 1.0 Introduction

### 1.1 Historical Background of Eucalyptus in Kenya

In Kenya, *Eucalyptus species* were introduced as early as 1902 by the colonial government to provide energy for the locomotives. Since then about 100 species have been planted in the country. Most of these were subjected to extensive research and currently less than 20 species have been recommended for wide scale planting. The area under Eucalyptus species in the country is estimated to be about 100,000 hectares of plantations, 15,000 Ha in gazetted forests, about 35,000 Ha planted by private companies and 50,000 Ha by farmers.

The main reason for the introduction of eucalypts was its fast growth, ability to re-sprout and the straight nature of its stems. The wide range of products such as firewood, charcoal, building materials, fencing posts, transmission poles, pulpwood, timber and plywood obtained from Eucalyptus have made the genus very versatile. As a result of these attributes, the government promoted the planting of *Eucalyptus spp.* With the increasing demand for wood, the government has further promoted and supported extensive growing of *Eucalyptus spp* which culminated in the introduction of high-yielding, shorter-rotation varieties through biotechnology between 1997 and 2003. The recent past has therefore experienced unprecedented growth in eucalyptus supported farm forests in various configurations throughout the country.

### 1.2 Distribution of Eucalyptus Species in Kenya

Some of the major *Eucalyptus species* in Kenya and their recommended planting areas are as shown in Table 1

**Table 1: Major Eucalyptus species in Kenya and their recommended planting areas**

No.	<i>Eucalyptus</i> species	Recommended Areas for Planting	Remarks
1	<i>E. grandis</i>	All districts in Western Province, All high potential areas of Rift Valley, Migori, Kuria, Kisii, Nyeri and Kiambu.	Most popular species in these regions
2.	<i>E. saligna</i>	All districts in Western Province, All high potential areas of Rift Valley, Migori, Kuria, Kisii, Nyeri and Kiambu,	Most widely distributed species
3.	<i>E. globulus</i>	Environs of Molo, Nyandarua and Railway stations country wide.	First species to be introduced in Kenya
4.	<i>E. regnans</i>	South Kinangop, Keiyo, Molo, Timboroa, Londiani and other high altitude areas	
.	<i>E. paniculata</i>	Nairobi, Kiambu, Nakuru, Nanyuki, Trans-Nzoia, hill tops of Makueni and Machakos	
6.	<i>E. maculata</i>	Nyeri, Nairobi, Nakuru, Nanyuki, Keiyo, Uasin Gishu, Trans-Nzoia	
7.	<i>E. camaldulensis</i>	Dry areas of Nyanza, Coast, Busia and the semi-arid lowlands country wide.	Fairly new in these areas and is gaining popularity.
8.	<i>E. citriodora</i>	Lower areas of Nyanza, Nairobi, Nakuru, Nyeri and Nanyuki	
9.	<i>E. urophylla</i>	Has been tried at the Coast, Busia, Meru and lower Nyanza	Recently introduced in Kenya and showing good potential.
10.	<i>E. tereticornis</i>	Kakuzi (Makuyu) and Coast region	On trials. Fire resistant
11.	<i>Eucalyptus hybrids</i>	Coast, Lower Nyanza, Mid-Eastern, Rift Valley and Western	Newly introduced

### 1.3. Eucalyptus and the Environment

#### 1.3.1 Eucalyptus and water use

A lot of concern has been expressed on the effect of *Eucalyptus spp* planting on the hydrological patterns with various claims that their presence on the landscape is causing the drying up of water sources, rivers and springs. These claims have not been conclusively supported by scientific evidence. However, studies have established that Eucalypts exhibit high efficiency in water use for biomass accumulation. For example, it has been established that eucalyptus requires less water to produce one (1) Kg of biomass than most crops. Some comparative data to support this is as follows (Munishi 2007);

- Eucalyptus species require on average 785 litres
- Cotton / coffee / bananas each require 3,200 litres
- Sunflower requires 2,400 litres
- Maize, potato and sorghum require 1,000 litres each

It should however be noted that, growing *Eucalyptus spp* in low rainfall areas may cause adverse environmental impacts due to competition for water with other species and an increased incidence of allelopathy.

The effects of eucalyptus on the water budget will depend on the species in question, climate, soil conditions, nature of rock substratum, vegetative cover, slope, tree growth stage, and tree density and amount of rainfall.

Comparisons of Eucalyptus species with other forest plants demonstrate that eucalypts do not consume more water than other native forest tree species as shown in the Table 2.

**Table 2: Water Consumption of eucalyptus compared with other tree species**

Species	Water consumed (litres/yr)	Biomass Produced				Total Biomass produced per litre of Water (g / litre)	Water Consumed per g of biomass (litres /g)
		Shoots	Roots	Leaves	Total		
		( g / yr)					
<i>Acacia auriculiformis</i>	1231.50	1023.5	361.6	327.9	1713.0	1.39	0.72
<i>Albizia lebbek</i>	1283.90	1132.4	1085.6	136.8	2354.8	1.83	0.55
<i>Dalbergia sissoo</i>	1534.05	1129.3	775.5	99.77	2004.5	1.31	0.77
<i>Eucalyptus hybrid</i>	2526.35	2519.0	2094.3	594.9	5209.0	2.06	0.48

Source: Senelwa K. et al (2009)

### **1.3.2 Eucalyptus and bio-diversity conservation**

The greatest positive contribution of eucalyptus is perhaps in replacing indigenous species for fuel-wood, thereby preventing further degradation of natural forests. Although it is claimed that there is limited biodiversity in eucalyptus plantations, their cultivation saves biodiversity elsewhere by preventing the destruction of natural forests. Furthermore, certain *Eucalyptus species*, by quickly producing firewood, would eliminate the causes which frequently may have led to land degradation and desertification.

