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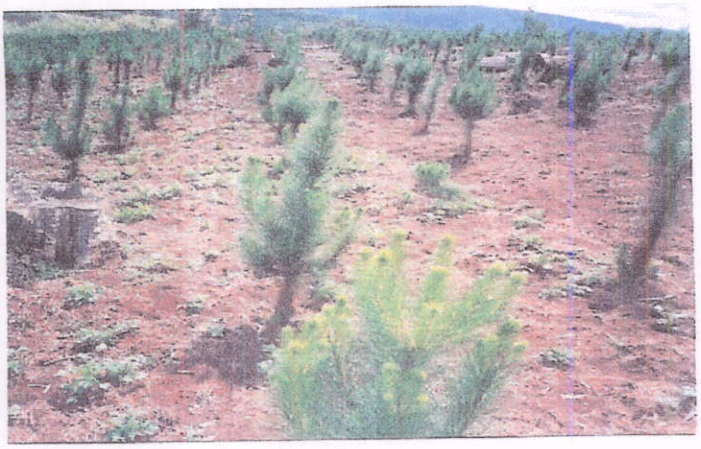

ANNUAL REPORT, JULY 2003-JUNE 2004

Produced by: Londiani Regional Forestry Research Centre. September 2004

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With inputs from Joshua Cheboiwo, Juliet Wanyondu, David Langat, Jonathan Njuguna, Michael Okeyo, Maina Kahuthia, Richard Siko, Thomas Kundos, Fanuel Wesonga and Steve Milimo.

Cover Page: Clockwise; 1. Demonstration in a Eucalyptus grandis stand during field day at Turbo, 2. Distribution of Eucalyptus grandis seedlings at Turbo, 3. Climbing a Plus tree to collect scions for grafting, 4. Intensive management of a young pinus plantation

Design and Layout: Joram Mbinga and Joshua Cheboiwo

Cover Photo by: Joshua Cheboiwo, Joram Mbinga

PREFACE

The year 2003 – 2004 was a very busy one for the centre. The six scientists strived hard to implement the sixteen approved GoK funded projects according to their schedules. The projects cut across four KEFRI research and development programmes namely: Plantations Forestry, Natural Forests, Farm forests and Service programme. Proirity forestry problems and issues in the region are well addressed through the implementation of these projects.

The Centre has worked with farmers to develop woodlots, forest based investments and enterprises and in social economic studies. We have assisted 5 farmers to establish upto 20 ha of *Eucalyptus* plantations in Londiani area and similar assistance has been provided in Turbo sub-centre. These are farmer driven activities for income generation and our role is advisory in the form of technical inputs. In our forest experimental farm at Kamara, Masaita, upto 32 ha of various plantation species were established for purposes of seed production (seed orchards and seed stands), breeding purposes (progeny trials and clonal trials), demonstration purposes (provenance trials and establishment methods) and a few for general conservation purposes. A number of trials were also established at our Turbo experimental farms. Catchment conservation received adequate attention with work going on in the Mau Forest complex where the centre is actively participating in the team running the European Union funded Mau Forest Conservation project. Vegetation restoration activities on the degraded Kipchorian river within Masaita forest block were carried out and upto 37 ha in the catchment were planted with different indigenous species. Seed collection, processing and dispatch activities were implemented as programmed. Upto 602 kg and 320 kg of seeds were realized at Londiani and Turbo respectively.

Infrastructure improvement continued with the renovation of the recently acquired old Forestry College facilities composed of administration block, scientists' offices, labs, library and conference hall, and other allied infrastructure. Effort was made to acquire a computer for each scientist. All the scientists computers were further installed with TEEL library- a handy reference of abstracts of many agricultural and forestry journals.

This annual report is a consolidation and record of all the things of significance that took place in Londiani during the year 2003/4. The larger part of it is composed of the scientific output in terms of the reports of the activities implemented. The contents of individual articles contained in this report are the responsibility of their authors. The last pages contain issues and activities that support research.

We would like to thank the Director Kefri for the support the head office has provided to Londiani which has enabled the centre to meet the challenges it faces in the region. Similar gratitude is extended to staff for their efforts towards achieving our objectives. We request you to partner with us by reading this volume either as a whole or the sections of interest to you. We therefore encourage you to share with us in areas that stimulate your interest. Similarly we welcome challenges on aspects contained in this report or on important areas which we may have left out or given little attention.

Joshua K. Cheboiwo
Centre Director.

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1. INTRODUCTION

The mandate of Londiani Regional Research Centre is to conduct forestry research and development in high potential areas West of the Rift. Located within Kericho district, its research activities extend to other districts namely Nakuru, Bomet, Buret, Koibatek, Keiyo, Marakwet, Uasin Gishu, Nandi, Lugari, Transnzoia, Mt. Elgon, West Pokot, Transmara and Narok. These are areas with a climate that is suitable for settlement and agricultural activities and consequently has high population pressure. Forestry activities therefore face intense competition from other land use systems and the biggest challenge is how to integrate forestry into farming and other land use activities. The centre has taken the challenge by endeavoring to develop and parkage appropriate forestry technologies and demonstrating them to farmers that forestry enterprises can make money and give them profits to improve their standared of living and at the same time play a role in environmental conservation.

Londiani Regional centre has two subcentres namely: Turbo, Kaptagat. These are focal points through which research relevant to specific sub regions is conducted. Turbo subcentre handles research mainly on Pines and Eucalypts, both onfarm and for industrial plantations.

2.0 RESEARCH AND DEVELOPMENT ACTIVITIES

The Research activities at the center are categorized according to Kefri's main research programmes which are listed as follows.

- **Plantation Forestry**
- **Natural Forestry**
- **Farm Forestry**
- **Service program**

The following is a summarized listing of the research activities undertaken at the centre during the year.

I. Plantations programme	**Main focus**
1. Development of Alternative Plantation Species	Species under consideration are *Pinus tecunumanii,* and *Liquidamber styraciflua,*
2. Development of indigenous plantation species	Species under consideration are *Croton macrostachyus* and *Polycias* sp.
3. Natural Regeneration Management Trials	*C. lusitanica* and *P. patula*
4. *Cupressus lusitanica*, *Eucalyptus grandis* and *Grevillea robusta* Improvement	-A 2.2 ha seed orchard of Cypress established. -9.5 ha seed stand/progeny trial of E. grandis was established at Londiani. -A 2.5 ha seed orchard of Grevillea established at Turbo
5. Demonstration Plots	Variouss species at Kamara-Masaita block

6. Silvicultural Management of Two Charcoal Producing Species in North Rift	The case of *Acacia meansii* and *A. geraldii*
II. Natural Forests Programme	
1. Natural Resource management-Chepalungu Forest	Secioeconomic and forest stock survey conducted
2. Rehabilitation of Kipchorian River Catchment	-Vegetation restoration with indigenous tree species, -Sensitization of farmers through field day -Monitoring of quality and quantity of river water flow
3. Market solutions to Cedar Conservation in Marakwet District	-Conducted socioeconomic and resource surveys -Held a stakeholders workshop
4. Natural Resource Management of Tinderet Forest	-Conducted a forest resource valuation exercise.
Farm Forestry Programme	
1. Production, Utilization, Marketing and Markets of Farm Forestry Products	-Held a stakeholders workshop -Recruited link scientists from other RRCs
2. Agroforestry / pyrethrum cropping system	-Trials in forest land and in farmers' lands conducted
3. Survey of tree management practices	-Surveys in maize, wheat, and tea zones
4. Appropriate Tree-Tea Management System	-Assessment of performance of different species of trees when grown with tea
5. Extension and Outreach (Technology Transfer activities)	-Held farmers field day at Turbo, participated in Baraka college farmers open day and took part in Nakuru ASK show.

3.0 PROJECTS IMPLEMENTED UNDER PLANTATIONS PROGRAMME

3.1 PROGRESS REPORT: PROMOTION OF ALTERNATIVE PLANTATION TREE SPECIES

By Joram Mbinga

INTRODUCTION

The tree species identified to be developed as alternative plantation species under this project were: *Pinus tecunumanii*, and *Liquidambar styraciflua.* After evaluation of their performance in species/provenance trials, the next stage was to plant them in pilot plantations for demonstration purposes before they are recommended for large scale planting.

However, the problem to be overcome before planting them in pilot plantations was the unavailability of seeds. *P. tecunumanii* does not seem to seed in Turbo where the trials were located. On the other hand, the first lot of seed collected from *Liquidambar* showed poor germination. However, when a second collection was done germination improved remarkably.

Efforsts aimed at accessing seeds from countries of origin of these species/provenances were largely unsuccessful as intercountry exchange of germplasm is very restrictive.

Aim of the project:

To widen the choice of species available for planting commercial forest plantations.

Objectives

1. Propagate *Pinus tecunumanii* vegetatively and establish a stand a region where pines are known to produce seeds.
2. Using *Liquidambar* material from the 17 year old provenance trial at Turbo, establish plots to demonstration how the species grows under plantation conditions

Activities undertaken.

1. *Pinus tecunumanii.*

-A total of 31 outstanding (Plus) trees were selected in the gene conservation stand at Turbo. They were marked with a ring and given an identification number which ranged from 1 to 31. The main consideration during the selection was stem diameter, height, straightness and freeness from defects.

-Scions were collected from 27 of those trees and grafted onto *Pinus patula* rootstock in the Turbo nursery. Scions could not be collected from 4 out of the 31 selections because they showed signs of unexplained stress exhibited by the slight yellowing of foliage.

-A total of 490 grafted seedlings were successfully raised. The grafted seedlings which survived from each of the selected mother tree was as shown in the table 1 below.

Table 1. Surviving grafts of P. tecunumanii at turbo nursery

Selected Mother Tree No.	No. of surviving grafts out of 50	% survival
2	36	72
3	17	34
4	30	60
5	29	58
6	21	42
7	24	48
9	21	42
10	40	80
11	19	38
12	28	56
14	39	78
15	18	36
16	16	32
17	20	40
18	23	46
19	23	46
20	20	40
21	10	20
22	3	6
24	7	14
25	11	22
26	10	20
27	3	6
28	5	10
29	6	12
30	4	8
31	7	14
Total	**490**	**36**

-A 1ha stand – to be managed for seed production- composed of the grafted material was established at Londiani, Masaita compartment 1C. Ref. Lay out in appendix 2.

2. *Liquidambar styraciflua*

- The two provenance trial plots at Turbo and Kakamega were maintained by general slashing of the undergrowth. NOTE, the Kakamega plot was slashed halfway. The ban on activities in the forest was imposed before the work was completed..
- The 17th. year assessment – height and dbh measurements - of the two plots was done. (an abstract of conference paper which is under preparation is given in Appendix 1)

- Seeds measuring 1kg were collected from the seeding trees in the Lugari (Turbo) replicate and used to raise 4500 seedlings in the nursery at Turbo. The seedlings were used to establish a 3 ha demonstration plot at Turbo and another plot of 1 ha at Kamara (Londiani). Both plots were established at a spacing of 3m x 3m.

Way forward: Work to be implemented in 2004/5

Pinus tecunumanii

Maintenance, management and observations of the stand established at Londiani with a view to managing it for seed production. Survival count, weeding and growth measurements will be done during the 2004/5 year.

Liquidambar

-Maintenance and observation of the demo stands at Turbo and Londiani.

-A write-up on the results of the provenance trial at 17 years will be presented and discussed at the proposed Kefri scientific conference in November 2004.

3.2 PROGRESS REPORT: DEVELOPMENT OF FAST GROWING HIGH VALUE INDIGENOUS FOREST PLANTATION SPECIES: CROTON MACROSTACHYUS

By J. Mbinga and G. Giathi

1.0 INTRODUCTION

For a long time, forest development activities were mainly concentrated on exotic tree species owing mainly to their fast growth rate and ease of establishment in commercial plantations. The indigenous species were generally regarded as slow growing and therefore given a low priority in plantation development programmes. However, not all the indigenous species are slow growing. Preliminary observations in Western Kenya show that species such as *Croton macrostachyus* grows relatively fast with a growth rate that is similar to that of *Pinus patula* and *Cupressus lusitanica.*

In addition to such indigenous species showing a fast growth rate, many have valuable wood, create a more stable ecological environment and are less prone to pests and disease. For these reasons, there is a growing shift in policy to incorporate indigenous species in planting programmes both by government and on-farm. Studies on the ecological requirements of most indigenous species are rare except for *Brachylaena huillensis* (Kigomo, 1989), *Vitex keniensis*, *Olea capensis, Markhamia lutea* and *Cordia Africana* (Konuche, 1994). Also little is known about most indigenous trees wood properties and fuelwood value.

2.0 CROTON MACHROSTACHYUS

Croton macrostachyus Hostch ex Del grows to 30m high in midlands and highland areas at elevations of 1350 - 2250m a.s.l. with rainfall of over 1000mm per year. It prefers well drained soils, and regenerates easily from the abundant seed crop it produces. The species is fast growing and can be managed on short rotation for a number of uses which include fuelwood, handles for stools and farm equipment, medicine (bark, roots and leaves), bee forage, mulch and green manure which make it suitable for intercropping with agricultural crops.

The species is rated alongside pines and cypress in growth rate and has a fuelwood value comparable to eucalypts. These attributes makes it a possible candidate for incorporation in plantation programmes.

It is widely distributed in; Kericho, Bomet, Tugen hills, Elgeyo escarpment, Cherangani, Mt. Elgon, Kisii, Nandi, Kakamega, Meru, Embu, Nyeri, Kakuzi, Kabete and Uplands. It is found growing naturally along forest boundaries, and in planted plots in Kakamega forest, parts of Nandi, and Kericho. However, the largest population of the species is found scattered on farms where they are successfully interplanted with agricultural crops. They are also found on grazing lands.

From preliminary observations, its possible to group the areas where it grows into 12 different zones (provenances) from which seeds collected can be subjected to a provenance test to establish their performance in different regions under plantation conditions. Similarly, since the species is being developed as a potential fuelwood tree, its fuelwood value has to be determined and form a basis for comparison with other known fuelwood species.

OBJECTIVES

1. Determine the ease of establishment of *Croton macrostachyus* and evaluate the growth of different provenances of the species at five sites namely: Kericho, Londiani, Turbo, Uplands, and Nyeri

2. Demonstrate the performance of *C. macrostachyus* under plantation conditions.

Activities undertaken during 2003/4

1. Determination of the species distribution

- Survey to determine the distribution and seeding condition of *C. macrostachyus* and *Polycias* spp. (another indigenous species with potential for growing under plantations).This was done in August 2003.
- The following areas were covered in the survey: Tugen hills, Elgeyo escarpment, Cherangani hills, Mt. Elgon, Kakamega, Nandi, Kisii, Bomet and Kericho/Bureti.

Findings from the surveys

- The greatest population of *Croton* was found widely growing as isolated trees in farmlands, on farm boundaries and on the edges of the forest.
- Seeds were in their early state of formation in most of the areas visited in September 2003. They were estimated to be ready for harvesting in November 2003. The seeding was also noted to be quite heavy.
- *Polycias* trees were mainly confined to forest edges and the trees were not as frequently sighted as the case was with *Croton.* Also, their seeding pattern was difficult to determine with local residents saying the seeds were consumed by birds and monkeys even before they got ripe.

2. Seed collection team collected seeds from the following provenances in November 2003:

- Bureti, Kakamega, Mt. Elgon, Kisii, Nandi, Cherangani, Elgeyo, and Tenges (Baringo)
- Seeds from Kakuzi and Kabete provenances were collected by a team from Muguga Seed Centre. Of the two, Kakuzi seeds had been freshly collected while the Kabete provenance had been collected earlier and stored.
- The Nyeri provenance was collected by the Kefri Nyeri station and sown in their nursery. Similarly, the Muguga provenance was sown in the Muguga nursery.

3. Seed sowing in the Nursery.

- 4000 seeds of each provenance were sown in the Londiani nursery by directly sowing 2 seeds per soil filled potting bag. In addition, 1000 seeds of each provenance were also sown in an open sowing bed and latter pricked out.

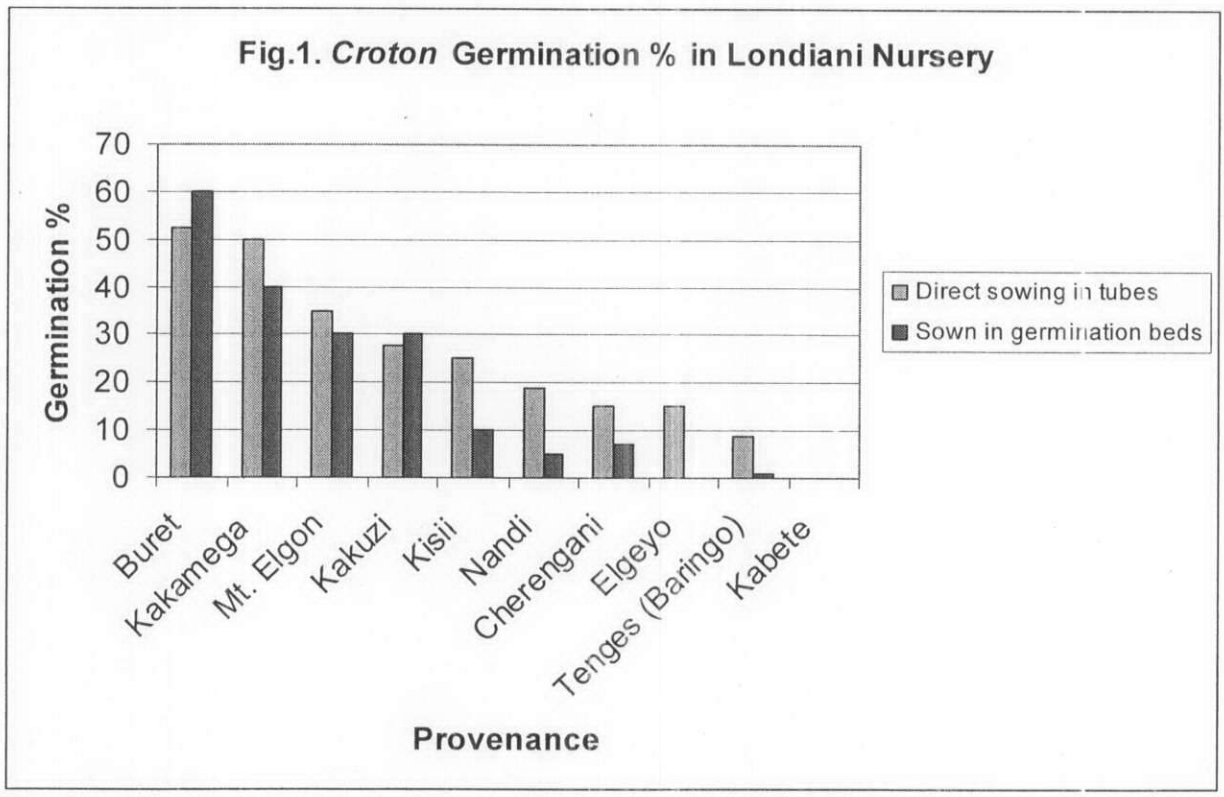
- **Nursery germination results:**

The results are as shown in table next page.