### **1.3.3 Eucalyptus and soil fertility**

When eucalyptus is grown as a short rotation crop for high biomass production and removal, soil nutrients are depleted rapidly which conforms to conventional scientific argument. However, areas under eucalyptus have been found to have higher levels of micronutrients compared to areas under crops such as tea of similar age. Long term planting of eucalyptus has been reported to improve soil fertility while comparative studies of soils under eucalyptus and adjacent grassland have found no significant differences if the trees have a rotation of more than 10 years (Draft Eucalyptus policy, 2009).

Studies have indicated that on degraded hillsides and wastelands, the net soil contribution of eucalyptus through litter fall is likely to be positive. Eucalypts also exhibit good potential for topsoil retention on degraded hillsides.

### **1.3.4 The allelopathic effects of *Eucalyptus spp***

*Eucalyptus spp* is known to exudates allelopathic chemicals that inhibit undergrowth regeneration. Allelochemicals negatively influence agricultural production and this is a more significant factor in dry regions. High rainfall may negate the allelopathic effects of trees on crops.

## **2.0 Justification for developing the guidelines**

### **2.1 Environmental conservation verses economic growth**

Since the late 1980's, planting of *Eucalyptus species* in Kenya has sparked nationwide debate arising from concerns on the species water uptake. This discourse was later expanded to include the effect of the species on biodiversity. On the other hand, advocates for the species argue that it has been responsible for the vibrant growth in the farm forestry sub-sector, particularly as supply from state forests has been inadequate in matching national demand for forest products. Eucalypts remain the most popular commercial forestry species for small, medium and large scale private forest owners.

This is due to availability of high quality planting materials, fast growth, ability to coppice, ready market for its wide range of products and wide ecological range. In addition, the species supports rural livelihoods in terms of fuelwood, poles and building materials.

Kenya Forest Service is alive to the need to balance the conservation and the productive functions of all forests. The development of this extension guide is therefore a step in ensuring that the species is planted, managed and utilized in a way that optimizes the envisaged gains and supports economic development with minimal undesirable environmental effects.

## **2.2. Contribution of Eucalyptus to the National Economy**

*Eucalyptus spp.* has a ready market niche which gives it a competitive edge over other tree species and contributes to the growth of national economy in the following ways;

- It provides power transmission poles for the expanded rural electrification programme. The current demand for power transmission poles is about 450,000 poles per annum.
- It is an alternative source of affordable industrial energy for the tea, tobacco, lime, cement and many other industries.
- It provides high quality fibre for pulp.
- It is socially acceptable for its wide range of products and benefits.
- Eucalyptus has formed the backbone of the emerging commercial forestry sub-sector where many large and medium scale land owners are turning to it as the cash crop of choice.
- It contributes to increased forest cover.
- It contributes to carbon sequestration which mitigates against climate change.
- It is good for gully stabilization and rehabilitation of degraded sites
- It reduces the pressure on natural forests by providing forest goods and services in alternative production areas such as private forests.
- It provides additional services as wind breaks, shelter belts and boundary demarcation.

The multiple uses and fast-growth of *Eucalyptus spp.* have made them economically important particularly to small-holder farmers as a means of livelihood. The financial viability of eucalyptus is not only an incentive but also justification for farmers to plant more trees. Studies have revealed that three eucalyptus enterprises involving production of construction poles, transmission poles and firewood are financially viable in Western Kenya. Further studies show that a hectare of firewood and poles could generate a net surplus of Ksh 540,000 and Ksh1, 000,000 respectively over a period of 8 years This is a high return compared with Ksh 88 000 for low to medium production maize, Ksh 96,000 for medium production maize and Kshs 376,000.00 for high production maize. This return is comparable to the return on tea which is estimated at Ksh 630,000 over the same period (Draft Eucalyptus policy, 2009)

The economic value and national income from woody resources including Eucalyptus has been grossly under-valued in the national accounting systems. For example, recent estimates of the contribution of forest products and services are indicated as Ksh 16.4 billion, equivalent to 1% of national Gross Domestic Product (GDP). The annual revenue from state commercial plantations is currently estimated at about Ksh 460 million per annum. These estimates do not include income generated by private farmers and communities, who are the major producers of eucalyptus products. It is approximated that short rotation industrial firewood, pulpwood, sawn wood, transmission and construction poles have a value exceeding Ksh 1.6 billion, which excludes non- traded domestic and small scale enterprises.

### **2.3. Technology Development – Biotechnology utilization**

Kenya has made great strides in ensuring that superior eucalyptus planting materials are availed to tree farmers. This has been done through use of tree biotechnology to propagate hybrids and clones besides procuring high quality seeds from recommended provenances. It is envisaged that this guide will enhance quality assurance through sensitizing tree growers on how to source high quality planting materials which will yield high quality products when planted.

### **2.4. Objectives of the guidelines**

- i. To promote cultivation of *Eucalyptus spp.* without compromising environmental conservation.
- ii. To assist the farmer in making informed decisions in planting, managing, utilizing and marketing eucalyptus trees and their products.
- iii. To reduce and resolve conflicts relating to investing in / planting of eucalyptus.

## **3.0. The process of developing the Guidelines**

The development of this guide brought on board, the concerns of commercial tree growers, subsistence farmers and the environmental lobby groups. The first draft of the guidelines was produced in a workshop where past experiences from field officers was collated and buttressed with extensive literature review. Thereafter, the draft guide was subjected to in-depth scrutiny by the senior management of KFS and also shared with other partners in the forest sector.

A second workshop was held to enrich the draft guidelines before finalization. The document was then published and released as a tool for eucalyptus management and to sensitize the public on the existence of the guidelines. These guidelines will be reviewed from time to time to reflect the realities on the ground.

## **4.0. Management of *Eucalyptus spp.***

The yield of eucalyptus trees and its environmental impact is greatly influenced by the management regimes that are put in place. The management objective to a great extent determines the processes of propagation, species planted and silvicultural operations.

### **4.1. Planting materials (propagules) and quality control**

#### **4.1.1. Seeds**

It is important to ensure that only seeds of superior quality are used to propagate eucalypts. High quality seeds can be sourced from;

- i. ***Kenya Forestry Seed Centre, KEFRI, Muguga*** as well as other KEFRI Regional outlets spread throughout the country including Maseno, Nyeri, Kitui, Turbo, Londiani, Kakamega and Gede.

When buying seeds ensure that the package has a KEFRI label with the following details; ***the species, batch number, source of seeds, date collected, provenance, germination rate and weight***

- ii. ***Importation***

When importing seeds, ensure that all conditions required by KEPHIS are met

- iii. ***Local collection***

Seeds can also be obtained through local collection from plus trees. In this case it is important to note the following;

- The plus tree should be healthy (that is not infected by pests and diseases), has straight bole/stem, heavy crown and exhibits vigorous growth.
- The mature fruits (capsules) should be golden brown in colour and not yet opened.
- The fruits should be handpicked, and then air dried before the seeds are extracted.
- To ensure seeds viability, the seeds should be placed in a dry container, sealed and stored in a cool and well ventilated room.
- Eucalyptus seeds do not require pre-sowing treatments.

- iv. ***Registered Seed Collectors***

The seeds can also be sourced from trained seed collectors who are registered with KEFRI. The collectors should provide proof of registration with KEFRI.

- v. ***Facilitation by KFS Officers***

KFS field officers can facilitate farmers to source seeds from the above organizations besides any other outlet that has good quality seeds.

### Caution

- For optimum viability, seeds should not be stored for more than 1 (one) month after collection.
- An investor / farmer should buy the right quantities of seeds depending on the number of seedlings required.
- Farmers should avoid buying seeds from unregistered seed vendors.

**Table 3 Indicates the weight (kg), average number of seeds and expected number of seedlings in each Eucalyptus species.**

Species	Weight (kg)	Number of seeds	Expected number of seedlings
<i>E. grandis</i>	1.0	300,000	210,000
	0.5	150,000	105,000
	0.25	75,000	52,500
<i>E. camandulensis</i>	1.0	300,000	210,000
	0.5	150,000	105,000
	0.25	75,000	52,500
<i>E. saligna</i>	1.0	300,000	210,000
	0.5	150,000	105,000
	0.25	75,000	52,500
<i>E. globulus</i>	1.0	200,000	140,000
	0.5	100,000	70,000
	0.25	50,000	35,000
<i>E. maculata</i>	1.0	160,000	112,000
	0.5	80,000	56,000
	0.25	40,000	28,000

Source: KEFRI, Muguga

#### 4.1.2. Seedlings

- A plantable seedling should;
  - have a height of 24-35cm,
  - be disease and pest free,
  - be potted singly in pots of sizes, 3 by 4 or 4 by 6 inches. (*Seedlings from the Tree Biotechnology Project are planted in a vermiculite and cocopit mixture and are exempted from this requirement. Also note that these seedlings are in bio-degradable pots which should not be removed during planting.*)
- Forest officers will facilitate farmers to source suitable seedlings from credible tree nurseries.
- Where a tree nursery owner claims to have raised seedlings from imported seeds, insist on the production of a Plant Import Permit (PIP), a Phytosanitary Certificate from the country of origin and a Seed Origin Certificate as proof of provenance.

### **4.1.3. Clones and Hybrids**

Clones and hybrids can be sourced from Tree Biotechnology Trust nursery in Karura, or their outlets in Meru, Eldoret and Gede or any nurseries which are registered with the Tree Biotechnology Project (TBP).

## **4.2. Nursery management**

### **4.2.1 Factors to consider when setting a tree nursery**

- i. Place the nursery near a permanent water source
- ii. Ensure that there is sufficient protection from livestock, human traffic, excess sunlight, storms etc
- iii. Ensure that there is adequate drainage to avoid water logging.
- iv. Ensure that the nursery has good accessibility for ease of delivering nursery production materials and sales

### **4.2.2 Seed sowing and management in the nursery**

- Soil should be collected at least three months before potting and should be watered for the weed seeds to germinate and ensure there is complete decomposition of organic matter. Regularly turn and mix the soil for complete germination of undesirable seeds.
- Seedbed and nursery beds should be oriented East-West direction
- Seeds should be mixed with fine sand in equal ratio and sown (spread) in a sandy medium in a seedbed. Cover the seedbed with mulch. Germination takes 7-14 days.
- They should be pricked out into individual suitable containers when the first two leaves are formed. This should be done under a shade.
- Use of manure or fertilizer is recommended for healthy seedlings. The recommended soil to manure ratio is 3:1.
- Seedlings should be watered every day before 9am and after 5pm.
- Avoid excessive watering. Keep the containers /pots moist but not water logged.
- Place the seedlings under light shade to protect them from excessive sunlight or rain storms.
- Use recommended herbicides, fungicides and pesticides as advised by the forest field officers.
- It takes 4-5 months to attain plantable size.
- Root prune at least twice for the open pots.

- Nursery records should be maintained in all tree nurseries. These include;
  - i. Nursery seed book
  - ii. Nursery cost allocation register
  - iii. Daily occurrence book
  - iv. Nursery ledger book
- Overgrown seedlings should be cut back and managed according to normal nursery procedures.