Table 1. *Croton macrostachyus* seed germination in nursery at Londiani

Provenance	No. of seeds Germinated		Total
	Direct sowing /4000	Germination bed/1000	
1. Bureti	2100	600	2700
2. Kakamega	2000	400	2400
3. Mt. Elgon	1400	300	1700
4. Kakuzi	1100	300	1400
5. Kisii	1000	100	1100
6. Nandi	750	50	800
7. Cherangani	600	70	670
8. Elgeyo	600	-	600
9. Tenges (Baringo)	350	10	360
10.Kabete	Nil	Nil	Nill
Total	**9900**	**1830**	**11730**

Additional seedlings were available as follows:
Nyeri: **5000 seedlings** of the Nyeri Provenance
Muguga: **1200 seedlings** of the Muguga provenance.
Total number of seedlings raised and planted during the season was therefore:
11,730 (Londiani nursery) + 5000 (Nyeri) + 1200 (Muguga) = **17,930 seedlings**



It is clear from the Table 1. and Fig. 1 above that variation in germination between provenances was high ranging from 60% for Bureti to 7% for Tenges (Baringo) and even nil for Kabete provenance.

With the exception of Bureti and Kakuzi, other provenances showed better germination when seeds were directly planted into pots than when sown in germination beds. Germination rate was less influenced by the method of sowing but more by the provenance from where the seeds were collected

4. Planting sites:

Sites were selected for establishing the trial plots for the 11 provenances at five locations namely: Kericho, Londiani, Turbo, Uplands and Nyeri. The size of the plots at each site was 1 ha and composed of 100 seedlings of each of the 11 provenances. The design adopted was randomized complete block design with 4 blocks and 25 tree plots per provenance per block. Ref. Appendix 1 – 3, provenance trial layouts.

- In addition to the 1 ha provenance trials, Nyeri and Londiani sites have an additional 4 ha demonstration plots each adjacent to the trial.

5. Site preparation and planting:

All the sites were prepared by slashing and pitting holes within the grasslands at a spacing of 3m x 3m. Kamara and Turbo sites were planted in June 2004 while Kericho, Kamara (the demonstration part), and Nyeri were planted in August 2004 due to the interruption of the rain season. The trials will be maintained by general slashing and sport weeding.

First assessment to determine establishment and survival will be done in December 2004 in all the plots. Growth measurements will be done in June every year upto age 5 and then every 5 years upto age 10, then every other 10 years.

6. Way Forward:

2004/5 Workplan.

- The workplan for implementing activities during the year 2004/05 has been prepared with emphasis on:

1). Completing the establishment of provenance trial/demo plots,
2). Assessments and maintenance of the plots during the year,
3). A quick evaluation of growth in existing stands and
4).Determination of the fuelwood value of the species.

3.3 Progress report on: - TRIAL STUDIES ON SILVICULTURAL MAGEMENT OF TWO CHARCOAL PRODUCING SPECIES IN NORTH RIFT: THE CASE STUDY OF A. MEARNSII AND A. GERARDII.

Joshua K. Cheboiwo Joram Mbinga and Michael M Okeyo

1.0 Introduction

Charcoal is an important farm forestry product widely traded in Western Kenya. Most of the charcoal produced in Nandi, Uasin Gishu and Keiyo districts come from farms that grow A. mearnsii. A. Mearnsii has a long history in the region, formerly grown by settler European farmers in 1940's for production of tannin but has since filtered to smallholder farms after independence. EATEC the last large-scale grower of A. mearnsii ceased its production activities in the region in 2000 after selling its vast land holdings to private individuals. The over 8,000 hectares of black wattle plantations have been subdivided by the new owners into individual holdings. The disposal of former EATEC plantations change has resulted in loss of over 1000 hectares that was being harvested annually for bark production and the polewood used in charcoal production. It is estimated that 80% of stem and branch biomass from EATEC farms was used in the production of charcoal yielding an estimated 800,000 bags of charcoal per year. It is estimated that the current landowners have retained less than 10% of the land area under black wattle mostly for farm and household uses. The bulk of charcoal supplies in Uasin Gishu the leading charcoal producer in the region is currently being produced from smallholder farms mostly from two species A. mearnsii and A. gerardii. The fall in roundwood supplies for charcoal production after subdivision of EATEC farms and declining sizes of A. mearnsii on smallholder farms has decreased charcoal outputs drastically leading to increased prices in the regional markets. Increased charcoal production has since been extended to Moiben Division to fill the gap, most of the charcoal from this new source is produced from A. gerardii a dominant naturally growing species in Lower Moiben locations of Meibeki and Koisagat, Lower Moiben.

The importance of A. mearnsii is well known, however, there is scanty information on its extend and management status. Studies by Cheboiwo(2001), estimate that about 64,000 ha. of A. mearnsii is grown on farms generating an annual average of Kshs15,000 to growers in Kesses and Kapseret divisions of which 41% is sold as standing volume, 45% in form of charcoal, and 14% in form of poles and small-wood (fitos) and Kshs 2287 is consumed by households.

2.0 Problem Statement

Despite A. *mearnsii* being planted by farmers for many years, little literature and research data is available on its management practices for optimal charcoal production. However shamba system of establishment approach based on farmers existing practices and that of commercial oriented EATEC farms improves its financial performance as compared to sole tree crop (Cheboiwo and Ongugo, 1989). EATEC management objectives were for optimal bark quantity and quality and hence its technical density and rotation were not geared to optimal charcoal output, which is the main objective on smallholder farms. Since farm forestry has become increasingly an important research undertaking, information and data on silvicultural management practices for optimal charcoal production from A. *mearnsii* need urgent attention to ensure that farmers receive necessary technical support to optimize its monetary values. The need for technical package is reinforced by the findings that up to 52% of the sample farmers in Uasin Gishu cite technical know how as a bottleneck on farm forestry activities (Cheboiwo, 2001).

A. *gerardii* is an indigenous species that has a limited ecological range and little is known about its growth performance, apart from its ability to colonize abandoned farms and the high quality charcoal produced from it. The species is known to grow very fast within its ecological range, a mature tree of about 20 years can produce up to 10 bags of charcoal. The species according to farmers has two attributes, its ability to improve soil fertility and fattening effect of its pods and seeds on goats during the dry season. The stretch occupied by the species support large number of goats that are reputed with delicious meat highly sought by butchers in Eldoret. Though the two attributes are not the focus of the study, they are worth because some of they are legendry and have some cultural significance especially the goat meat. The species currently occupies about 20% of the farms in lower Moiben area. Its growth rate, technical rotation and management for optimal charcoal production is unknown although it is estimated that currently up to 30% of the charcoal supplies in Uasin Gishu is from A. gerardii. There is need for scientific approach to the production, management, processing and marketing of A. gerardii in the region to ensure that farmers benefits from its presence on their farms.

3.0 Objective

Develop silvicultural management guidelines for optimal production of charcoal on farms for A. mearnsii and A. gerardii the two important charcoal producing species in Uasin Gishu.

4.0 Specific Objectives

1. Document the farmers experiences and indigenous knowledge in the management of the two species
2. Initiate experimental trials on spacing and rotation for charcoal production.
3. Monitor and record the growth performance over the rotation period
4. Quantify and value the interim and final products
5. Make a comparative evaluation of the two species in charcoal production
6. Develop some guidelines for silvicultural management of the two species for optimal charcoal output and quality.
7.

5.0 Duration: 8 years

6.0 TRIAL DESIGN

Experimental layout was as follows:

Treatments: 3 different spacing of 1 x 1 m, 2 x 2 m and 3 x 3 m

Harvesting time (for charcoal production): 4 yrs, 6 yrs, 8 yrs.

Two tree species: *Acacia meanrsii* and *A. geraldii.*

The experimental design was a split-split- plot, which will be as below;

Main plots – Spacing

Sub plots – Species

Sub –sub plots – Year for harvesting.

The size of a sub subplot will be 13m x 16 m = 0.05 acres so a complete experiment (one block) will occupy 2 acres and this can be replicated in two other areas.

Acacia mearnsii experimental plot

Treatments (Spacing)	**Rotation age of the experiment**		
	4 years	6 years	8years
(1 X 1) m	8	1	5
(2 X 2) m	2	3	9
(3 X 3) m	4	7	6

Acacia gerradii experimental plot

Treatments (Spacing)	Rotation age of the experiment		
	4 years	6 years	8years
(1 X 1) m	8	1	5
(2 X 2) m	2	3	9
(3 X 3) m	4	7	6

The trial occupies 2 ha of land at Chebororwa Farmers Training Centre in Moiben division and in Turbo Sub-Centre but for only *Acacia meanrsii*. The size of each sub-plot is 16 m x 13 m (208 m^2 = 0.0208 ha). One complete experimental block for a single species occupies 0.2 ha of land; this was replicated four times, thus occupying (0.2 x 4) =0.8 ha of land. For the two species 1.6 ha of land was prepared at each site.
Experimental design adopted is a 3 x 3 factorial laid out in a randomized complete block design (RCBD). Field lay out is rectangular plots of 96 m x 78 m or 156 m x 48 m or 192 m x 39 m. Each block has nine-treatments as shown below and this is replicated in all the four blocks.

The treatment codes per block (for the two sites) are as follows:
Sub-plot: 8 (1 x 1) m spacing; with a rotation age of 4 years

Sub-plot: 1 (1 x 1) m spacing; with a rotation age of 6 years

Sub-plot: 5 (1 x 1) m spacing; with a rotation age of 8 years

Sub-plot: 2 (2 x 2) m spacing; with a rotation age of 4 years

Sub-plot: 3 (2 x 2) m spacing; with a rotation age of 6 years

Sub-plot: 9 (2 x 2) m spacing; with a rotation age of 8 years

Sub-plot: 4 (3 x 3) m spacing; with a rotation age of 4 years

Sub-plot: 7 (3 x 3) m spacing; with a rotation age of 6 years

Sub-plot: 6 (3 x 3) m spacing; with a rotation age of 8 years

N/B Spacing (1 x 1) m is replicated tree times in plots one, five and eight; spacing (2 x 2) m is replicated in sub-plots two, three and nine and spacing (3 x 3) m is replicated in sub-plots four, six and seven; each to be harvested at ages four, six and eight respectively. The experiment is replicated in two sites. RCBD experimental design was adopted

Experimental management

The above experiments were planted in April – may 2004. In the Turbo experiment, the above replicate was planted from seed while the below replicate was planted from seedlings. During planting we ensured that each block was planted with relatively the same size of seedlings.

In June 2004 the turbo experiments were found to be bushy and weeding was to be done immediately. While, the chebororwa experiments were to be weeded in September 2004. Weeding the experiments will be done three times in a year or depending on the weeds. Weeding method adopted is spot weeding a half a metre radius around the seedlings (plants); and slashing in between the rows.

Singling and beating up (i.e. replanting with seedlings in spots where germination failed) will be done during the long rains in April – May 2005. During singling leave one or two health seedlings on each planting spot. The plants to be removed during singling can also be used for beating up. Height and base diameter measurements are to start after the second year of growth.

3.4 A SOCIOECONOMIC REPORT ON THE MANAGEMENT AND UTILZATION OF *ACACIA GERARDII* IN MEIBEKI LOCATION, UASIN GISHU DISTRICT

Joshua K. Cheboiwo and David Langat

1.0 SOCIOECONOMIC AND RESOURCE SURVEY

1.1 Introduction

Charcoal is an important farm forestry product widely traded in Western Kenya. Most of the charcoal produced in Nandi, Uasin Gishu and Keiyo districts come from farms that grow A. mearnsii. A. Mearnsii has a long history in the region, formerly grown by settler European farmers since 1940's for production of tannin but has since filtered into smallholder farms after independence. Esat African Tanning and Extract (EATEC) the largest grower of A. mearnsii ceased its production activities in the region in 2000 after selling its vast land holdings to private individuals. The over 8,000 hectares of black wattle plantations have been subdivided by the new owners into individual holdings. The disposal of EATEC plantations resulted in a loss of over 1000 hectares that was being harvested annually for bark production and the polewood and branches used in charcoal production. It is estimated that 80% of the biomass harvested from EATEC farms was used in the production of an estimated 800,000 bags of charcoal per year. The new landowners have retained less than 10% of the land area under black wattle mostly for household uses. The bulk of charcoal supplies in Uasin Gishu the leading charcoal producer in the region is currently being produced from smallholder farms. The two most important species for charcoal production in the North Rift districts are A. mearnsii and A. gerardii. The fall in A. mearnsii material supplies for charcoal production after subdivision of EATEC farms and declining sizes of A. mearnsii on smallholder farms has decreased charcoal outputs drastically leading to increased prices in the regional markets. To fill the gap sourcing of charcoal has extended widely within region thus bringing new sources outside the A. mearnsii zones. One such new source is Moiben Division of Uasin Gishu that has increased its production mostly from A. gerardii a dominant naturally growing species in Meibeki and Koisagat locations.

The importance of A. mearnsii is well known, however, there is scanty information on its extend and management status. Studies by Cheboiwo(2001), estimate that about 64,000 ha. of A. mearnsii is grown on farms generating an annual average of Kshs15,000 to growers in Kesses and Kapseret divisions of which 41% is sold as standing volume, 45% in form of charcoal, and 14% in form of poles and smallwood (fitos) and Kshs 2287 is consumed by households.

1.1 Problem Statement

Despite A. mearnsii being planted by farmers for many years, little literature and research data is available on its management practices for optimal charcoal production. However shamba system establishment approach based on farmers existing practices and that of commercial oriented EATEC farms is reported to improve its financial performance as compared to sole tree crop (Cheboiwo and Ongugo,1989). EATEC management objectives were for optimal bark quantity and quality and hence its technical density and rotation were not geared to optimal charcoal output, which is the main objective on smallholder farms. Since farm forestry has become increasingly an important research undertaking, information and data on silvicultural management practices for optimal charcoal production from A. mearnsii need urgent attention to ensure that farmers receive necessary technical support to optimize its monetary values. The need for technical package is reinforced by the findings that up to 52% of the sample farmers in Uasin Gishu cite technical know how as a bottleneck on farm forestry activities (Cheboiwo, 2001).

A. gerardii is an indigenous species that has a limited ecological range and little is known about its growth performance, apart from its ability to colonize abandoned farms and the high quality

charcoal produced from it. The species is known to grow very fast within its ecological range; a mature tree of about 20 years can produce up to 10 bags of charcoal. The species according to farmers has two attributes, its ability to improve soil fertility and fattening effect of its pods and seeds on goats during the dry season. The stretch occupied by the species support large number of goats that are reputed with delicious meat highly sought by butchers in Eldoret. Though the two attributes are not the focus of the study, they are worth because some of them are legendry and have some cultural significance. The species currently occupies about 20% of the farms in Lower Moiben area. Its growth rate, technical rotation and management for optimal charcoal production is unknown although it is estimated that currently up to 70% of the charcoal from non A. mearnsii sources in Uasin Gishu is from A. gerardii. This has prompted the need for scientific approach to its production, management, processing and marketing of A. gerardii in the region to ensure that farmers benefits from its presence on their farms,

1.2 Objective

Develop silvicultural management guidelines for optimal production of charcoal on farms for A. mearnsii and A. gerardii the two important charcoal producing species in Uasin Gishu.

1.2.1 Specific Objectives

8. Document the farmers experiences and indigenous knowledge in the management of the two species
9. Initiate experimental trials on spacing and rotation for charcoal production.
10. Monitor and record the growth performance over the rotation period
11. Quantify and value the interim and final products
12. Make a comparative evaluation of the two species in charcoal production
13. Develop some guidelines for silvicultural management of the two species for optimal charcoal output and quality.

2.0 SOCIOECONOMIC STUDY RESULTS

2.1 Socioeconomic characteristics of Sample Households

The survey sampled 60 households in Meibeki Location of Moiben Division in Uasin Gsihu District who owned land below 60 hectares. The household size averaged 7 persons of which 51% were children below 18 years (Table 1). The land ownership averaged 7.6 hectares per household that translated to an average per capita of one hectare. However, some medium scale landowners had over 50 hectares whereas smallholders had land sizes as low 0.5 hectares. Most smallholder farms were inherited from parents through subdivision. Also few new settlers who bought smaller pieces of land due to high prices averaging Ksh.100, 000 per hectare were among the smallholder landowners found in the sample area. Most of the households settled in the area between 1960 and 1970 an average of 28 years of settlement.

The study area is dependent on agricultural activities with crops occupying an average of 3.6 hectares or just over 50% of the household land and generated Ksh. 52,310 or 52% of the total agricultural incomes and was greater for smallholder between 80-90%. Livestock production was the second important land use occupying an average size of 3.5 hectare, households had on average 11 cattle and 16 shoats that generated an income of Ksh. 47,744 in 2002/2003 season. Horticulture and forestry activities trailed with average annual income of Ksh 9,284 and Ksh.3,484 respectively.

The income earned by households were spend overwhelmingly on farming activities Ksh 57,309 (49 %) to include servicing of machines, hiring agricultural machines, purchase of fertilizer, labour, herbicides, animal health products. School fees payment was second with an annual expenditure of Ksh 33,897 (29%). Expenditure on consumers goods, business investment and

investment in other activities followed in the order. The expenditure reflects the importance of agricultural activities to the household economies in the region. The importance of education cannot be overemphasized for it's an investment that prepares young members of the household for off-farm employment. The households thus invest a significant amount of their household incomes to prepare them for future challenges and opportunities mostly outside the farm.

Table1 : Socioeconomic characteristics of Sample Households(N=60)

Variable	Mean
Household family size	7.0
No of children<18 years	3.6
No. of household members employed	0.24
Years of settlement	28
Household land size in ha.	7.6
Land under crops in ha.	3.6
Land under grazing in ha.	3.5
Land under trees in ha.	1.1
Price of land per hectare	100,000
Number of cattle	11
Number of shoats	16
Household income from crops in Ksh.	52310
Household incomes from livestock in ksh.	47744
Household income from horticultural products in Ksh.	9284
Household incomes from farm forestry products in Ksh.	3484
Household expenditure on farm investment	57309
Household expenditure on school fees	33897
Household expenditure on consumer goods	13167
Household expenditure on business investments	6732
Household expenditure on Other goods and services	6887

2.2.0 Main Agricultural Activities

Crop production and livestock keeping are the two main agricultural activities in the sampled area. Horticultural activities are concentrated along Barsombe and Chebororwa rivers mostly for production of tomatoes and vegetables from furrow and sprinkler irrigation systems. The high demand for horticultural mostly tomatoes and cabbages in Eldoret and other urbanizing centers mostly Moiben and Ziwa have encouraged farmers to grow them in the sample area mostly during the dry seasons when the demand is high. However, the dominant crops remain maize wheat and beans as dairying in the area has been on the decline since 1980's when milk-processing industries collapsed. The recent revival of Kenya Cooperative Creameries (KCC) and emergence of other smaller processing enterprises have encouraged re-stocking and improvement of dairy stock in the area but it may take time for it reach the previous levels.

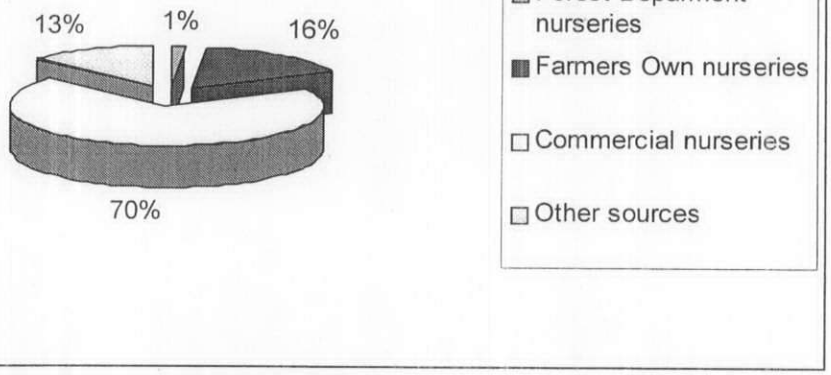
2.3 General Tree Planting activities.