### 4.3. Species choice and site matching

#### 4.3.1. Ecological requirements

Different *Eucalyptus spp* are suited for different agro-ecological zones as tabulated in Table 3

**Table 4: Eucalyptus species their suitability in terms of Eco-zone, Altitude (m) and Rainfall (mm) in Kenya.**

<b>Eucalyptus species</b>	<b>Eco Zone</b>	<b>Altitude, m</b>	<b>Rainfall mm</b>
<i>E. grandis</i>	I , II,III	2200 and above	900 and above
<i>E. saligna</i>	I, II, III,	2200 and above	900
<i>E. globulus</i>	I, II, III,	1200-2200	1000
<i>E. regnans</i>	I,II,III	2200 and above	1000
<i>E. paniculata</i>	III,IV	1200-2200	600 – 900
<i>E. maculata</i>	III, IV	1200-2200	600 – 900
<i>E. camaldulensis</i>	III, IV,	0-1200	600
<i>E. citriodora</i>	II, III,	1200-2200	1000
<i>E. urophylla</i>	III, IV	0-1200	1000
<i>Eucalyptus hybrids</i>	Match to respective Zones	From sea level and above	Average 750

#### 4.3.2 Areas where Eucalyptus should not be planted

- i. Wetlands and marshy areas
- ii. Riparian areas
  - a) Along rivers (reserve not less than 30 meters as stipulated in the Survey Act Cap 299 of the Laws of Kenya. In addition allow for an extra 20 meters to ensure that the trees do not adversely interfere with the water source.)
  - b) Areas around lakes, ponds, swamps, estuary and any other body of standing water.
- iii. Irrigated farm lands.
- iv. Areas with less than 400mm of rainfall.
- v. In farms next to water sources, planting should be minimized by inter-planting with indigenous tree species or in mosaic plantations between indigenous trees with the

latter occupying a greater percentage or strip planting of eucalyptus with natural vegetation.

#### 4.3.3 Areas suitable for Eucalyptus planting;

- i. Areas degraded through soil erosion and loss of soil fertility
- ii. As shelter belts and wind breaks on large scale farms
- iii. Water logged areas for purposes of draining the area.
- iv. On areas with saline soils
- v. Farm lands as plantations or woodlots



*Eucalypts planted in saline and degraded site in Ganze, Malindi district.*



*Eucalyptus plantation in Kericho district*

#### NOTE

*While planting Eucalyptus on farm and along road reserves, ensure that the trees are planted at least six (6) meters from the boundary. In view of this requirement, planting of Eucalyptus in land sizes of less than quarter (1/4) of an Acre is not recommended. Planting, near buildings is not recommended as branches/stems of some species break off easily.*

#### 4.3.4. Species choice and management objectives

Management objectives will to a large extent determine the species planted. Table 4 indicates the species best suited for various management objectives.

**Table 5: Eucalyptus species best suited for various management objectives.**

<b>Management Objective</b>	<b>Recommended Species</b>	<b>Remarks</b>
Transmission poles	<i>E. grandis</i> , <i>E. saligna</i> <i>E. globulus</i> , <i>E. hybrids</i>	The species have good form, straight bole and ability to self prune.
Construction poles	<i>E. grandis</i> , <i>E. saligna</i> <i>E. globules</i> , <i>E. paniculata</i> <i>E. hybrids</i>	The species have good form, straight bole and ability to self prune.
Fuelwood	All <i>Eucalypts</i>	All the species have high calorific value.
Timber	<i>E. grandis</i> , <i>E. saligna</i> <i>E. globulus</i> , <i>E. camandulensis</i> <i>E. hybrids</i> , <i>E. citriodora</i> <i>E. paniculata</i>	The timber is hard, durable, strong and termite resistant
Carbon credits	All <i>Eucalypts</i>	The species have high biomass conversion rate
Pulp	All <i>Eucalypts</i>	They have long and durable fibre,
Charcoal	All <i>Eucalypts</i>	They grow fast and have high calorific value
Fibre	<i>E. globules</i>	It has the best fibre
Pharmaceutical	<i>E. globulus</i> , <i>E. citriodora</i> <i>E. camaldulensis</i>	The leaves and barks
Apiculture	All <i>Eucalyptus</i>	The flowers

#### **4.4. Silvicultural Practices**

##### **4.4.1. Site preparation**

Eucalypts are very sensitive to competition from all types of weeds in the early years. It is therefore essential to prepare planting sites properly using one of the following methods

- i. Complete ploughing, carried out and completed during the dry season
- ii. Strip ploughing done during the dry season
- iii. When pitting on stony or sloppy sites, pits should be centered in well cultivated and cleaned patches of at least one meter diameter; and
- iv. On grassland sites, pitting or trenching should be carried out if it is not possible to prepare the planting site by methods (i) and (ii) above.

#### 4.4.2 Planting

**Table 6: Recommended planting espacement in both high potential and ASAL areas for various management objectives.**

Management Objective	Espacement (m)		Remark
	High potential areas	ASALS	
Transmission poles	2.5 by 2.5	3 by 3	Thinning not necessary, Coppice management is required
Construction poles (props)	2.0 by 2.0	2.5 by 2.5	Thinning not necessary. Coppice management is required
Fuelwood	2.0 by 2.0	2.5 by 2.5	Coppice management is necessary
Timber	2.5 by 2.5	3.0 by 3.0	Coppice management is required
Pulp	2.5 by 2.75		No thinning is required. but coppice management is required after clear felling
Plywood	2.75 by 2.75		No thinning is required but coppice management is required later
Fibre-board	2.5 by 2.5	3.0 by 3.0	No thinning is required but coppice management is required late
Charcoal	2.0 by 2.0	2.5 by 2.5	Coppice management is necessary

#### 4.4.3 Tending

Once seedlings are planted, they require nurturing to ensure that competition from weeds for water, soil nutrients and sunlight is kept at a minimum. To ensure this;

- Keep trees free of weeds for the first two (2) years or until they are about 1.5m high
- For plants of 1.5m and above spot weeding around the seedlings (one meter diameter) and slashing in between the seedlings should be done during the first year.
- A high standard of farm hygiene should be maintained throughout for the first three year period
- There should be continuous monitoring of pests and diseases
- Trees can be intercropped with food crops for the first (1) year

#### 4.4.4. Pruning

Most Eucalypts are self pruning and therefore pruning may not be necessary. However, when necessary prune to half height.

#### 4.4.5. Thinning

- Thinning will not be carried out on crops grown for pulpwood, poles, woodfuel, timber, plywood and for the production of fiber board material.
- In cases where thinning has to be done ensure this is followed by coppice management.
- The thinning regimes are dependent on the different eco-zones.

**NB:** For more information on thinning regimes consult the local forest officer.

#### 4.4.6. Harvesting

- The harvesting age (rotation age) will vary depending on the management objective of the species (Table 6). Harvesting should be done using saws and not axes and pangas because they damage the tree stump and affect its ability to coppice.
- The stump should be cut in a slanting way to ensure that water does not accumulate on the stump.
- Harvesting should be done during the rainy season.
- The stumps should not be less than 10cm height.
- Care should be taken not to damage the bark of the stump.
- The stump should not be left covered with slash as this will obstruct coppice shoots.

**Table 7: Eucalyptus, harvesting age and rotations under various management objectives**

Management objective	Harvesting age (years)	Rotations
Fuel wood	4 and above	4
Pulp wood	8	3
Fibre-board	8	3
Timber	15-20	2
Plywood	30	1
Transmission poles	8-15	2 -3
Construction poles (props)	3-4	5
Charcoal	6-8	4

*Note: The rotation age of Eucalyptus hybrids may vary from those indicated in the table above.*

#### 4.4.7 Timber seasoning (drying)

To avoid timber from cracking and warping, logs should be split or sawn when they are dry.

For more information on timber seasoning consult your local forest officer.

#### 4.4.8. Coppice management

Eucalypts have the ability to coppice heavily after cutting.

- i. Reduce the coppices to the desired number of stems depending on management objective.
- ii. Coppice reduction should be carried out six months after harvesting leaving the most dominant shoots with best form and good attachment to the stump.
- iii. At least 3 coppice stems should be left during the first (1<sup>st</sup>) coppice reduction and then reducing to 2 stems one year later depending on the management objective (Table 7).
- iv. The stump losses vigour after a number of coppices depending on the management objective and should therefore be replaced with a new crop (Refer to Table 8).

**Table 8: Eucalyptus ages, when coppice management should be done under various management objectives**

Management objective	1 <sup>st</sup> coppice (yrs)	2 <sup>nd</sup> coppice (yrs)	3 <sup>rd</sup> coppice (yrs)	4 <sup>th</sup> coppice (yrs)
Fuelwood	8	12	16	20
Pulpwood	16	24	32	-
Fibre board	16	24	32	-
Timber	28-33	40-45	-	-
Transmission poles	16-24	24-33	32-42	-
Construction poles (props)	5-6	8-9	11-12	14-15
Charcoal	12-16	18-24	24-30	30-36

#### 4.4.9. Pest and diseases

For a healthy crop there is need for continuous monitoring for pests and diseases.

Table 9 and 10 show common diseases and insect pests that affect and infest *Eucalyptus* species in Kenya respectively

**Table 9: Common diseases affecting Eucalyptus species in Kenya**

	<b>Disease</b>	<b>Symptoms</b>	<b>Common Host</b>	<b>Control / Management</b>
1.	Phytoplasma disease	Seedlings stunted, smaller than normal leaves	<i>E. tereticornis</i> <i>E. globulus</i>	Seasonal, more common in wet season and recovery in dry season
2.	Cylindrocladium leaf spot blight	Leaf spot and shoot blight	Most <i>Eucalyptus</i> spp.	Infected plants should be destroyed
3.	<i>Eucalyptus</i> rust <i>Puccinia psidii</i>	Yellow pustules on branches and terminal shoots	Most <i>Eucalyptus</i> spp.	-
4.	Mycosphaerella leaf spot	Straw – coloured necrotic leaves	Common in <i>Eucalyptus</i> plantations e.g. <i>E. globulus</i> and <i>E. nitens</i>	-
5.	Botryosphaeria canker	Dead tops	<i>E. grandis</i> , <i>E. nitens</i> , 1 – 2 years old	-
6.	Cryphonectria canker <i>Cryphonectria cubansis</i>	Girdled trees; dead young trees esp. 2 year old with copious gum exudes	<i>Eucalyptus</i> spp. of <i>grandis</i> , <i>saligna</i> , <i>camaldulensis</i> , <i>tereticornis</i> , <i>urophylla</i>	Destroy infected trees urgently.
7.	Endothia canker <i>Endothia gyrosa</i>	Cracking outer bark and cankers with kino	<i>Eucalyptus</i> spp. of <i>grandis</i> , <i>saligna</i> , <i>camaldulensis</i> , <i>tereticornis</i> , <i>urophylla</i>	Destroy infected trees urgently.
8.	Coniothyrium canker	Referred to as “Measles disease” – dark spots on bark of young trees	Most <i>Eucalyptus</i> spp.	Destroy infected trees urgently.