2.3.1 Source of Seedlings

Most of the farmers who planted trees obtained their seedlings from local private commercial nurseries or those located in Eldoret Town.(70%), farmers own nurseries(16%), Other sources(13%) and Forestry Department nurseries was very small at 1%. The number of commercial tree nurseries in Eldoret Town and other urbanizing centers in the region has been on

the increase and have become important source of planting materials to farmers. Hawking of seedlings on markets days has become a common feature in Moiben and Ziwa where farmers can purchase them. The many tree nurseries have enabled farmers to access and purchase various types of seedlings ranging from ornamental to utility species.

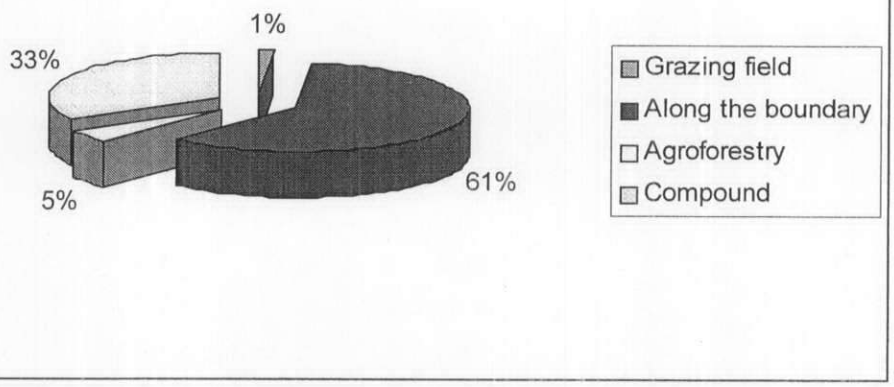
Figure 4: Source of planted seedlings



2.3.2 Location of the planted trees

Most of the trees planted by sample households were located along the farm boundary (61%) and in the compound (33%) few were planted on crop fields and grazing land. The tree-planting pattern is a typical phenomenon at initial stages in tree planting where boundary marking and beauty are the main purposes for tree planting.

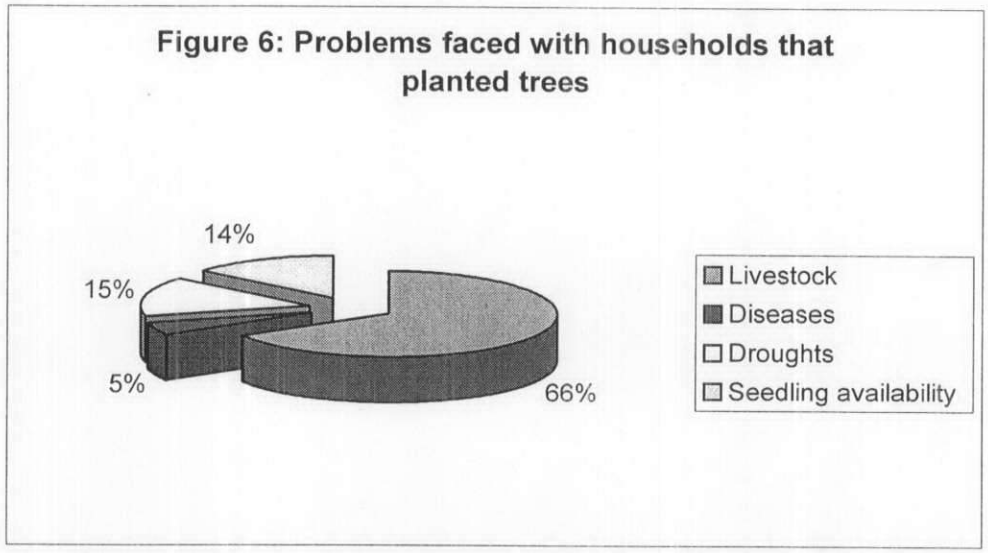
Figure 5: Location of planted trees in farmland



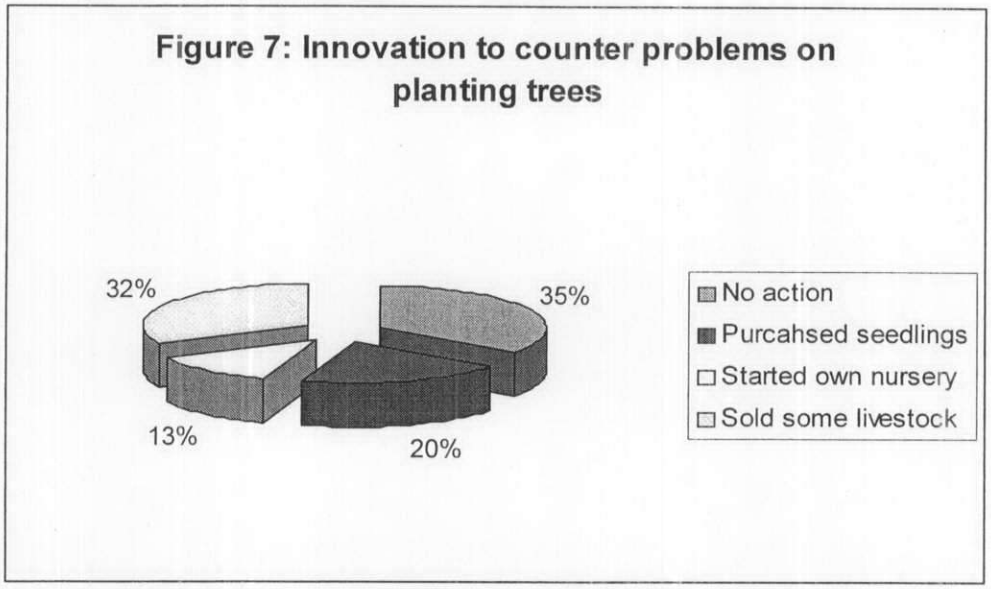
2.3.3 Problems associated with planted trees

Livestock damage is the most important problem that households that planted trees faced (66%), droughts (15%) and seedling availability followed in that order. Livestock browse are critical challenges that face households that planted trees especially during the dry season when shortage of grass and fodder increase the vulnerability of the planted trees. Meibeki, Location experiences

extreme dry conditions during the dry season due its trough like shape in the Uasin Gishu Plateau. Young planted trees rarely survive these conditions without watering during the dry season sometimes up to 4 months thus making tree planting an expensive and laborious exercise.

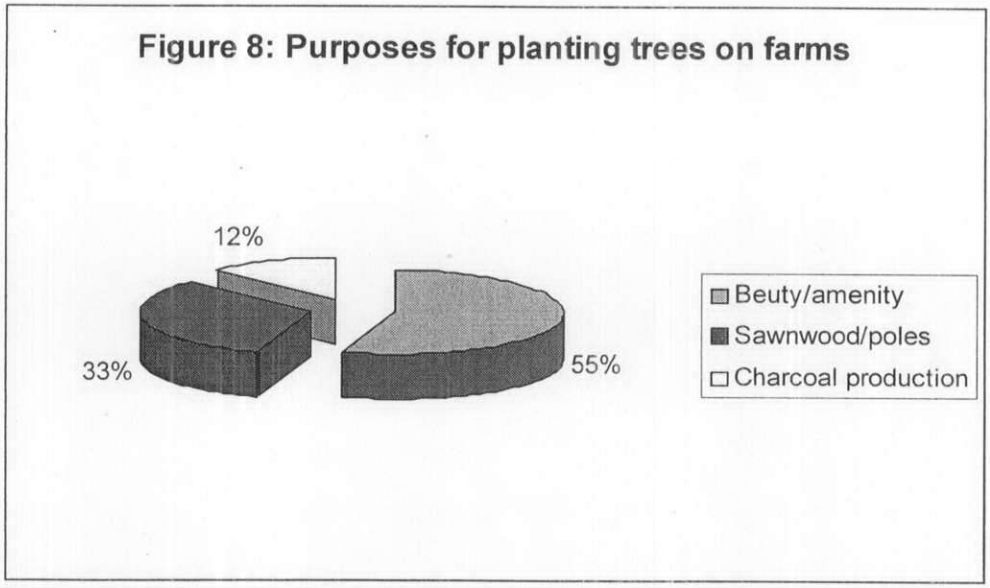


To counter these problems, most households reported to have taken no action (34%), some reported to have sold some livestock (31.8%) an extreme action indeed to reduce browsing. To counter seedling shortage, 12% reported to have raised own seedlings and 19% purchased seedlings from commercial nurseries (Figure7).



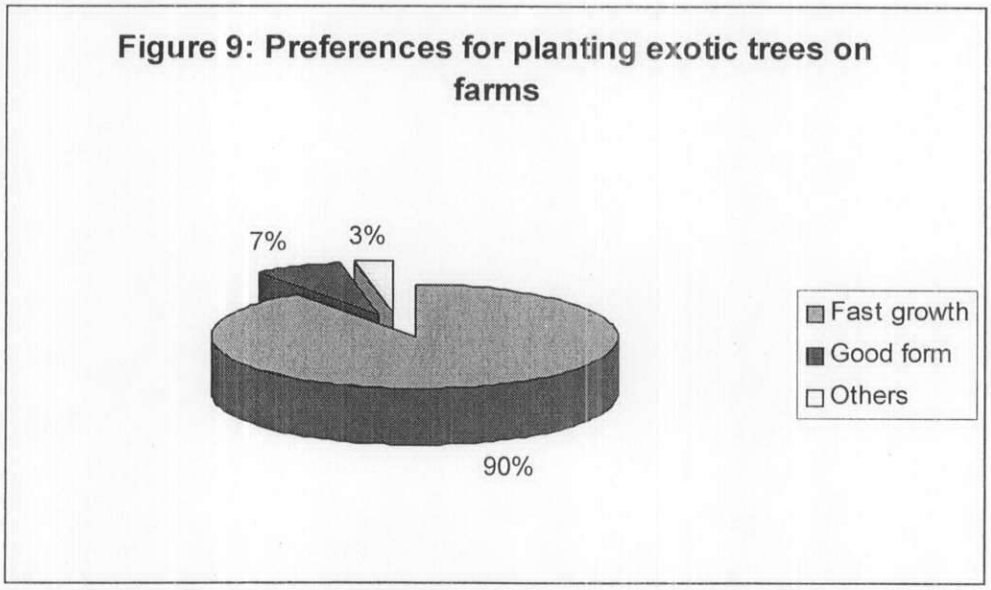
2.3.5 Main purposes for planting trees on farms

The purposes mentioned for planting trees by sample households was mostly for beauty/amenity (55%), sawnwood and polewood production (33%) and production of charcoal (12%). The concern with utility and environmental goods and services were equally valued by the sample households.



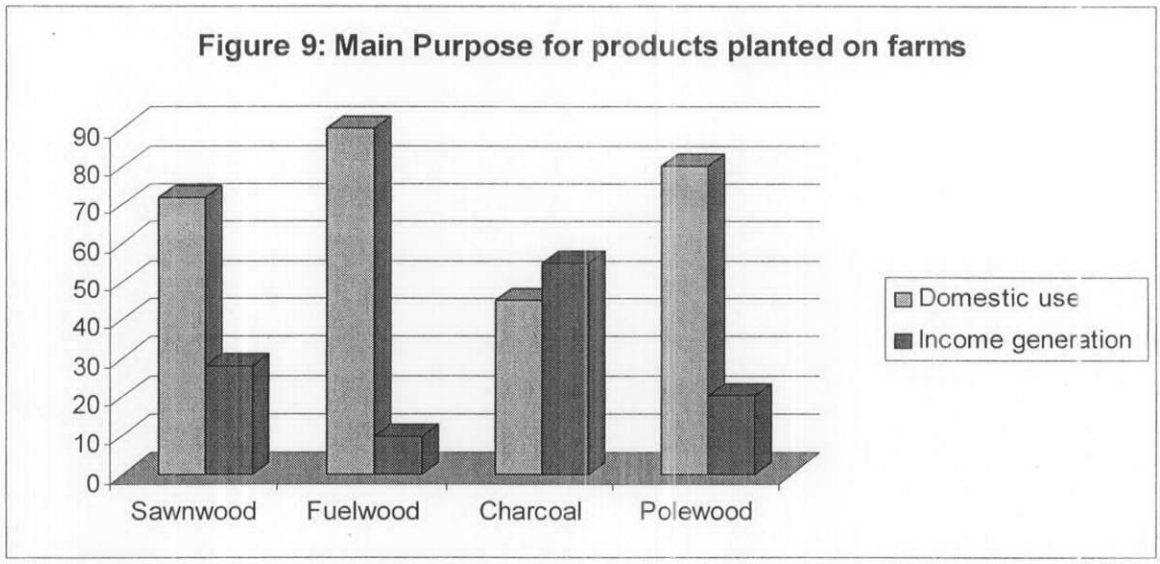
2.3.7 Preferences for exotic species

The sampled farmers reported to prefer planting of exotic species as opposed to indigenous species such as A. gerardii for several reasons to include fast growth (90%), good form (7%) and other attributes (3%).



3.3.6 Main uses of products from planted trees

Four types of trees products were derived from planted trees by the sample household, sawnwood, fuelwood, charcoal and construction polewood. Products that generated income were led by charcoal (50%), sawnwood (22%) and polewood (18%) with fuelwood contributing the least. Fuelwood was the most important product used by households for food preparation, lighting and house warming (88%). Others were construction materials, sawnwood (70%) and polewood (76%) mostly for construction of houses and farm structures.



3.0 Acacia gerardii in Meibeki Uasin Gishu District

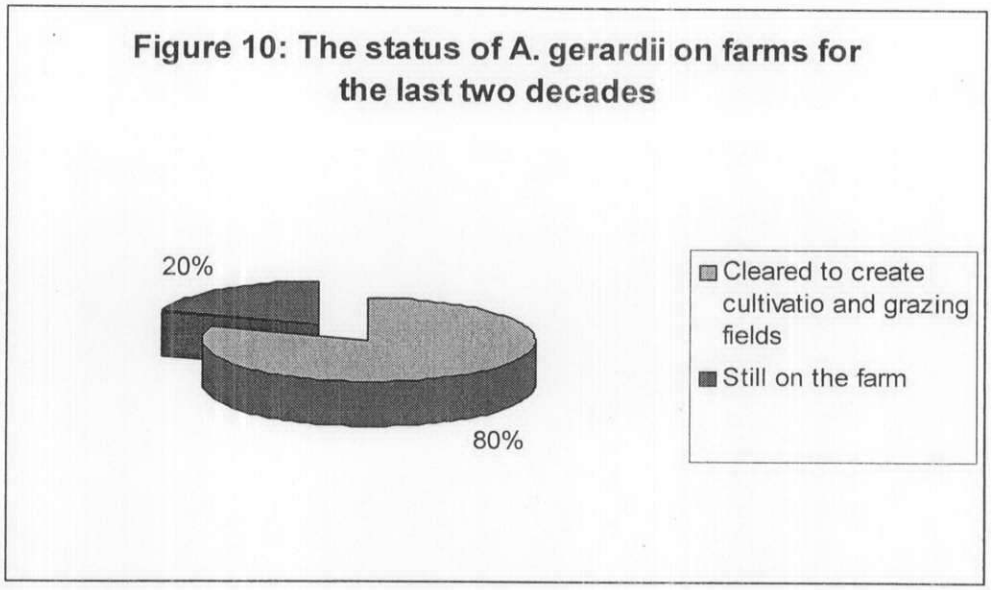
3.1 History and Evolution

Acacia gerardii is the dominant species in the study area accounting for over 80% of the vegetation cover. The species dominance was higher during the settler periods of 1950's and 1960's when the succession had climaxed and old large trees were the majority. However, the new settlements from mid 1960's to 1970's changed the vegetation age and composition because of mass clearing of vegetation that took place to create new cultivation fields and settlements for those not allocated former settler wheat growing fields. The removal of climax species gave room to young stands on abandoned fields and opened grazing areas (Table 4). A. gerardii is an aggressive colonizer and does well in abandoned cultivated fields and open grazing land and does not establish well under old growths or mature stands. There are some qualities that make A. gerardii grow well in Meibeki area. It has the ability to establish very fast thus out competing other species for space, it is thorny in early stages a characteristic that disappear with maturity thus avoiding heavy browse and does well under sandy and loamy soil conditions.

Table 4: The period that plorific establishment of A. gerardii was observed

Period	Response(%)	Remark
1960-1970	95	Clearing of mature trees to create cultivation fields
1970-1980	5	Further subdivision of farms

On the status of A. gerardii on farms for the last decade, 80% of the farmers reported to have removed large amounts to create room for cultivation and grazing fields and 20% reported to have retained a significant amount on their farms.



3.2 Current Status

The trees observed on farms are at different stages in their growth cycle and thus uneven forest type in terms of size and age. Our survey team categorized A. gerardii into three groups, large trees, over 40 centimeters diameter, medium between 15 to 40 centimetres and small those between 8-15 centimeters diametre. According the survey, on average, each household had 260 large trees, 1047 medium trees 787 small trees(Table 5) Large trees are estimated to take up to 30 years when its growth reduces to almost replacement but constant pollarding induces new growth from the cut branches and retains the re-growth for many years. According to charcoal burners, a large tree can produce on average between 8 to 20 bags of charcoal depending on the branching and sizes of the branches, medium between 4 and 12 bags and small between 1 to 3bags. The potential charcoal output using the estimates was approximately 7055 bags using local farm gate price of Ksh. 165 per bag translates to Ksh 1,164,075 or K.sh.19,400 per household.

Table 5: Tree sizes groups in sample farms.

Tree size category	Mean	Std	Estimated charcoal bags
Large trees	260	641	8-20
Medium trees	1047	2647	5
Small trees	787	1968	1

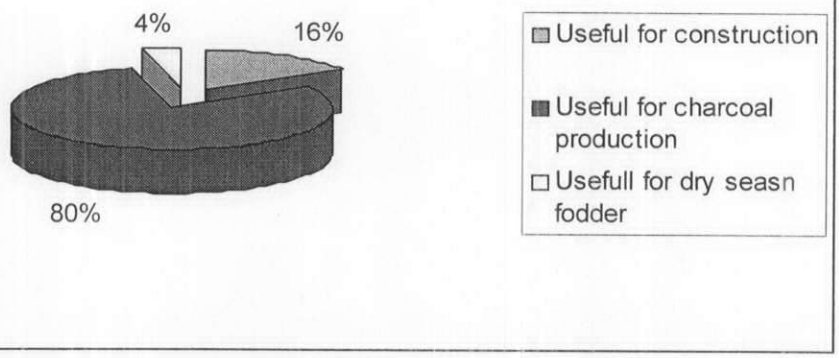
3.3 Control of A. gerardii on Farms

On control and management of A. gerardii on farms, 45% reported to regularly remove them themselves, 42% hired labour whereas 13% reported to have used no control.

3.4 Main uses A. geraardii

On the usefulness of the A. gerardii to land owners, 16% reported to use them for construction, 81% for charcoal production and 4% reported to value it for fodder provision during the dry season.

Figure 12: The farmers perceiped uses of A. gerardii on farms.