**Table 10: Common insect pests that infest Eucalyptus species in Kenya**

	<b>Name</b>	<b>Host</b>	<b>Symptoms</b>	<b>Management</b>
1.	Blue Gum chalcid	<i>E. grandis</i> , <i>E. globulus</i> , <i>E. camaldulensis</i> , <i>E. tereticornis</i> , <i>E. saligna</i>	Galls on foliage	Destroy infected young trees urgently / spray seedlings.
2	Aphids / scales	Most <i>Eucalyptus</i> spp.	Damage foliage, discoloration.	Spray young trees / seedlings.
3	Snout beetle	<i>E. globulus</i> , <i>E. grandis</i>	Defoliation	Biological control by egg parasite
4.	Termites	All <i>Eucalyptus</i> spp.	Girdling of stem at the base	Chemical control

**Note:**

*For any sign of disease or pest attack consult the local forest officer.*



*Blue gum chalcid, in Mwea Division, Kirinyaga District*

## 5.0. Marketing of Eucalyptus products

Before tree products are harvested, an investor / farmer must consider how to process and market the product. Processing capacity at the local level in combination with marketing capacity from local organized groups will increase the economic benefits.

Farmers are advised to carry out extensive market research so as to realize best product prices before disposing their products in the market place. It is also recommended that forest owners join associations such as the Forest Tree Nurseries Association of Kenya and Kenya Forest Growers Association. This will increase their negotiating power as they market their products.

Farmers should consult their local forest officer for additional information on valuation and pricing of their products.

### 5.1. Eucalyptus products and markets

Eucalypts yield a wide variety of products which has varying degrees of demand.

**Table 11: Various products of Eucalyptus and their respective demand in the Market**

Product	Market	Demand
Transmission poles	KPLC, Uganda, South Sudan	Very high
Poles /props/posts	Construction industry, flower industry, fencing, horticulture	Very high
Timber	Construction industry, furniture and joinery	Very high
Fuel wood	Tea, tobacco, cement, brick making, sugar, jaggary industries, urban and domestic use, institutions (prisons, schools, hospitals among others)	Very high
Charcoal	Urban and domestic use	Medium to high in Western, Kenya.
Fibre-board	Fibre-board Industries	High
Pulp	Industries	Medium
Plywood	Industries	Medium
Bark ( <i>E. globulus</i> )	Industries (Flavoring food)	Medium
Leaves	Industries (Flavoring food)	Medium
Essential Oils	Industries (menthol)	Medium
Tool handles	Farmers	High

### 5.1.1. Comparative advantages of Eucalyptus enterprises

Investment in eucalyptus has a competitive edge over other tree species and some agricultural crops. This is due to its fast growth, a wide range of products and its high coppicing ability (**Annex 1**).

### 5.1.2. Cost Benefit Analysis of Eucalyptus enterprises

Studies carried out in various parts of the country indicate that investment in eucalyptus enterprises is a profitable venture (**Annex 2**)

### 5.2. Utilization and value addition

- For high recovery when converting logs to sawn timber, the use of band, circular or pit saws is recommended. Chainsaws (power saws) with low recovery should not be used. However modern power saws with high recovery are recommended.
- Sawdust from sawing activities should be converted to briquettes for energy, particle boards, furniture making, poultry and organic manure.
- Farmers are encouraged to do integrated harvesting to maximize the utilization of the entire tree (timber from the stem, essential oils from the leaves, flavouring from *E. globulus* bark, fuelwood and charcoal from tops and branches etc).
- Farmers are encouraged to add value to poles by pre-treating them with simple on farm treatments techniques such as used engine oil or carbonize the base.
- Farmers should use the correct species, for the desired management objective. They should also ensure that harvesting is done at the recommended age for the different products.



*Mature woodlots of Eucalyptus at 6 years*

## ANNEXES

### ANNEX 1: COMPARATIVE ANALYSIS FOR ONE HECTARE OF CYPRESS AND EUCALYPTUS

		<b>Eucalyptus</b>	<b>Cypress</b>	<b>Remarks</b>
Harvesting ages	12 yrs	virgin		
	22 yrs	1 <sup>st</sup> coppice		
	30yrs	2 <sup>nd</sup> coppice	Clear fell	
Production	Timber	150m <sup>3</sup>	400m <sup>3</sup>	
	Poles	300 no.	nil	
	Fuelwood	300m <sup>3</sup>	100m <sup>3</sup>	
Market price	Timber	2400	3500	
	Poles	2500	0	
	Fuelwood	1000	1000	
Income	Timber	360,000	1,410,000	1. cypress thinning accounted for 2. for euc. multiply income by 3 harvests with compounding
	Poles	750,000	0	
	Fuelwood	300,000	100,000	
	Sub-total	1,410,000	1,510,000	
	Grand total	7,681,944	1,510,000	
Costs		1,486,800	960,000	
Margins		6,195,144	550,000	

#### **Eucalyptus**

There are three harvests in 30 years. Each brings an income of Ksh.1, 410,000 this translates to  $1,410,000(1.06^{18} + 1.06^8 + 1.06^0) = \text{Ksh.}7,681,944$ . The total cost over the entire period is as indicated in the table. Since the returns are coming earlier than those of cypress and the wider product range the Net Present Value (NPV) for eucalyptus is significantly higher.

#### **Cypress**

The income from the thinning has been calculated to offset the costs and this path leads to the same total earnings.

#### **CONCLUSION**

There is no difference between Eucalyptus and Cypress on the production costs per m<sup>3</sup>.

The analysis conforms to capital budgeting theory on returns on investments against time horizons. The private forestry sector in the country is heavily skewed towards eucalyptus as compared to other species. Obviously this has a sound financial base.

**ANNEX 2: COST BENEFIT ANALYSIS FOR ON FARM EUCALYPTUS ENTERPRISE UNDER DIFFERENT MANAGEMENT OBJECTIVES**

**1. TRANSMISSION POLES**

**Area:** 1 Acre

**Espacement:** 2.5.by 2.5m

**Rotation Age:** 10-15 Years

**Rainfall:** >1000mm  
(G/C)

**Working Cycles:** 2

**Species:** *Eucalyptus grandis*/*E. saligna*/*E. Clones*

No.	Item / Activity	Unit	Quantity	Unit Price	Amount (Ksh)
<b>a)</b>	<b>Inputs</b>				
1.	Seedlings	No.	640	14.00	8,960.00
2.	Manure	Tonnes	7	1000.00	7,000.00
3.	Fertilizer- DAP	Kgs	12	70.00	840.00
4.	Confidor	Litres	1	2500.00	2500.00
5.	Furadine	Kgs.	2	1000.00	2,000.00
6.	Fencing (Barbed wire+ posts + nails + Labour)	Metres	252	200.00	50,400.00
	<b>Total Cost</b>				<b>71,700</b>
<b>b)</b>	<b>Labour</b>				
1.	Land Preparation	Mandays	9	200.00	1,800.00
2..	Staking out	Man days	4	200.00	800.00
3.	Pitting	Man days	32	200.00	6,400.00
4.	Planting	Man days	8	200.00	1,600.00
5.	Complete Weeding	Man days	60	200.00	12,000.00
	<b>Total Cost</b>				<b>22,600</b>
<b>c.</b>	<b>Other Costs</b>				
1.	Transport of seedlings	Car Hire	1	6,000.00	6,000.00
	<b>Total Cost</b>				<b>6,000.00</b>
	<b>Total Expenditure (a +b + c)</b>				<b>100,300.00</b>
<b>d)</b>	<b>Output / Product</b>				
1.	Transmission Poles	No.	448	1500.00	672,000.00
	<b>Gross Margin per Acre</b>				<b>672,000.00</b>
	<b>Total Expenditure</b>				<b>100,300.00</b>
	<b>Net Profit</b>				<b>571,700.00</b>

**Assumption:**

Thirty percent (30%) of the original number of trees planted will not survive to maturity.

**2a. CONSTRUCTION POLES (PROPS)**

Area: 1 Acre

Espacement: 2.0.by 2.0m

Rotation Age: 3-4 Years

Rainfall: &gt;1000mm

Species: *Eucalyptus grandis*/*E. saligna*/ *E. Clones (G/C)/Hybrids*

No.	Item / Activity	Unit	Quantity	Unit Price	Amount (Ksh)
<b>a)</b>	<b>Inputs</b>				
1.	Seedlings	No.	1000	14.00	14,000.00
2.	Manure	Tonnes	7	1000.00	7,000.00
3.	Fertilizer- DAP	Kgs	12	70.00	840.00
4.	Confidor	Litres	1	2500.00	2500.00
5.	Furadine	Kgs.	2	1000.00	2,000.00
6.	Fencing (Barbed wire+ posts + nails + Labour)	Metres	252	200.00	50,400.00
	<b>Total Cost</b>				<b>76,740</b>
<b>b)</b>	<b>Labour</b>				
1.	Land Preparation	Mandays	9	200.00	1,800.00
2..	Staking out	Man days	6	200.00	1,200.00
3.	Pitting	Man days	50	200.00	10,000.00
4.	Planting	Man days	10	200.00	2,000.00
5.	Complete Weeding	Man days	60	200.00	12,000.00
	<b>Total Cost</b>				<b>27,000.00</b>
<b>c.</b>	<b>Other Costs</b>				
1.	Transport of seedlings	Car Hire	1	6,000.00	6,000.00
	<b>Total Cost</b>				<b>6,000.00</b>
	<b>Total Expenditure (a +b + c)</b>				<b>109,740.00</b>
<b>d)</b>	<b>Output / Product</b>				
1.	Poles / props	No.	1000	40.00	40,000.00
	<b>Gross Margin per Acre</b>				<b>40,000.00</b>
	<b>Total Expenditure</b>				<b>109,740.00</b>
	<b>Net Profit</b>				<b>-69,740.00</b>

During the first cycle, the initial cost will be more than the returns by **Ksh. 69,740** but obviously the returns from the subsequent cycles will be good.

The cost of buying and transporting seedlings from Karura could be reduced by purchasing the locally available Eucalyptus seedlings. This would bring the cost down by **Ksh. 6,000**. Fencing using barbed wire is another optional cost that could also be avoided by use of live fence or locally available materials. An extra cost of **Ksh.50, 400** could therefore be avoided. The farmer can also use their own labour instead of hiring which will also reduce the costs by a great margin.

**2b. Coppice Management of Eucalyptus G/C or *E grandis* or *E saligna* after 1<sup>st</sup> 3-4 years cycle and subsequent cycles up to 30<sup>th</sup> year**

**Area:** 1 Acre      **Espacement:** 2.0.by 2.0m      **Rotation Age:** 3-4 Years  
**Rainfall:** >1000mm      **Species:** *Eucalyptus grandis*/*E. saligna*/*E. Clones (G/C)/Hybrids*

No.	Item / Activity	Unit	Quantity	Unit Price	Amount (Ksh)
<b>a) Labour</b>					
1.	Coppice reduction	Mandays	5	200.00	1,000.00
2.	Weeding	Man days	5	200.00	1,000.00
	<b>Total Cost</b>				<b>2,000.00</b>
	<b>Total Expenditure (a)</b>				<b>2,000.00</b>
<b>b) Output / Product</b>					
1.	Poles / props	No.	3033	40.00	121,320.00
	<b>Gross Margin per Acre</b>				<b>121,320.00</b>
	<b>Total Expenditure</b>				<b>2,000.00</b>
	<b>Net Profit</b>				<b>119,320.00</b>

The farmer starts getting more profit during this 1<sup>st</sup> Coppice crop.