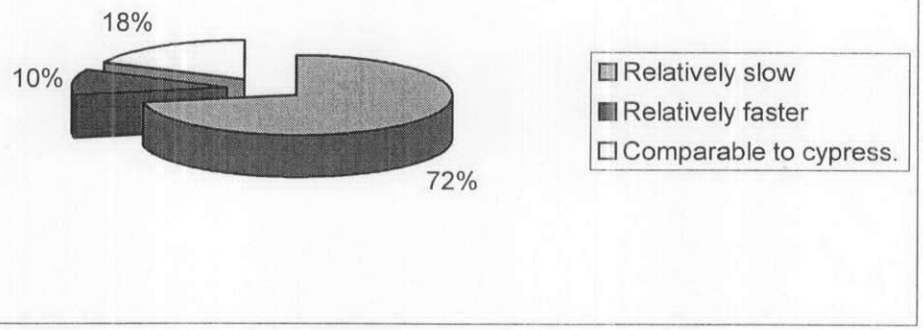


3.5 Comparative Growth of A. gerardii

On the growth performance of A. gerardii as compared to cypress, 72% viewed it as a relatively slow, 18% felt it was comparable and 10% reported to be faster than cypress.

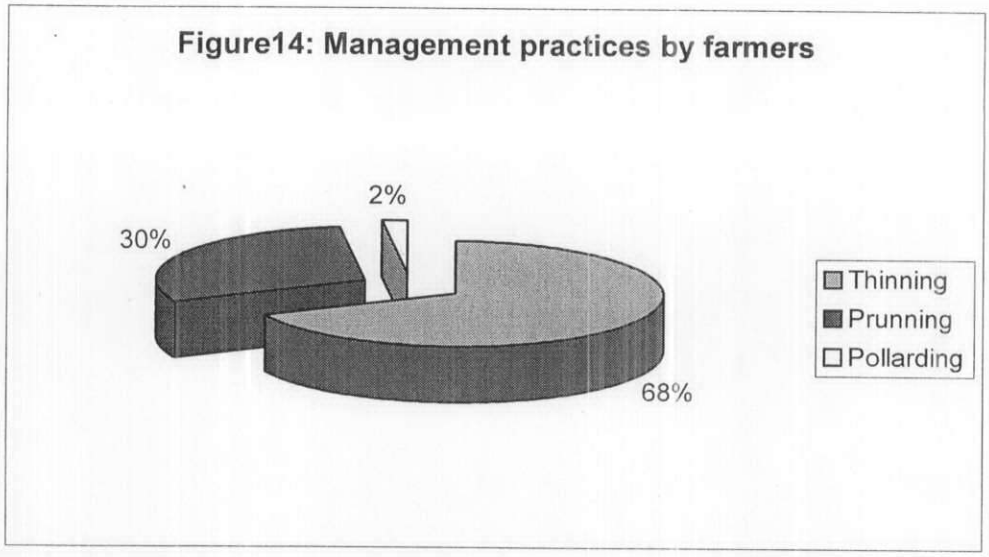
Due its drought tolerance A. gerardii's survival and growth performance may compare well to those of exotic species that have to surmount the dry drought conditions.

Figure 13: farmers view on the relative growth of A. gerardii



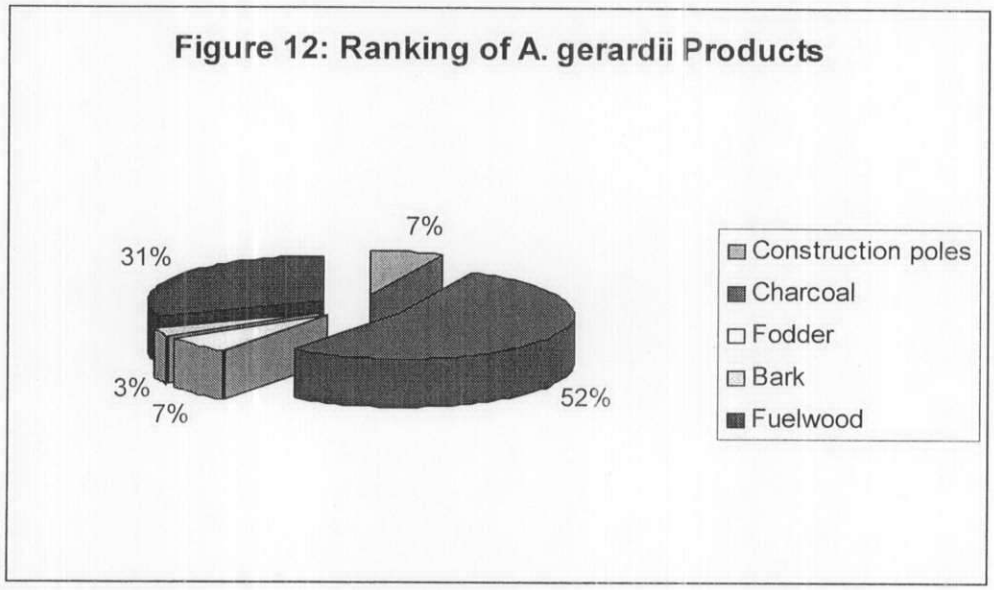
3.6 Silvicultural Management

The management practices that farmers used to maximize benefits and reduce competition to crops and grass on farms by A. gerardii include thinning (68%), prunning (30%) and pollarding(2%). The by products from these operations are used by households mostly for firewood, fencing and construction.



3.7 Main uses of A. gerardii

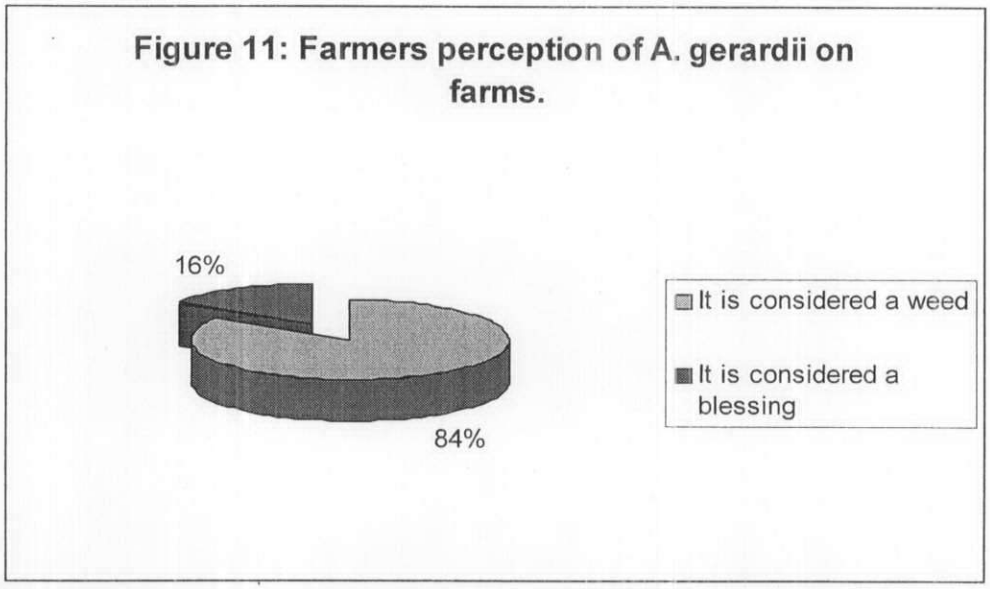
Farmers utilize A. geradii on their farms for various uses such as construction of mud houses, livestock fodder, charcoal and fuelwood for domestic use and sale whereas the bark is used in constructions, mostly for tying smallwood together in mud houses. The sample households ranked each of these uses as follows: construction poles (5%), Charcoal(40%), fodder(5%), bark(2%) and fuelwood (23%).



4.0 The Future of A. gerardii on Farms

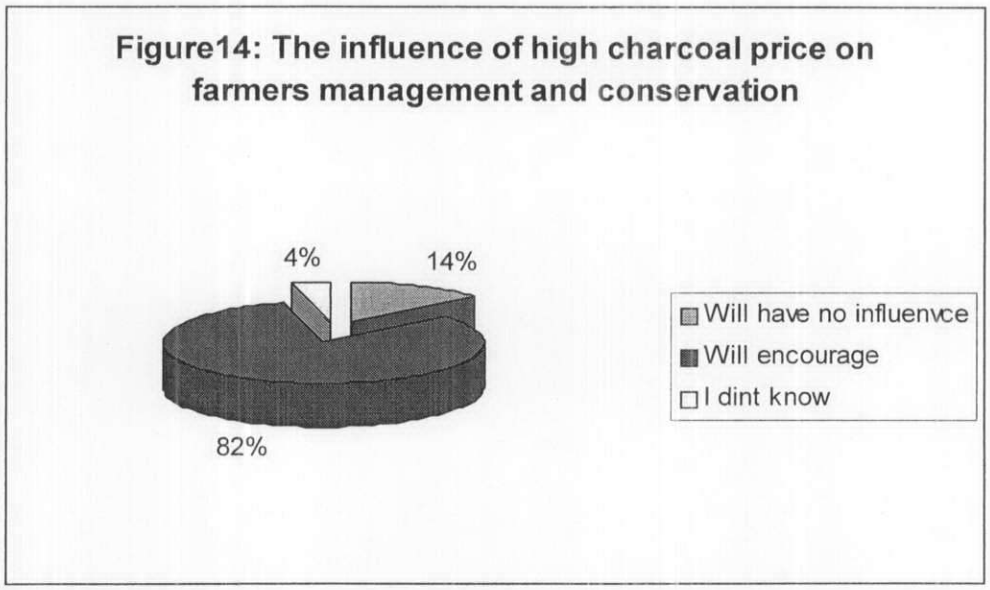
4.1 Household Perceptions

On their perception of A. gerardii on the farms, 84% reported that its is a weed and nuisance to their farming activities whereas 16% saw it as a blessing for it is useful to them. The farmers' perception is based on species ability to colonize large areas of their farms thus reducing grazing areas for their cattle. Many farmers complained of its ability to invade farms and grazing lands that involve frequent removal through hiring labour or giving it free to charcoal burners.



4.2 Impact of Charcoal Prices on the conservation and Management of A. gerardii

Charcoal is an important A. gerardii activity that generates income and it was our expectation that high charcoal prices will motivate farmers to conserve and manage it better on their farms. When the sample farmers were asked about the potential influence of better charcoal prices on their management of A. gerardii on farms, 82% reported that it will encourage them to improve its management and conservation, 14% reported that it will have no influence, and 4% reported that they didn't know if it will change their management and conservation strategies. From farmers responses it is evident that good charcoal prices will influence the future direction and management of A. gerardii on farms.



5.0 Charcoal Production

5.1 Characteristics of Charcoal Burners.

In Meibeki Location there are several full time and part time charcoal producers dotted over several production sites. The sample charcoal burners were on average 52 years old. This may be because charcoal production is labour intensive, dirty work and require some skill and thus may not attract young persons. Those sampled have been in the business for less than 15 years and employ less than two persons in their businesses. This is because most of the charcoal producers work as a gang to reduce the need to hire labour due to their low financial endowment. The period engaged in active production averaged 7 months with the most active extending to 9 months in a year. On average each produced 37 bags per month thus generating about Ksh 6200 from the business. Most of the charcoal is sold on site and the few that are transported by the producers are mostly to local markets that cost on average Ksh 20 per bag in transport charges. During the wet season the demand for charcoal is high especially in urban areas and prices are generally higher as compared to the dry season. It was reported that soil working during the dry season required twice that of the wet season. However, charcoal production activities are more pronounced during the dry season due to idle labour that is usually in short supply during the high labour demanding wet cropping season. The wet season prices were on average Ksh 30 higher than the dry season averaging Ksh 190 per bag of charcoal. The average selling price in production site and Chebororwa Market was Ksh.165 per bag.

Table 6: Characteristics of charcoal burners

Characteristic	N	Mean
Age of the charcoal burners	6	52
Number of year in charcoal production	6	8
Number of employees	6	2
Number of charcoal bags produced per month	6	37
Transport costs to outlets	6	10
Wet season price per bag	6	190
Dry season price per bag	6	160
Number of months spend in charcoal production	6	7
Selling price at the local outlets	6	165

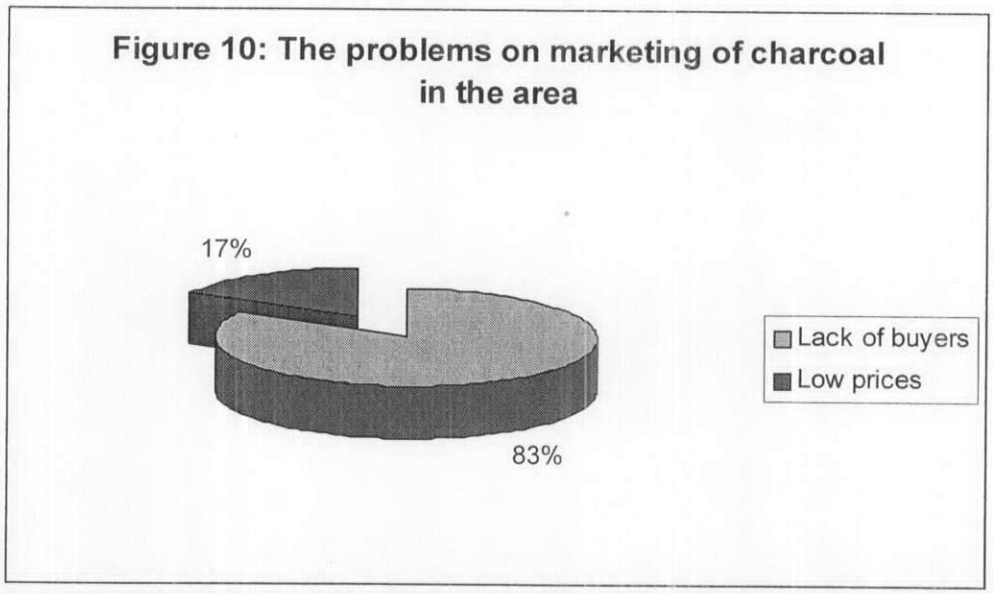
5.2 Sources of A. gerardii for Charcoal Production

The sampled charcoal producers used A. gerardii and small proportion of other indigenous species in their charcoal production activities. They reported to source their trees from Chebororwa FTC (67%) and Irong Farm (33%). These two farms are sparsely populated and the populations of A. gerardii are relatively high as compared to those on neighbouring smallholder farms. Most sample producers reported to have sold their charcoal to merchants at the production site and few ferried to Chebororwa Market.

5.3 Problems facing Charcoal Burners

On the problems facing charcoal production business, sample producers gave equal weight to the three eminent problems low supply of trees, lack of customers and permits and harassment in the production and movement. All the producers reported that A. gerardii on farms are fast dwindling and that remaining were small and scattered and cannot produce high quality charcoal. Most of the charcoal producers put fair and poor on future availability of A. geardi materials on

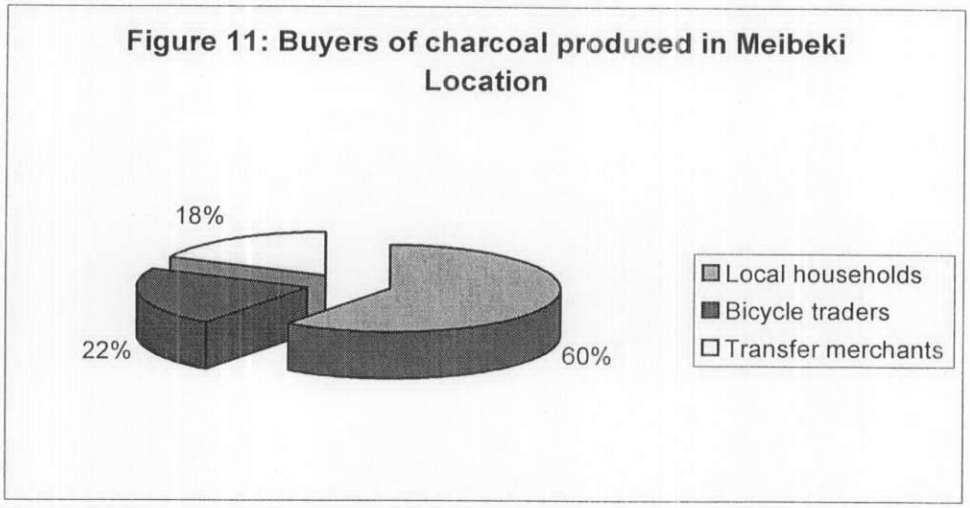
farms for charcoal production. On charcoal business, lack of buyers was more critical as it was cited by 83% of the sample producers and low prices being offered was reported by 17%.



All the producers viewed the future charcoal production activities in the areas as uncertain and were not sure when it would collapse. The combined falling number of trees on farms, permit procedures, low prices and lack of buyers makes the future of charcoal production bleak in the eyes of the sample producers.

5.4 Production site Charcoal Buyers

The main on site buyers of charcoal were local households, bicycle traders and distant merchants that transported the charcoal to Ziwa, Moiben and Eldoret Town.



6.0 Trade in Acacia gerardii Charcoal

6.1 Productions Characteristics

Charcoal production is a small-scale activity mostly from clearing of farms for pasture improvement or cultivation. Large-scale farmers may obtain permit for farm clearing purposes in rare occasions when large clearing is to take place. Such clearings are far apart and thus

unreliable source for traded charcoal. The output per activity is thus small ranging between 5-20 bags of charcoal.

6.2 Charcoal Market Chain

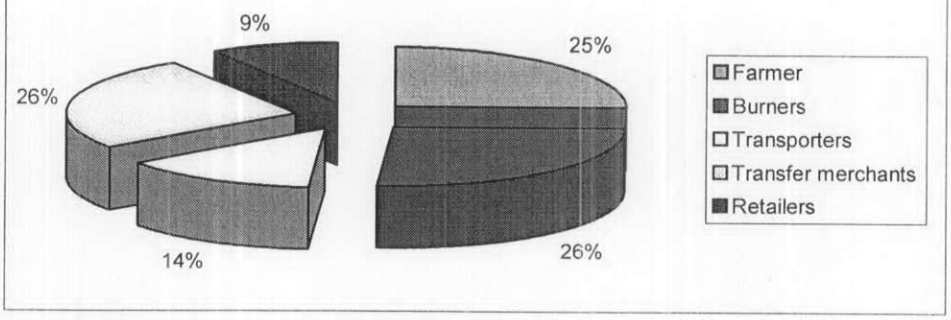
Most of the charcoal produced from A. gerardii in Meibeki Location is consumed locally mostly by civil servants and surplus is sold to bicycle traders who ferry them to Moiben and Ziwa for sale. The market chain is short and may undergo up to 3 stages: Farmer/burner-Transfer traders-Retailers-consumer. It is rarely traded in regional markets because of the stringent requirements in seeking permits. Some of the charcoal is transported to Eldoret by pick-ups mostly for personal use or for use in hotels and butcheries. This is because charcoal produced from A. gerardii is rarely issued with permits because it is a small-scale activity that may not warrant the cumbersome permit seeking procedures. Matatu operators fear to transport more than one bag of charcoal for fear of police harassment and sometimes vehicle confiscation.

Though charcoal from A. gerardii because of its high calorific value is regarded a premium product by households in Eldoret Town few downtown charcoal dealers stock it in their yards. This is due to irregular supply and poor quality control in the production and packaging process thus resulting in poor uniformity and high dirt content. This is attributed to lack of skilled charcoal burners and sometimes mixing of materials from inferior species with those of A. geradii in charcoal production. The traders reported that some producers sold them charcoal produced from inferior species that produce low heat output claiming to be from A. gerardii. Due frequent complaints from customers, most traders have opted to deal on a more uniform charcoal from black wattle to satisfy their customer expectations. The likelihood of police harassment on source of origin is reported to make traders fear transporting and stocking it as well.

7.3 Income Distribution from Charcoal Trade

The main players in the production-consumption chain in charcoal trade are farmers, burners, traders and retailers. During the survey the site price in Meibeki was Ksh 165 per bag whereas the retailing price in Eldoret was Ksh 330. The farmer and the burners operate on a 50-50 share of the site price and the transport cost was Ksh 50 to Eldoret Town. The share of consumer price received by most of the players in the production-consumption chain was relatively well distributed with farmers getting 25%, transfer merchants (26%), burners (26%) and retailers (9%). Since trees take up some portion of the farm that could have been used for agricultural uses for such a long time, the consumer price share of the farmer is relatively low to compensate them for the lost income opportunities. Most of the charcoal is produced from trees being removed to pave way to cultivation or improvement of pasture. Instead of hiring labour to uproot the trees, most farmers engage charcoal burners to do the work and as well earn some share from charcoal sales. The other players earn their incomes over a short time investment often in few weeks. The risks of arrest and bribes may explain the high shares earned by transfer merchants over the short distance of 60 kilometres to Eldoret Town.

Figure 14: Share of Eldoret consumer price from trade in charcoal produced from Meibeki Loaction



8.0 Discussions and Recommendations

Acacia gerardii is an important indigenous tree resource in the study areas that not only provide households with construction and woodfuel but also do generate income from charcoal sales. It has the ability to regenerate itself and thus save farmers from establishment costs associated with exotic trees. As compared to exotic trees grown in the area, A. gerardii is relatively slow grower but it does well within the climatic conditions especially the severe dry seasons and sandy soils prevalent in the area. Large-scale farmers can generate substantial incomes through selective harvesting of trees from their farms for charcoal production. However, most farmers have not fully exploited the potential benefits from management and sustainable production of charcoal from A. gerardii. The farmers revealed that better charcoal prices, freer environment in processing and marketing of its products and support in setting up of producer associations may encourage conservation and sustainable use A. geradii.

However, A gerardii is under pressure from expanding agricultural activities especially among smallholder farms. The market survey revealed that despite its high quality charcoal produced from A. gerardii is not popular with wholesalers and retailers in Eldoret due to unstandardized production procedures. This may be attributed to poorly skilled charcoal burners and production technology in use. Some of the handicaps can be addressed through field education and training of the principle players in the charcoal sector.

The situation is made worse by prevailing government restrictions on harvesting and movement of products from natural trees growing on farmlands. This makes investment in the sector a risk business thus preventing entry of entrepreneurs into the sector mostly in production, processing and marketing. Such development could not only inject skill and technology into the sector but as well improve quality and quantity charcoal outputs from the area. The predicament facing the A. gerardii sector in Meibeki is not unique but is replicated in the whole farm forestry sector in the region and the country. This is traced to archaic policies and legislations that are unfriendly to farm forestry investors in both time and space. The high costs are traced to the various permits that have to be sought from several authorities that are often far apart. These permits include letter of existence of trees on the farm, felling permit and movement permits. The series of authorities that have to consent include few or all of the following chiefs, DO's, DC's, OCPD, DFO, forester or DAO.

To improve income opportunities from charcoal production in Meibeki and the neighbouring areas may need some structural transformation of the sector through the following interventions and investments:

1. Scientific approach to management of A. gerardii tree crops for optimal charcoal production among other products.

2. More professional approaches in the production, quality control and packaging of charcoal for sale in regional markets.
3. Self-regulatory mechanism for management of production, processing and marketing of charcoal through some form of producers associations.

The above can only be done within a friendly policy and regulatory framework and hence call for speedy amendments of the existing statues or enactment of more farm forestry friendly policies and laws. The major objective of the changes is to focus on giving powers to the farmers to regulate their farm forestry decisions and as well make flow of farm forestry products from farms to markets less cumbersome and cheaper to all stakeholders in the forestry sector. Short of this changes will enhance further marginalization of farm forestry by landowners by diverting their resources into more rewarding agricultural farming.

3.5 ESTABLISHMENT OF DEMONSTRATION PLOTS AND ARBORETA AT KAMARA

By. Jonathan Njuguna, Juliet Wanyondu and Joram Mbinga

Introduction

Kamara demonstration site was started in year 2000 when Kefri Londian Centre requested for research land from the Kenya Forestry College. Two sites were suggested and after consultation with the research team we landed with Kamara which is 12 km through the forest road and 18km through the provincial road away from the Centre.

Kamara block has an area of 75 Ha and was under forest plantation before shambas were issued to the local residents (non residential cultivators).

Another 30ha was added which increased the area to 105 ha. The 30ha is situated in compartment 1 two kilometers away from the centre while Kamara is in compartment 7.

Work started in May 2000 by planting a boundary line of Eucalyptus grandis around the 75ha to demarcate the land.

The materials for planting were secured from Muguga and Turbo since we were not prepared. No other planting was done that year and a100% survival count was recorded.

In the part of that year a proposal was floated for funding in the consultative meeting and Ksh180000 was voted for the establishment of demonstration plots of various species and sizes. Serious work started in September 2000 by propagating materials for planting in year 2001 and to date seventy hectares of various species have been established.

Objective

To establish demonstration plots of high potential tree species for research, educational, training, and recreational purposes

Methodology

The study area is Kamara compartment No.7 of Masaita block. The area was clearfelled in 1994-97 and abandoned until the re –introduction of the non-residential cultivation (NRC) in 1998. For 2001 upto 2003 planting, the plots are established with the shamba system where NRC farmers were allotted half (1/2) an acre each. Since the NRC shamba system was suspended this year (2004), it caused us to adopt bush planting of this years plots and maintained by slashing and spot weeding a 1m radius around each plant.

Eucalyptus grandis has occupied the largest portion of land followed by *Pinus radiata* and the other species only occupy 1 (ha) each. The *grandis* are meant for fuel wood and peel log in future.

Establishment

There has been an increase in the number of species this year as we introduced *Casuarina montana*, *Eucalyptus sidexylon*, and *Cuppressus lustanica*. The species now stands at nine occupying an area of 1ha to 9ha.The total area under tree crop is estimated to be 4ha and this year alone saw a great expansion when 23 ha were planted. The breded own per spp per year is as indicated below

Year 2001

Alnus accumiata	(provenance Uganda)		1.0Ha
Eucalyptus grandis	"	Turbo	5.0Ha

Eucalyptus regnance	"	south Kinangop	1.0Ha
Pinus patula	"	Mondia South Africa	2 0Ha
Pinus radiata	"	Kaptagat	2.5Ha
Prunus africana	"	Londiani	1.0Ha
			12.0Ha

Year2002

Acacia melanoxylon	(provenance	Londiani	1.5Ha
Eucalyptus grandis	"	Turbo	6.0Ha
Pinus radiate	"	Kaptagat	6.0Ha
			13.5Ha

Year 2003

Cuppressus lusitanica	(provenance	Londiani	2.0Ha
Casuarina Montana	"	Muguga	1.0Ha
Eucalyptus grandis		Kaptagat	9.0Ha
Eucalyptus sideloxylon	"	Turbo	1.5Ha
Eucalyptus regnance	"	Timboroa	2.0Ha
Pinus radiate	"	Kaptagat	8.0Ha
			23.5Ha

Year 2004

Cuppressus lusitanica	(provenance	Londiani)	4.5Ha
Eucalyptus grandis (clones)	"	AHP Kericho	9.0Ha
Eucalyptus grandis	"	Kericho	2.0Ha
Eucalpytus globules	"	Molo	3.0Ha
Liquidumber	"	Turbo	1.0Ha
Pinus patula	"	Molo	4.5Ha
			24.0Ha

A small area is remaining which will be filled up next year. There is need therefore to request for more land for any future expansion. Our future plans will depend on the land made available to us by the college.

Annual assessment of Experimental plots

Assessment for height and diameter over time is important to monitor growth performance. Assessment for these two parameters should be done on a sample of trees in an established permanent sample plot. These assessment plots were established for each species. Trees are assessed twice in a year to obtain the mean height and diameter increments for analysis. There was a delay in some plot established in year 2001 and for the past two years they were not assessed. Trenches were dug on plots randomly selected. The sample sizes were 1/30 of a hectare and this gave a radius of 10.3m. Height and diameter measurements were measured in each plot established in year 2001and 2002 and their results is as shown below.

Results

In the plots established in 2001 the mean species height and diameter is as shown below

	Mean height	**Mean diameter**
Eucalyptus regnance	7.25M	7.89cm
Eucalyptus grandis	6.10M	6.25 cm
Pinus radiata	3.14M	3.78cm
Pinus patula	2.21M	2,27cm

Alhus accuminiate	2.91M	3.34cm

The mean annual height increament at age two for the species above is as shown below.

E.regnnance	3.625m
E.grandis	3.05m
P. radiata	1.57m
P.patula	1.15m
A.accuminiate	1.46m

This increment is far much below the growth performance obtained from other sites but the difference could be attributed to rainfall and timing of planting operations. There were general complains on poor timing as the rainfall has changed it pattern and has become rather eratic in this region for the last few years.

Since the assessment of these plots is continuous more data will be collected to ascertain this differential growth pattern.

Future plans

We intend to plant more indigenous species probably those that can be established into plantations. A two hectare plot of each of the under listed species will be established.

1. *Croton microstachys*
2. *Podocarpus latifolia*
3. *Fagara microphylla*
4. *Prunus africana*
5. *Hagenia sbyssinica*
6. *Vitex keniensis*
7. *Grivelia robusta*
8. *Casuarina montana*
9. *Bambo-setum*
10. *Juniperus procera*

The other trial proposed to be established is that of biomass production mainly for essential oil distillation which can be raw material for cottage industries in future.

This will comprise of 0.025ha of the species listed below.

Eucalyptus citriodola
Eucalyptus globulus
Eucalyptus maculata
Eucalyptus sideloxylon
Eucalyptus tereticornis
Eucalyptus regnance

The objective of the above trial would be to determine the looping regimes, biomass production and essential oils production capacity.

Way forward

Our aim is to increase the number of species and assess their performance although some had been proven elsewhere.

Indigenous species will be incorporated in order to give wide diversity and assess their performance, since there has been a lot of emphasis on the high value indigenous species.

Movements remain our bottleneck, as we have to cover long distance using the provincial road. This is only good during the wet season but if the forest road is graded, this could reduce the cost and time.
Feeder roads need to be graded and on bad sections quarry chips place to allow mobility always. Since the discontinuation of the shamba system, maintenance costs of the planted plots is expected to escalate. Silvicultural operations for established blocks will further increase the required financial resources. The stocking in the arboretum is not full because of incidences where NRC farmers were uprooting the seedlings especially the indigenous ones. *Eucalyptus grandis* that was planted in year 2001 require some attention due to its branching behavior. This was established on wider espacement which has encouraged heavy branching habit that is reducing their height growth. Some difficulties were encountered with some farmers who uprooted some of the seedlings and this has given this stand a diffence in height growth.

The centre is in the process of establishing a patrol base at Kamara in collaboration with the Kenya Forestry College in order to improve the security of the trials.

4.0 NATURAL FORESTS PROGRAMME

4.1 STUDIES ON THE ROLE OF MARKET SOLUTIONS TO NATURAL RESOURCE CONSERVATION AND MANAGEMENT ON FARMS: A CASE OF *JUNIPERUS PROCERA* IN MARAKWET DISTRICT.

Joshua K.Cheboiwo And David Langat

1.0 Introduction

Marakwet District is one of the 17 districts of the Rift Valley Province. It borders West Pokot to the North, Trans Nzoia, to the West, Uasin Gishu and Keiyo to the South and Baringo to the East. The district measures about 1709 Sq.km and consists of 4 divisions Kapcherop(462 sq.km), Chebiemit(509 Sq.Km, Tirap (529 Sq.Km) and Tot (209 Sq.Km). The district fall into three geographical zones the highlands, plateau and Kerio Valley. The rainfall in the higland range from 1,000mm to 1300mm, escarpment 850mm to 1000mm and valley less than 850mm. The plateau measures about 2800m above sea level that rises to about 33500m at Cherangany Hills. Kapcherop, Tirap and Chebiemit divisions covers most of the Cherangany Hills that hosts the bulk of the public and private forests in Marakwet District. Cherangany Hills forms an important watershed in Western Kenya, western escarpment is an important source of rivers that drain to Lake Basin Moiben and Chepkaitit), those that drain Northwards to semi-arid lands include Kerio, Chesegon, Embobut, Embomon, Arror and Morun, The population of Marakwet District was 156,303 in 1999 and was estimated at 169766 in 2001. Kapcherop, Tirap and Chebiemit that cover most of Chrangany Hills account for 77.5% of the population in Marakwet District. Highlands is a rich agricultural areas producing such crops as maize, potatoes, wheat, tea, pyrethrum. Livestock include improved and traditional beef producing cows, wool producing merino sheep and traditional sheep. Kerio Valley is classified as marginal agricultural potential zone and main crops grown include maize, millet,cotton and horticultural crops under irrigation. Livestock activities include beef cattle and goats.

The district is rich in forest resources most of which are gazetted and occupies 128760 hectares. The forest administration stations include Chesoi, Cheptongei and Cherangany. Forest blocks include Kiptaber, Kerrer, Kapkanyar, Embobut, Koroit and Chemurgoi Public forest boundaries exhibits some zig zag and have long boundaries with private farms and sometimes separated with corridor of farms. Private farms host significant natural forests mostly on hillsides and river courses. Among the important indigenous trees tp be found on both public and private forests are Africa Pencil Cedar(J. procera, East Africa Yellow Wood (P. latifolius), Mueri(P. africana) and Mkorombozi (Hagenia abyssinica). However, poaching of valuable roundwood mostly from Cedar and podo and many other species is rampant due to high market demand for sawnwood and Cedar posts in Western Kenya. Unlike other districts, planting of cypress is widely adopted in Marakwet District where it is grown to mark boundaries and enclose homesteads. The district is also characterized by deep gorges cut by fast flowing tributaries of various rivers and steep sloping farmlands. These two features enhanced by low population density and relatively large farms has made some farms the district among the leading in conservation of high value trees mostly podo and Juniperus procera along steep river belts that cut across farmlands and gorges along streams. Farming along steep river gorges and hill sites is unfavorable due to high soil erosion and need for intensive terracing. Most households migrated to settler district of Uasin Gishu and Trans Nzoia in 1960's and 1970's thus abandoning their steep farmlands mostly in Kondabilet, Kabelio, Sumbeiywet and Kipkundul among other areas. For unknown reasons dense natural regeneration of Juniperus procera has engulfed most farmlands to add to those retained

along river belts thus making farms to have some of the densest Juniprus procera on farmlands in some of the study areas. The natural regeneration is still ongoing and has high potential to expand to occupy larger areas of farmlands in the future.

However, demographic changes taking place may halt such developments. There has been an increase a marked increase of population across the district due to insitu population growth and return of more families from settler districts. Apart from domestic food needs market opportunities for several horticultural crops in the region have encouraged more farming activities than before. These new development has brought into conflict the conservation culture of the local population and the need for increased farm outputs hence clearing of more forested sites to create cropping land. The scenario is made worse by failure of households to generate some income from sale of J. procera products due to prevailing restrictive regulatory procedures and risks related to harvesting and marketing of farm forestry products. Most farmers have resorted to burning of trees and products in excess of their domestic needs. In some cases Cedar trees are converted into low value uses such as fencing splits and firewood despite the high demand for Cedar products in regional markets. The district has very high potential to supply large amounts of Cedar posts and sawnwood from mature Cedar trees and polewood from young trees. These products have high demand in the regional markets such as Eldoret, Bungoma, Nakuru, Kitale and Kisumu. The durability of Cedar posts has made it a popular product for fencing and construction activities among farmers and estate developers in the region.

2.0 Problem Statement

There is eminent conflict between farmers financial and subsistence needs from existing land base and the need to conserve high value natural species such as Cedar. The future of Cedar on farms may depend on some policy interventions that minimize the land use conflicts while maximizing the farmer's financial objectives. Such strategy may involve market-based solutions that ensure that the farmers get full benefits from its conservation efforts. Recent farm forestry development approaches have concentrated on material subsistence and intangible benefits. Although such approaches may have positively influenced tree planting and conservation culture among land owners, current situation where over 46% of Kenyans are classified as under poverty line (GOK, 2001) may call for new approaches that address poverty among land dependent rural population. The potential role of market based conservation approaches in natural resource conservation is least understood at the moment. However, its basic theory is simple, create markets for tree products in order to increase the value that landowners place on it and hence motivate them to conserve and manage trees better. Those who benefit may be more inclined to invest in the protection of Cedar seedlings and tree stands. However, high prices is also known to accelerate harvesting thus may have contrary results than those expected especially for Cedar from public and communal properties. Other factors known to inhibit farmers from realizing full benefits include poor infrastructure, imperfect trade, credit squeeze, punitive policies and regulations that impose greater costs in the marketing systems and ensures that those who overcome barriers benefit more than the resource managers.

3.0 Project Goal/Purpose

Promote market driven conservation of Juniperus procera on farms through efficient processing, utilization and marketing of its various products.

3.1 Broad Objectives

To evaluate the potential of market based conservation approaches in the promotion of Cedar on farms in Marakwet District and its replication elsewhere in the country.

3.2 Specific Objectives/Activities

1. Do a reconnaissance survey in the district to select study locations
2. Carry out socio-economic survey on households having Cedar on their farms in selected locations in Marakwet District.
3. Carry out sampling survey of Cedar stands on farms in selected locations in Marakwet District in order to quantify Cedars resources on farms
4. Evaluate the traditional attributes and government policies that promote conservation of Cedar on farms.
5. Study markets and marketing systems for Cedar product in western Kenya
6. Evaluate existing policies and regulatory structures that affect trade in Cedar products.
7. Hold participatory workshop for selected to discuss way forward in the conservation of Cedar on farms.

4.0 Expected Outputs

1. Documentation of the extend Cedar conservation on farms in Marakwet District.
2. Document traditional attributes and government policies that motivate farmers to conserve Cedar trees on farms.
3. Evaluate the potential of market based conservation strategies on the promotion and conservation of Cedar on farms
4. Evaluate the impacts of existing trade and regulatory policies on the conservation of Cedar on farms.

5.0 Benefits and Beneficiaries

The study is aimed at promotion of sustainable production, utilization and marketing of Cedar resources to meet household subsistence and market demand in Western Kenya.

The development is expected to provide some exciting tools of promoting biodiversity conservation of high value native trees on farms in Western Kenya.

6.0 Study Methods and Sample Frame.

The survey work done in October 2003 involved three components, Socioeconomic survey, forestry resource survey and marketing survey. The two surveys were done concurrently on the selected farmers and farms.The survey was carried out in Kapkochur Location of Kapcherop Division around Kipgundul Hill in Lelan and Kapkochur sublocations. The sample area is located in Kipgundul Hill, which is one of the heights among the many series of heights in Cherangany Hills with an average height of about 3400m above sea level. The stratified sampling procedure was adopted where the sample area was divided into three transects to cover the households along the major water streams, middle upland and those at the hillsides. Forestry resources generally differed mostly in composition across the farm transects but glades and open spaces were more abundant on the upland and hillsides than riverside transects. Random visits to each of the farmers in the selected transects was done and the selected farmers were interviewed and their on-farm forestry resources sampled. The survey team interviewed 53 households using a structured questionnaire that included household characteristics, income opportunities and forestry land use activities. The forestry resource survey measured regeneration and sizes of dominant species.

The marketing survey involved some random interviews with Cedar owners, post contractors, transfer merchants and wholesalers in Kisumu and Bungoma. The surveyed was intended to capture the gate price of roundwood, processing costs at the farm, transfer costs and wholasle prices at the major destination outlets in the region.