**2c) A case study of Kasiala scenario in Kitui District**

**Area:** 1 Acre      **Espacement:** 1.0.by 1.0m      **Rotation Age:** 2 Years  
**Rainfall:** >1200mm      **Species:** *Eucalyptus grandis*/*E. saligna*

No.	Item / Activity	Unit	Quantity	Unit Price	Amount (Ksh)
<b>a) Inputs</b>					
1.	Seedlings	No.	4000	5.00	20,000.00
2.	Manure	Tonnes	7	1000.00	7,000.00
3.	Fertilizer- DAP	Kgs	12	70.00	840.00
4.	Confidor	Litres	1	2500.00	2,500.00
5.	Furadine	Kgs.	2	1000.00	2,000.00
6.	Fencing (Barbed wire+ posts + nails + Labour)	Metres	252	40.00	10,080.00
	<b>Total Cost</b>				<b>42,420.00</b>
<b>b) Labour</b>					
1.	Land Preparation	Mandays	9	200.00	1,800.00
2..	Staking out	Man days	12	200.00	2,400.00
3.	Pitting	Man days	100	200.00	20,000.00
4.	Planting	Man days	10	200.00	2,000.00
5.	Complete Weeding	Man days	60	200.00	12,000.00
	<b>Total Cost</b>				<b>38,200.00</b>
	<b>Total Expenditure (a +b)</b>				<b>80,620.00</b>
<b>c) Output / Product</b>					
1.	Poles / props	No.	3600	40.00	144,000.00
	<b>Gross Margin per Acre</b>				<b>144,000.00</b>
	<b>Total Expenditure</b>				<b>80,620.00</b>
	<b>Net Profit</b>				<b>63,380.00</b>

**Assumption:**

Four hundred (400) of the original stems planted will not reach maturity.

### 3. FUELWOOD

Area: 1 Acre

Espacement: 2.5.by 2.5m

Rotation Age: 6-8 Years

Rainfall: >1000mm

Working Cycles: 4

Species: *Eucalyptus grandis*/*E. saligna*/ *E. Clones*

(G/C)

No.	Item / Activity	Unit	Quantity	Unit Price	Amount (Ksh)
<b>a)</b>	<b>Inputs</b>				
1.	Seedlings	No.	640	14.00	8,960.00
2.	Manure	Tonnes	7	1000.00	7,000.00
3.	Fertilizer- DAP	Kgs	12	70.00	840.00
4.	Confidor	Litres	1	2500.00	2,500.00
5.	Furadine	Kgs.	2	1000.00	2,000.00
6.	Fencing (Barbed wire+ posts + nails + Labour)	Metres	252	40.00	10,080.00
	<b>Total Cost</b>				<b>31,380</b>
<b>b)</b>	<b>Labour</b>				
1.	Land Preparation	Mandays	9	200.00	1,800.00
2..	Staking out	Man days	4	200.00	800.00
3.	Pitting	Man days	32	200.00	6,400.00
4.	Planting	Man days	8	200.00	1,600.00
5.	Complete Weeding	Man days	60	200.00	12,000.00
	<b>Total Cost</b>				<b>22,600</b>
<b>c.</b>	<b>Other Costs</b>				
1.	Transport of seedlings	Car Hire	1	6,000.00	6,000.00
	<b>Total Cost</b>				<b>6,000.00</b>
	<b>Total Expenditure (a +b + c)</b>				<b>59,980.00</b>
<b>d)</b>	<b>Output / Product</b>				
1.	Fuelwood	No of stacks.	400	500.00	200,000.00
	<b>Gross Margin per Acre</b>				<b>200,000.00</b>
	<b>Total Expenditure</b>				<b>59,980.00</b>
	<b>Net Profit</b>				<b>140,020.00</b>

**ANNEX 3: EUCALYPTUS MANAGEMENT RECORD SHEET FOR FARM FORESTRY**

**FARM REGISTER**

**(A) Background Information**

1. Name of Farmer.....
2. District .....Division.....Location.....
3. Farm / Block No.....Land size (Acres).....
4. Species.....
5. Management objective.....
6. Spacing.....
7. Seed /seedling source.....
8. Date of planting.....

**(B) Land Description**

- 1 Nature of Land: Virgin, farmed, .....
- 2 Pre-planting operations e.g.  
Ploughing.....  
Draining.....  
Cultivation then planting.....  
Others.....
- 3 Establishment methods  
Direct sowing.....  
Seedlings.....  
Coppice.....  
Others.....
- 4 Percentage area under trees established on Farm.....
- 5 Survival rate .....

**(C) FOREST EXTENSION OFFICER PRESCRIPTIONS FOR SILVICULTURE OPERATIONS TO THE FARMER**

<b>YEAR</b>	<b>DATE</b>	<b>PRESCRIPTION</b>

**(D) ACTION TAKEN ON PRESCRIPTIONS**

<b>YEAR</b>	<b>DATE</b>	<b>ACTION TAKEN</b>

**(E) PLANTATION OCCURANCE RECORD**

This information should include record of observed damage suffered through action of animals, insects, fungi and fire.

<b>Day</b>	<b>Month</b>	<b>Year</b>	<b>Nature of damage</b>	<b>No. of trees damaged</b>	<b>Estimated cost of damage.</b>

#### **ANNEX 4: CONTACT ADDRESS**

Forest Trees Nurseries Association of Kenya (FOTNAK)  
Waumini House  
1<sup>st</sup> floor Westlands  
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Kenya Forest Growers Association  
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