6.1 Forest Resource Sampling

Point sampling was done at the farm level where the plots were established on the portion of the farm- forested. Temporary sample plots of (20mX20m) were established to capture tree information: species composition, tree mensurational characteristics (tree- shape, Diameter at breast height (Dbh) and height), other information noted included the tree growing niches, age of the tree, regenerations, saplings and human impacts. The tree information was captured using the data sheets as shown in appendix 1.

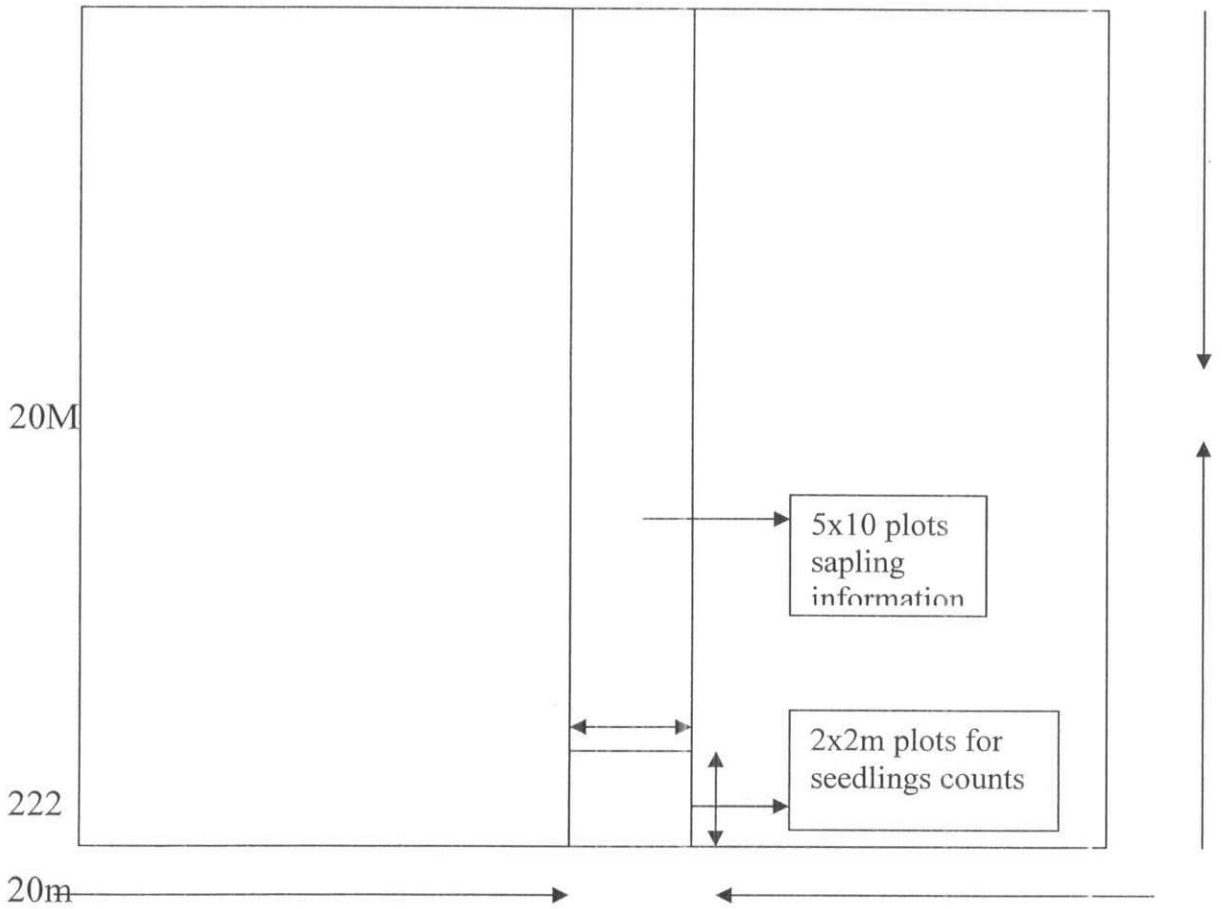


Fig 1: Schematic representation of plot lay –out in the field for data collection

7.0 Study Results.

7.1 Households Characteristics.

The mean age of the household head was 49 and mean number of household members was 5 but some household had up to 30 members. Most of the sampled households have been in the area for an average of 45 years. Households on average owned about 27.2 hectares a relatively large piece of land and as well owned about 4.4 hectares elsewhere mostly in Uasin Gishu District. The prevailing price of land was approximately Ksh 70,000 per hectare

Table 1: Descrptive statistics of Sample Households

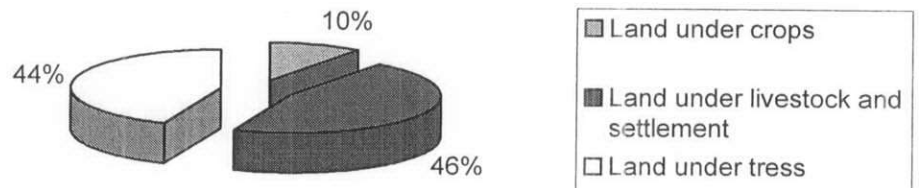
Characteristic	Sample number	Mean
Number of family members	49	5
Number of children under 18 years	49	4.8
Age of household head	49	49
Year of settlement	49	45
Land size per household	49	27.2 ha
Average price of land per ha.	49	70,000

8.2.2.0 Agricultural activities

The study area is classified as high altitude zone experiencing low and cool temperatures throughout the year. In early 1960's and 1970's when white settler farmers left Uasin Gishu and neighbouring districts most of sample households purchased land from the settler areas and out-migrated in large numbers. When wool markets collapsed in 1970's most farmers abandoned merino sheep keeping and concentrated on maize and wheat farming in their alternative farms in settler in the former areas. However, the populations of migrant families in Uasin Gishu and other settler districts have steadily increased over the last decades forcing some family members to return Lelan. The main on-farm economic activities are mostly forestry and agriculture. Sheep keeping has emerged in the last three years when wool markets for textile industry peaked up and households are currently opening grassland and restocking sheep.

The sample household land use distribution results show that livestock and settlements accounted for 46% of the total land area. Land occupied by trees was second accounting for 44% and whereas land under crop was least accounting for 10%. The average agricultural incomes amounted to Ksh.85835 of which livestock accounted for 51% and crops 49% of the total.

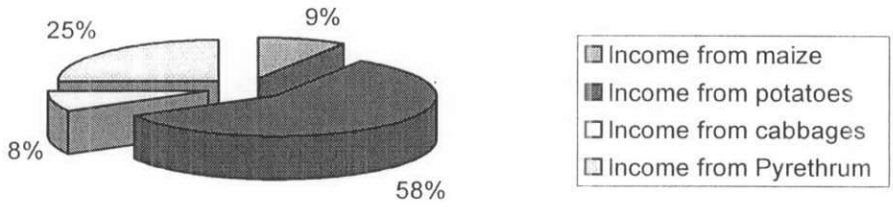
Figure 1: Land use distribution in the sample area



The agricultural crops grown by sample household include maize, potatoes, cabbages and pyrethrum. The area being high altitude is marginal zone for maize farming but because it grown by most households in the are because it is a stable food for most households in the area despite the long period that it takes to mature and low yields. However, potatoes, cabbages and pyrethrum do very well in the region and are the major cash crops. The leading crop in income

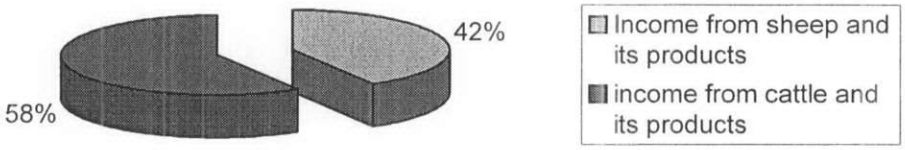
generation among the sample households was potatoes (58%), followed in that order by pyrethrum(25%), whereas maize and cabbages followed in that order.

Figure 2: Household incomes from sale of crops



The sample households kept mostly cattle and sheep, on average each household kept about 24 cattle of both hybrids and local types and 55 numbers of sheep. The area is too cold for traditional goats and non-was kept. In 2002/2003 season each households sold on average about 29 cattle and 12 sheep generating an income of about Ksh 42723 with Cattle accounting for 58% and sheep 42% of the income respectively.

Figure 3: Household income from livestock



9.0 Natural Tree Resources On-Farms

9.1.1 The Status of African Pencil Cedar (Juniperus procera).

9.1.1.1 Composition of tree resources on farms

There are substantial forest resources in Lelan, area. Most indigenous species are found on the farms. Tree species such as *Juniperus procera* are found scattered or in extensive clusters and in some cases, covers a sizeable proportion of land in individual land holdings. The forested area is slightly above 40% on average for individual farms. Sixty percent of the forested area is covered by cedar and forms about 20% of the total acreage in the study area (Fig 15).

Fifure 14: Relative Occurance of some indigeneous species recorded on farms in Lelan, Marakwet District

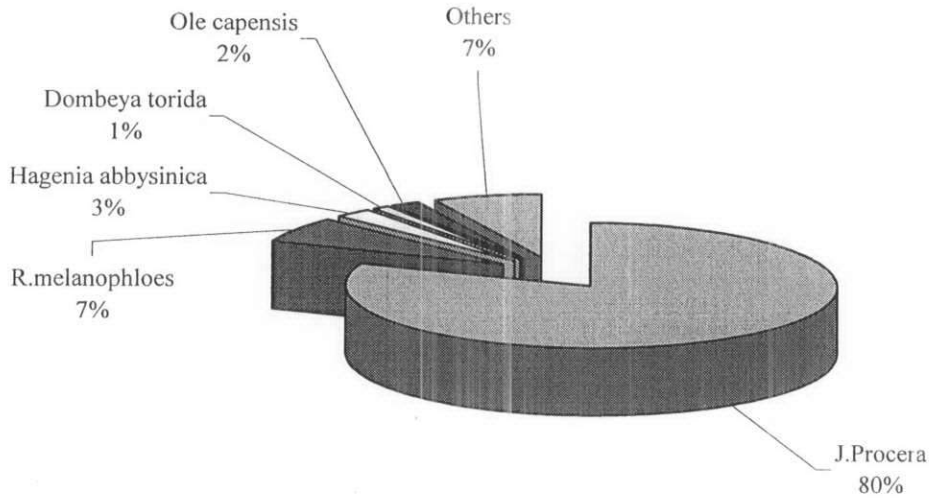
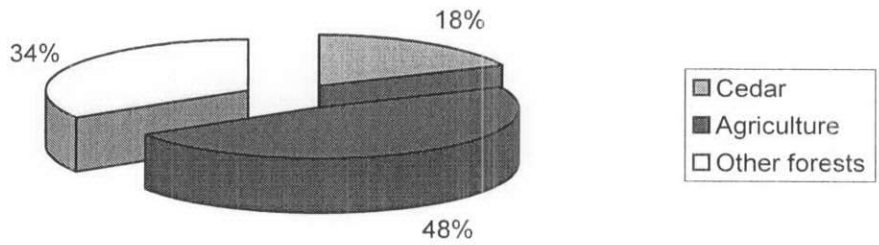


Figure 13: The proportion of household land under various land uses in Lelan, Marakwet District.



The other species found in the area are: *Rapaenae Melaphloes, Hagenia abbysinica, Dombeya torida,and olea capensis.* Juniperus procera is the most dominant species on farms. The occurrence is plentiful and regeneration has been prolific in recent years. It is dominant in both stages of sapling and seedling in the farms surveyed. According to local area residents- there has been prolific regeneration of Cedar in recent years and the farmers are frustrated by the apparent invasive nature of the species on their farms. The locals, though having plentiful of tree resources on their farms cannot dispose off the cedar resources, due to the ban on the exploitation of indigenous species. Figure 13 and Table 2

Table 2: Characteristics of farm tree resources in Lelan, Marakwet

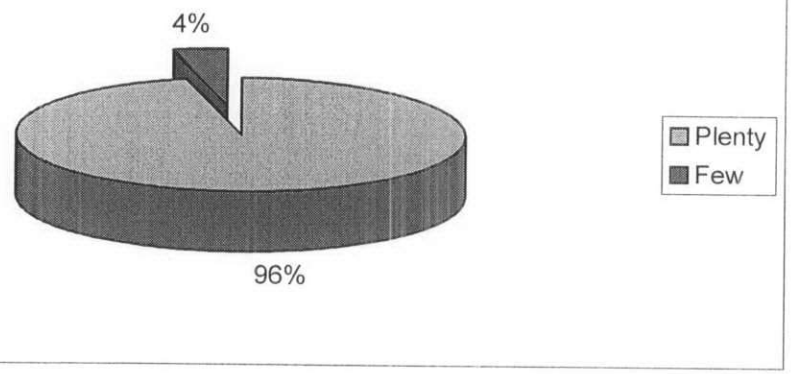
Tree Species	Volume m3	DBH (cm)	Height (m)
Juniperus procera	0.731(.13)	25.37(17.73	19.00(9.28)
Olea capensis	0.864(.10)	51.77(26.08)	30.69(13.66)
Ficus natalensis	0.874	45.00	30.00
Rapaenae melanophloes	0.751(.11)	30.93(33.67)	16.09(9.03)
Nuxia congesta	0.787(.11)	32.50(20.85)	15.50(5.74)
Euclea divinorum	0.52	9.00	8.00
Maythenus heterophylla	0.597(.05)	11.50(2.12)	2.00(.00)
Hagenia abbysinica	0.862(.08)	50.28(27.08)	26.67(9.82
Dombeya torida	0.871(.06)	48.75(20.38)	28.25(7.96)
Total	0.745(.13)	27.78(20.77)	19.38(9.57)

9.1.2 History of Cedar on Farms

9.1.2.1 Evolution of Cedar on Farms

Most responds reported that there were plenty of Cedar on their farms during childhood or time of settlement(96%) .

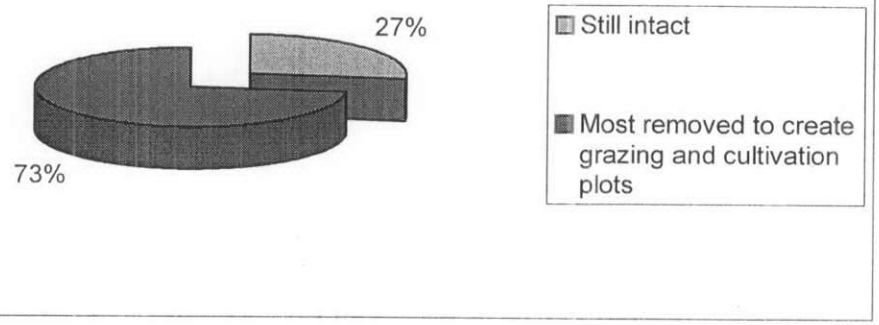
Figure 15: The population of cedar during childhood or settlement



9.1.2 Cedar Population Trends

On the Cedar population trend on the farm, 27% reported the most of the Cedar trees are intact whereas 73% reported significant removals to create pasture and cultivation plots.

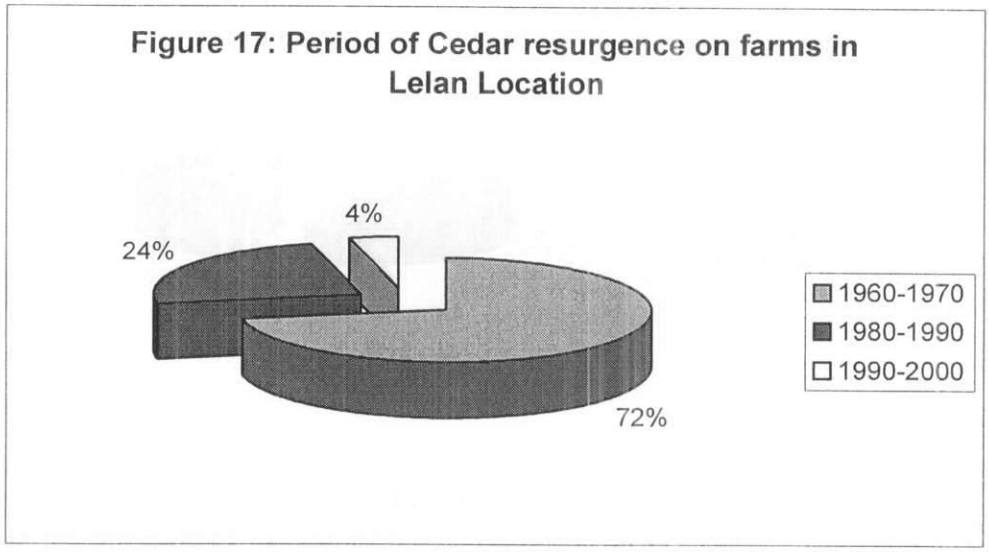
Figure 16: The population of cedar during childhood or settlement



9.1.3 Resurgence of Cedar

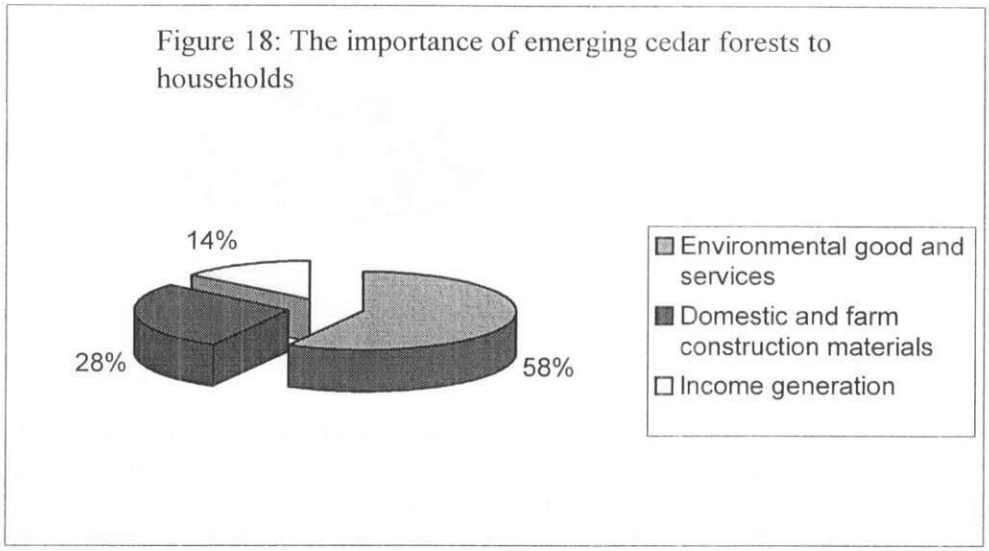
Households reported that the most prolific emergence of young Cedar stands on their farms was in between 1960 and 1970(72%), between 1980 and 1990(24%) and 1990-2000(4%). The reasons offered by the farmers were that out-migration in 1960's reduced grazing and cultivation activities in the sample area whereas in 1980's the collapse of wool markets reduced drastically the number of merino sheep and as well the general economy of the study area. More people migrated to the former settler farms to seek new income opportunities and many farms were left to aging farmers or abandoned. However, with declining economic opportunities in former

settler areas and emergence of wool markets and horticultural produce has attracted more people in the last decade leading to more land being opened for pasture and cultivation of crops.



9.1.4 Environmental and Socio-Economic Importance of Cedar

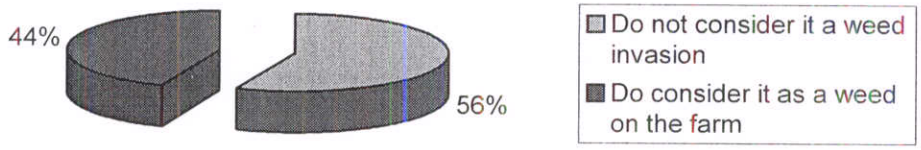
Households reported that the emergence of Cedar on their farms will be of immense benefits to them in form of environmental goods and services(58%), domestic and farm construction materials (28%) and income generation(14%).



9.1.5 Impacts of Cedar on On-Farm Activities

On the view of the proliferation of Cedar trees on farms, 56% of households did not consider it as a weed problem whereas 44% reported to that it is a menace and can be considered along side other infectious weeds and need for their control.

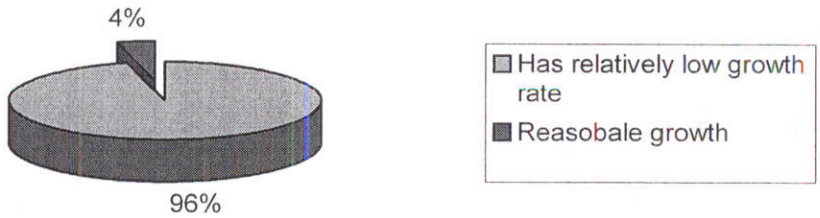
Figure 19: The views on proliferation of cedar forests on farms



9.1.6 Comparative Growth of Cedar

On the question of growth of Cedar on farms, as compared to Gravillea or cypress most farmers considered it as slow (96%) and only 4% referred it as reasonable.

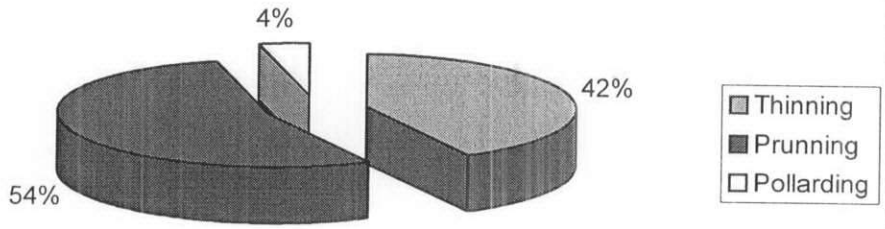
Figure 20: The growth rate od cedar as compared to Gravillea or cypress.



9.1.7 Silvicultural Operations on Cedar

The majority of the farmers reported to have carried some management operations to improve Cedar stands on their farms. Some 42% of the sample households reported to carry out thinning, 54% pruning and 4% pollarding to reduce it competing with pasture or agricultural crops.

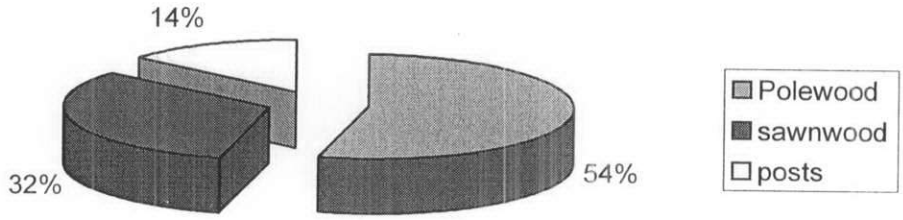
Figure 21: Management operations carried out by the households on cedar trees on the farms



9.1.8 Important Cedar products

Most households reported that they expected to harvest polewood from their Cedar trees (54%), 32% expected to produce sawnwood whereas 14% were expecting to split some posts from the Cedar tree on their farms.

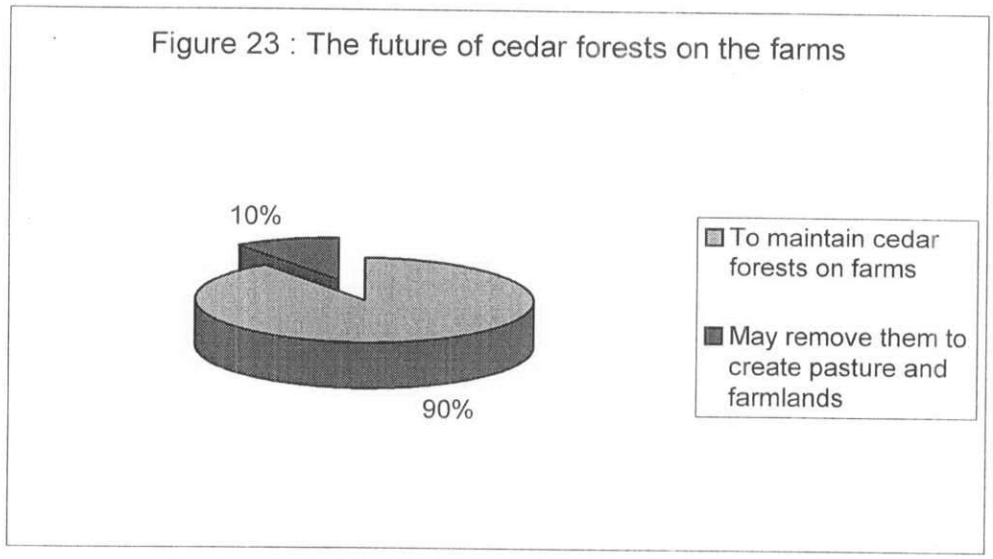
Figure 22: The important product expected from cedar forests on farms.



10. Future of Cedar on Farms

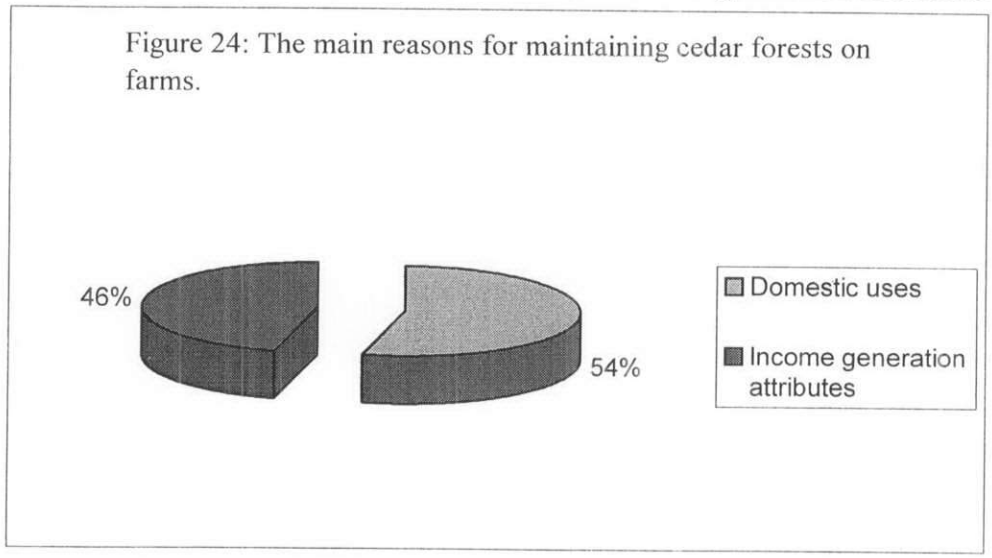
10.1 The Household Projections

On the question of the future of Cedar trees on the household land, majority (90%) reported that they will maintain them and only 10% reported they are planning to reduce them to create room for pasture and cultivation land.



10.2The Reasons Maintaining Cedar On-Farms

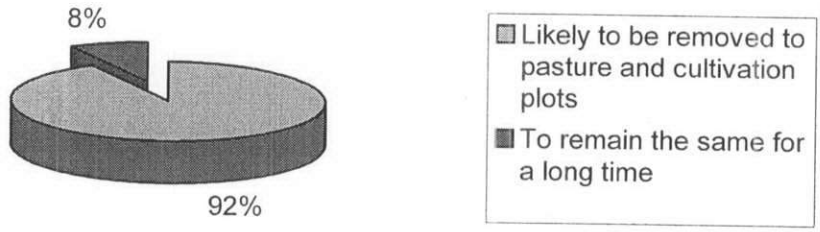
On the main purpose for retention of Cedar forests on farms, 54% of the sample households cited its importance for domestic use and 46% cited income generation attributes.



10.3 Impacts of Farming Activities on Cedar on Farms

On the future of Cedar trees on the farms with the increasing population of family members on the farm, 92% reported that they are likely to be cut to create room for pasture and cultivation plots whereas paltry 8% expected the population to remain the same for some time to come.

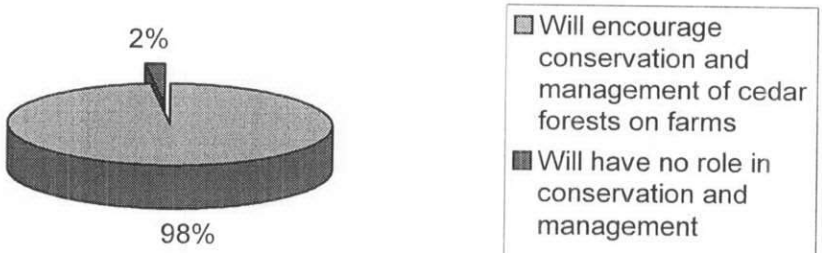
Figure 25: The future of cedar on the farm with increasing family members dependent on the farm.



10. 4 Impacts of Good Prices on Conservation of Cedar

On the impact of good Cedar prices on encouraging conservation and management of Cedar forests on farms, 98% reported that it will encourage them and only 2% reported that it would not have any role.

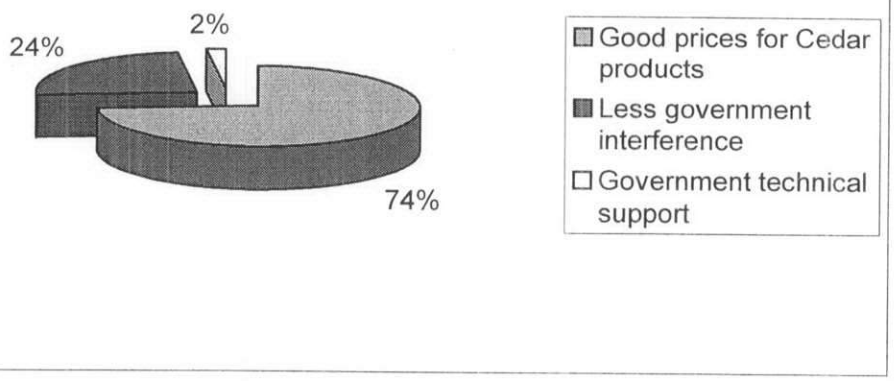
Figure 26: The influence of good prices for cedar product on future conservation and management cedar on farms.



10.5 Factors that Encourage farmers to Conserve Cedar

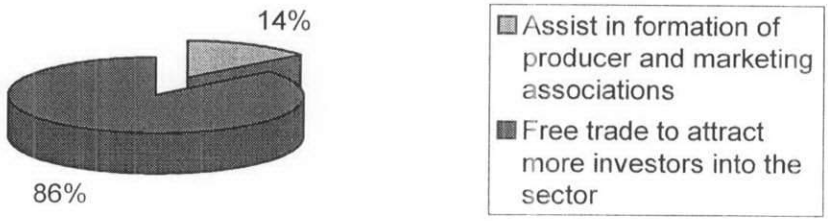
On the factors that will make a farmer to continue with the conservation and management of Cedar forests on their farms into the distant future, 74% of the households reported that good prices for Cedar products, 24% cited less interference by government on Cedar activities to include trade and paltry 2% cited some technical support in management and processing of Cedar on farms and marketing of Cedar products from farms.

Figure 27: Some sugesstion to encourage farmers to conserve Cedar On-Farms



In order to popularize Cedar management and conservation on farms in the region, 86% of the sample households wanted the government to allow free trade to attract more investors and merchants into the sector, and 16% wanted the government to assist them to form producer associations to market Cedar products in distant markets thus earning them more money.

Figure 28: Government support to encourage conservation of Cedar on farms

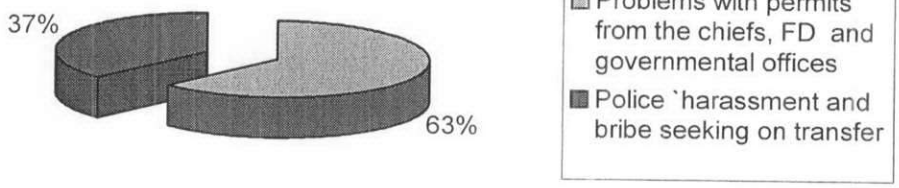


11.0 Markets and Marketing of Cedar Products

11.1 Problems in Harvesting and Transfer of Products

All the sample households reported to encounter some problems in harvesting and processing of Cedar trees on their farms (100%). On the nature of problems, 72% had problems with permits and 28% reported on harassment and bribe seeking by police when transporting Cedar products for use on their other farms or for sale in distant markets.

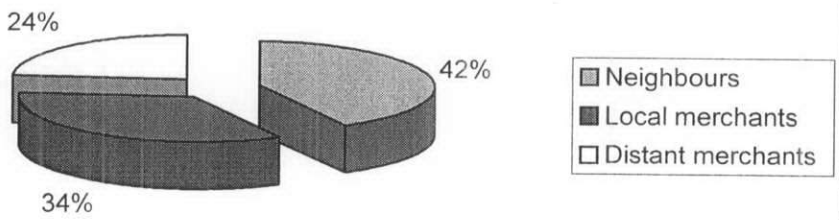
Figure 29: Problems encountered by households on harvesting, processing and transfer of cedar products.



11.2 Current Buyers of Cedar Products

The households reported that they main buyers Cedar products were neighbours (42%), local merchants (34%) and distant merchants (24%). Though the neighbourhood trade is still predominant in the area, the entry by both local and distant merchants is significant and attests to the increasing trade on cedar product. However, there is more room for entry of more consumers to enhance competition and overall demand for the various products Cedar products.

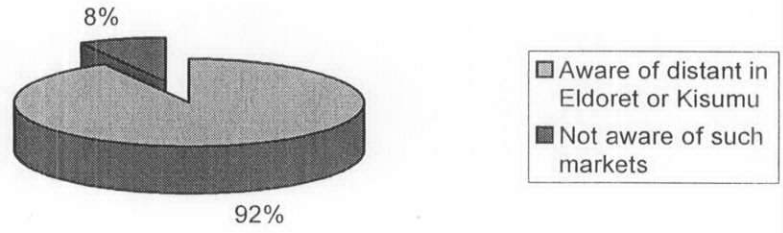
Figure 30: Main buyers of cedar product from farms



11.3 Household Market Awareness

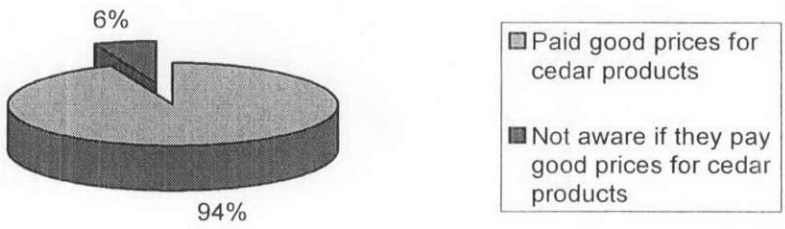
On the awareness of markets for Cedar products in Eldoret or Kisumu, most households reported to be aware of such markets and only 8% reported to be not aware.

Figure 31: Awareness on distant markets of Cedar products in Eldoret or Kisumu



On the price expectation in distant markets, 94% reported that they offer good prices as compared to local buyers whereas 6% were not aware if such markets offered good prices or not.
This is an important revelation on the access of households to market information. Thus liberalization of trade in Cedar products will not only enhance farmers bargaining powers but also their participation in regional markets and incomes from sale of Cedar products.

Figure 32: Price information for Cedar products in distant markets



12.0 Markets and Marketing Opportunities for Cedar Products

12.1 Existing Opportunities.

There are three main tradable that have high demand in local and regional markets. These are posts, sawnwood and poles. Polewood has limited market outside the farms and rarely traded outside the study area. Shingles from Cedar bark and wood has increasingly become popular roofing of houses in the study area. Cedar sawnwood is not a popular structural material in the construction industry as compared to those from podo, Hagenia, and cypress and thus rarely traded in the region.
The most important product for trade is fencing posts that are in very high demand in regional markets for use in fencing farms, residential estates and houses in urban areas. Its ability to endure moist conditions, termite attack and ease in nailing makes it a first class fencing material.
There is severe shortage of Cedar fencing posts in the region and stockists and property developers are now switching to inferior Eucalyptus posts. In contrast farmers frustrated by

prevailing punitive and restrictive government decrees on processing and trade in Cedar products have resorted to burning large Cedar trees on their farms to kill them to free land for use in agricultural activities.

The restrictions by administrative prohibitions and decrees on Cedar felling and processing led to closing down of lucrative tiling and saw milling enterprises long time ago due uncertainty in procurement of raw materials and ability meet customer orders.. These enterprises used to produce premium sawnwood floor tiles and other valuable products for specialized markets and even export. These developments have left Cedar with no competitive market except conversion into low value and wasteful fencing posts by local artisans using crude tools. Urgent remedial measures for reviving Cedar based industries may involve investments in well-equipped micro-enterprises to process Cedar materials into fancy products.

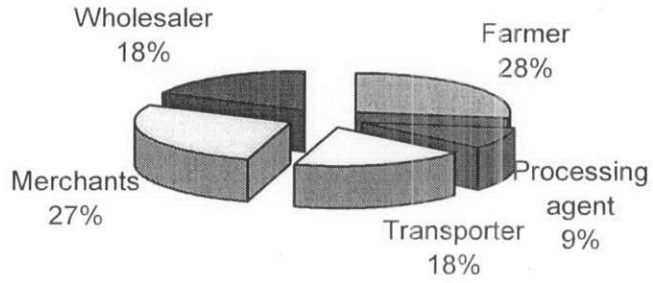
12.2 Distribution of income and marketing efficiency in Cedar Trade

There is general difficulty in movement large consignment of Cedar posts from farms to large regional markets such as Kisumu by farmers and small-scale traders. The business is being undertaken by well connected and risk taking traders. These traders prefer large markets that can purchase lorry load of between 1000-2000 posts on delivery that not only reduces risk but also enables them to cover the large bribes that have to be paid on the routes. However, farmers, small-scale and large property developers in Eldoret and other urban areas of North Rift can get posts on orders from various small scale traders through porous routes.

Figure 33: Graphic illustration of a typical Cedar post marketing channel from Marakwet District to Regional Markets.

The distribution of the consumer price of consignments delivered to Kisumu indicate that a farmer in Marakwet received relatively low income (28%) as the rest are shared among on-farm processing agents (9%), transfer merchants (27%), transporter (18%) and wholesaler (18%). The farmer's share may not fully compensate for the cost of keeping the tree on the farm for such a long time thus indicating that the marketing system penalizes the farmer more that it encourages.

Figure 34: Share of consumer price at Kisumu among producers, processors and markets agents for cedar posts



Farmers though aware of good prices being offered in regional markets are discouraged from taking such advantage to increase their share of consumer by complex procedures in seeking permits and unknown obstacles to be encountered enroute to these markets. The merchants are well informed on procedures for seeking permits and well connected to overcome any obstacles on the route to regional markets at some reasonable costs in terms of bribes. Thus extra transfer costs in terms of time and financial outlays being forced into the marketing system penalizes the farmer and consumers as the two principal players the merchant and wholesaler try as much to maintain their trading margins. The existing regulatory framework is hostile and punitive to emergence of vibrant trade in Cedar products in the region as it introduces rent seeking and other inefficiencies in the marketing system. At its current form the marketing system may not provide any motivation to the farmers to conserve Cedar on farms on the expectation of household welfare improvement. Freer marketing environment will encourage competition and development of newer products and markets for Cedar products that will in the long run improve incomes flowing back to the farmer.

4.2 SUSTAINABLE UTILIZATION AND CONSERVATION OF CHEPALUNGU NATURAL FOREST – DEVELOPMENT OF A PARTICIPATORY MANAGEMENT FRAMEWORK

By David Langat

1.0 INTRODUCTION

1.1 GENERAL INFORMATION

Chepalungu natural forest is the only remaining natural forests in Bomet district. It is experiencing immense human pressure and can be described as highly degraded (Langat et al 2003). It is a remnant semi-deciduous forest, which, originally composed of Oleas and Cedar.
Chepalungu forest is administratively divided into two management blocks, Kapchumbe and Siongiroi; each block is under a forester. Kapchumbe block covers 70% of the Chepalungu forest and is mainly composed of indigenous vegetation while, Siongiroi with only 30% area coverage has planted forests of Pines and Cypress (106.ha) and natural forest.
This forest is a source of tributaries of Mara River. The forest has served the adjacent communities to meet their basic needs especially for fuelwood and medicine; however, the immense pressure now exerted on it - is jeopardizing its integrity as a source of forest products and services for the local population and other downstream areas. This forest has been under constant pressure by adjacent communities. The areas surrounded by human settlement are highly degraded and the users are currently experiencing shortages of wood products and have to travel long distances in search of these products.

1.2 MOGOR LOCATION

Mogor- location is one of the locations bordering one block of the forest to the southern-Kapchumbe. The area has a population of 7,350 with 1000 households (Malel[1], 2003 pers.comm.). The location has 3 sub locations (Kataret, Cheboyo and Mogor) each headed by an assistant chief. There are 21 villages in the location and covers area of about 20km².It is in southwestern part of Siongiroi division and borders Chebunyo location to the east and Transmara district to the south–Oldirkir/Emarti- areas experiencing immense shortage of wood products.

1.2.1 SOILS

The villages, which border the forest, experiences bimodal rainfall and has predominantly loamy (Sandy clay loam to clay loam) black cotton soils. The area is good for maize, millet, onions, vegetables, coffee, and sugarcane, beans and sweat potatoes.

1.2.2 LOCAL ETHNIC COMPOSITION

The area is inhabited by Kipsigis and most (nine in ten are original settlers) who are mainly mixed farmers.

[1] Area Chief Mogor -Location

IMPORTANCE OF THE SELECTED AREA

Mogor location borders, the Chepalungu forest to the south east-and the adjacent villages collect forest products from Chelelach beat. The level of destruction in this part of the forest can be described as mild and there is low level of charcoal making prominent in other parts of the forest (Langat et al. 2002). The portion of the forest is also exposed to pressures from outside the area due to shortage of wood products in Kapkesosio and parts of Transmara district. The forest adjacent communities are receptive to forest management and there have been development interventions in the location especially in Cheboyo. There are nascent community based organizations in the area that have started conservation activities. Due to rising population within the immediate settlement and other areas - there is anticipated demand for forest products and this will place more pressure on the already degraded forests.

Why community participation in forest Management?

Although, there is mechanism for controlled use of state forests resources in Kenya under the present Forest Act (1968)[2], the lack of enforcement of laws and regulations, among others, has exposed these resources to degradation. In most cases, it is difficult to differentiate between state controlled and open access forest resources.

There is a growing concern that with diminishing natural resources, there is a need to devise an equitable framework for partnership between the various stakeholders (users) of the resources in the management. This is based on the principle that the resources will be more rationally utilized if the ownership and participation is recognized, especially among the people who are likely to lose more if the resources are diminished.

New Forest Policy and Forest Bill have been formulated and await Parliamentary approval. It is anticipated that once the Government and Parliament endorse the policy, it will set stage for the enactment of the Forest Bill to change the present Forest Act – which has been a big impediment to forestry development. The new forest policy and Forest Bill 2004 recognizes the communities as partners in sustainable development of natural resources (Forest Bill 2004).

The new forest Bill seeks to legalise the local community participation in the management of forest resources but does not however underline the modalities of involving them. The Bill is silent on how local communities will be involved in decision making, provision of protection services, reforestation activities and how the benefits and costs are to be shared.

In addition, the Bill is silent about who constitute the local community around the forest areas and what criteria will be used to qualify the various stakeholders. It is therefore essential to develop a model framework for initiating and implementing a community participation in forest resource management. The selection of this forest was therefore to gain some understanding on the likely role of the local forest adjacent communities and to study their level of dependence for income and subsistence.

2.0 PRA METHOTHOLOGY

The study was undertaken using PRA and household surveys. In the PRA component- knowledge about the forests, historical transformation, livelihoods of the people, perception of the people towards the resource degradation and how the local community has coped with the diminishing forest resources.

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[2] There is a new Forest Bill awaiting discussion in parliament and proposals in it are expected to substantially change the old Forest Act of 1968

In the PRA exercise, the following data or information was acquired: **spatial data**-sketch mapping, **temporal data**-time related data, trend lines, historical profiles and seasonal calendars and **social data**- institutional analysis, livelihood mapping, gender analysis and the data or information was synthesized together with the community so that we could visualize the notable problems and particularly those related to forests resources management and use.

2.1 HISTORICAL TIMELINES AND TRENDS

The local community through probing outlined the major historical events that have influenced and impacted on their lives and development of Mogor –location since first settlement around 1800. The local community scored the trends of the main local parameters on a 5 –point scale over major periods. The following important parameters were assessed: population size, land size, food production, tree resources, water availability and income.

2.2 SEASONAL CALENDER

The local community with guidance of the research team mapped the various cyclic events (activities) that occur or are done during a normal year.

2.2.1 GENDER CALENDER

The community was grouped by gender and each was guided to draw a daily calendar. This covered all the activities performed on daily basis- from the time one wakes up in the morning to the time one goes to bed.

2.3 LIVELIHOOD MAPPING

The community discussed and listed all the resources they use for their livelihood. These resources included food and other non-food resources. The community was by consensus asked to indicate the sources and availability of these items within and from outside the community.

2.4 INSTITUTIONAL ANALYSIS

Guided by the research team, the community members listed all institutions operating in the area and discussed the roles of each institution. These institutions were ranked using different sizes of stones- to indicate services rendered and accessibility of these services from the perspective of the local community.

3.0 RESULTS

3.1 HISTORICAL BACKGROUND

3.1.1 Introduction

Local community neighboring the Chepalungu forest attaches great value to continued presence of the forests. They have since time immemorial accessed forest resources such as building materials, honey, medicine and water especially during dry seasons. Due frequent food shortages in the area, the local community mentions the forest as a source of food (vegetables, fruits and game meat) - during the dry periods.

3.1.2 Meaning of local names

Kataret is the name of Ndorobo (Ogiek) man from Kaplelach age group[3] who lived as hunter-honey gatherer. He mainly subsisted on wild game and honey about 200 years ago and his first settlement was near an expansive stone near the present Kataret settlement. After many years, the population of the Ogiek grew and they started diversifying their food sources and developed farming systems like growing of finger millet. The population of the Ogiek grew and they expanded and colonized new areas around the present Kataret, Siongiroi and beyond to what is presently referred to as Chepalungu Community.

The term **Chepalungu** is derived from the prefix CHEPO meaning daughter and LUNGU refers to original inhabitants of the area whose first settlement was at Kataret and therefore the term Chepalungu owes its origin to daughters of Lungu who gave birth to the present Kipsigis community occupying what is today called Chepalungu.

Mogor is the main river, which when it overflows does not allow people to pass through. Those early years there used to be civil war between Kisiis and Kipsigis. When it overflows it could stop the two communities from passing through to fight.

"Cheboyo" the area was settled by two old men arap Koboyo and Kipkatam. The two were known beekeepers and had placed beehives on standing trees on the then main human tract and

[3] There are seven age groups in Kipsigis community and each generation takes about100 years

when people passed the place they could ask who the owner of beehive was and the reply was always 'arap Koboyo" until the place was named after him.

Kapchumbe- the present name of the forest station derived its name from the first white man who inhabited the area around 1914, the name is derived from the prefix-KAP+CHUMBE: Kap- refers to household and Chumbe- local reference to a white man. He reconciled the Kipsigis and Maasai to minimize civil wars and helped protect the natural forest. The community named the white man – **Kipleel-tiondo** meaning white man with white horse. He liked strolling around with a white horse and the present forest station is described in reference to the white-man's homestead. They were the first settlers to plant exotic trees in the forest such as cypress, eucalyptus, wattle and Mauritius thorn tree (locally referred to Chep-komon).

"**Yumu – simbeiwonii**"– this is a saying from the local community admonishing people to use the forest resources in sustainable manner and calls for restrain in the harvesting forest products extravagantly and appeals for wise use for sustainability. This practice is not common today because people who extract these products are in most cases not local community members but people from diverse areas and who as are not unified by the local philosophy of resource utilization and conservation.

3.2 FOREST PRODUCT AND SERVICES

The local community listed the following products and services as derived from the forest namely: fire wood, constructions poles ,honey, herbal medicine, thatching grass, animal fodder(grazing), game meat, rain attraction and handicraft(yoke, clubs , trough, tools handles, bull carts)

3.2.1 Fire wood

A great number of tree species can be used as firewood. In Chepalungu, however, the following tree species are preferred for fuel wood: *Olea capensis (Emitiot),Trichocladus ellipticus(Paregeiywet)and Euclea divinorum (Usuet).* Though the *olea capensis* is the most preferred for fuel wood and charcoal production it is now very rare in the forest. Charcoal makers have decimated the species and what are left in the forest are mainly stumps (Langat et al 2003). The fuel wood collectors mainly woman are aware of the imminent shortages and have turned to other less preferred species.

(a) Quantities of firewood extracted

From the focused group discussions with fuel wood collectors, each household uses about two back-loads of firewood per week when not supplemented with other energy sources such as paraffin and one back-load when fire wood is supplemented with other energy sources.

Fire wood sales are seasonal activity and occur mainly during time of food scarcity between the months of January and April.

Photo2 (a) Women collecting firewood inside the forest

According to the women, because of growing scarcity of firewood from the traditional source (Government forest) there are requesting to be given a portion of forest area for them to grow firewood trees such as Eucalyptus (Blue gum), *Grevillea robusta* and *Cuppressus Lusitanica* (Cypress).

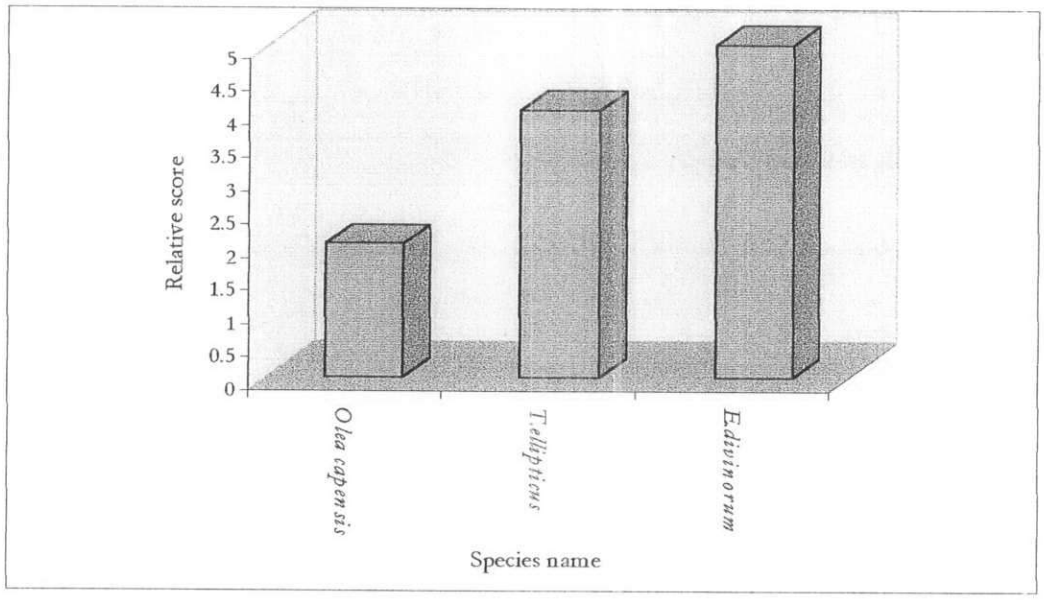


Fig.1. Relative availability of fire wood tree species in Chepalungu forest as perceived by collectors

3.2.2 Building materials

The forest adjacent communities extract tree products for building and construction.

Table1: Tree species used for construction collected by local community

Species name	Use	Estimated consumption per household/year
Mimusops kummel(Lalwat), *Warbugia ugandensis*(Soget), *Diospyros abyssinica* (Cheptuiyet),*Euclea divinorum*(Usuet), *Juniperus procera*(Tarakwet) *Cassipourea malosana(* Mangoita) and *Teclea nobilis(Kuriot)*	Poles	60 pieces are enough to built a house
Cassipourea malosana (Mangoita), *Diospyros abyssinica* (Cheptuiyet), *Euclea divinorum* (Uswet)	Trusses	(200 –500)
Juniperus procera (Tarakwet), *Diospyros abyssinica* (Cheptuiyt).	Pillar posts	
Juniperus procera (Tarakwet),*T.ellypticus*(Paregeiywet)	Fitos	This is an alternative to cypress
Celtis africana(Chepkeleliet) and *Kinyelwet*	Fibre	
Juniperus procera (Tarakwet), *Olea capensis* (Emitiot)-:	Hut-top	Durable

Table 2: Pair wise ranking of tree species used as building trusses by local community

Botanical Name	*Cassipourea malosana*	*Diospyros abyssinica*	*Euclea divinorum*	*Mimusops kummel*	Score	Rank
Mimusops kummel	*Mimusops kummel*	*Mimusops kummel*	*Mimusops kummel*	-	3	1
Euclea divinorum	*Cassipourea malosana*	*Diospyros abyssinica*	-	-	0	4
Diospyros abyssinica	*Cassipourea malosana*	-	-	-	1	3
Cassipourea malosana	-	-	-	-	2	2

The most preferred species for building trusses are *Mimmussops kummel* and *Diospyros abyssinica.* The two species are now very rare in forest due to past extensive harvesting and now the local are turning to exotic species such as cypress. There are few exotic trees which are planted by locals. This is causing immense pressure on the forest.

3.2.3 HONEY PRODUCTION

This is one of the non-consumptive uses of the forest and its development is compatible with forest conservation because it leaves the forest structurally and functionally intact. The local communities place the beehives in the forest and use some tree species to make traditional beehives. The activity has been there for many years. Twenty-five percent of the population adjacent to the forest practice bee keeping in the forest (Langat 2002).

Photo3: Traditional bee hive placed inside the forest- this is common in most parts of the forest

Juniperus procera is highly valued for making traditional hives but is presently not available or very few in the forest. Bee keepers are forced to use other species such as *Celtis africana* (Chepkeleliet), *Cassipourea malosana* (Mangoita), *Ficus natalensis* (Simotwet),*Diopyros abbyssinica*, (Cheptuiyet) *E.buchanania* (Saonet) and *Ficus ruepeleana*. These species are still available in the forest but very few. One interesting observation from this activity is that Cedar trees hosting beehives are left intact by illegal harvesters. According to the local people, it is considered a taboo to cut a tree hosting a beehive. This is one entry point for conservation of few remnant cedar trees by encouraging bee keeping in the forest.

(a) Nectar and Pollen plants found in Chepalungu

Potential amount of honey to be produced depend on tree species size of beehive the nectar flows in a season to which is invariably related to the flowering pattern of the species. Nectar and pollen species (melliferous resources) which are found in the forest as rated highly by the locals are namely: *Euclea divinorum* (usuet), *Juniperus procera*(Tarokwet), *D.Macrocalyx* (Cheptabirbir), *P.stellation* (Kipkoskosit) and *Apodytes dimidiata*((Chesimboliet) (Table 1).

(b) Flowering pattern of honey flora

Table3: Floral calendar for common honey trees reported by traditional bee keepers

Species name	Month of the year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
P.stellation (Kipkoskosit)			✓	✓	✓	✓	✓					
Simbeywet			✓	✓								
Euclea divinorum (Usuet)					✓	✓	✓	✓				
J.Procera (Tarakwet)				✓	✓	✓						
D.Macrocalyx (Cheptabirbir)											✓	✓
Apodytesdimidiata(Chesimboliet)					✓	✓						

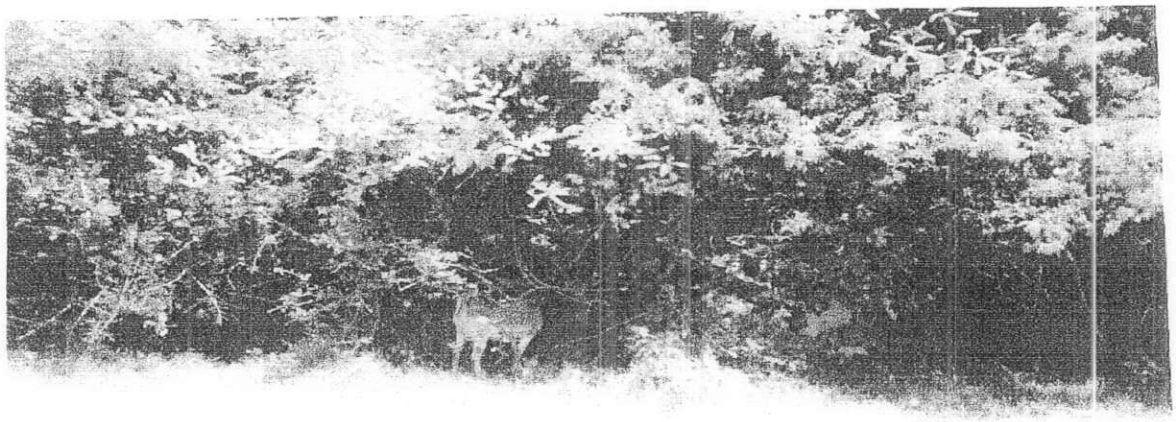


Photo4: One of the honey flora (*p.stellation*) in its flowering stage and is also good browse for goats

According to the local beekeepers –Usuet (*Euclea divinorum*) leads in the amount of nectar flow during its flowering and produces crude honey of twice amount of as compared to other floral nectar sources.

(c) Marketing

The main market for honey is primarily neighbours and nearby local markets of Chebunyo, Kapkatet market and Kericho tea estates at the price of Ksh.500 per gallon. Workers or children either do marketing. In 1980's the beekeepers were selling their honey to a co-operative society but the farmers were discontented with the buying price of Ksh. 400.00 per gallon and this discouraged them from delivering their honey harvests to the society.

BOX1: PROBLELMS FACED BY BEE KEEPERS

The beekeepers are faced with constraints in processing and marketing of their honey among them are:

1. Lack of markets
2. Local prices are poor
3. Insects pests which invade beehive making the bees to migrate
4. Poaching and destruction of beehives by honey badger
5. Poor traditional hives which when not covered allows rains to enter during rain seasons and destroys the beehive and makes the bees to migrate.
6. Lack proper tools and equipment for honey harvesting
7. Lack of proper packaging materials for honey

3.2.4 HERBAL MEDICINE

Herbal medicine is highly valued by the local community. Various parts of the tree are extracted - roots, sap, bark, leaf and fruit. During focused group discussions with herbalist –they reported that medicinal plant species are not abundant now compared to some years back. The species are collected from the forest free for sell or own consumption. The species extracted from the forest and parts used as shown below:

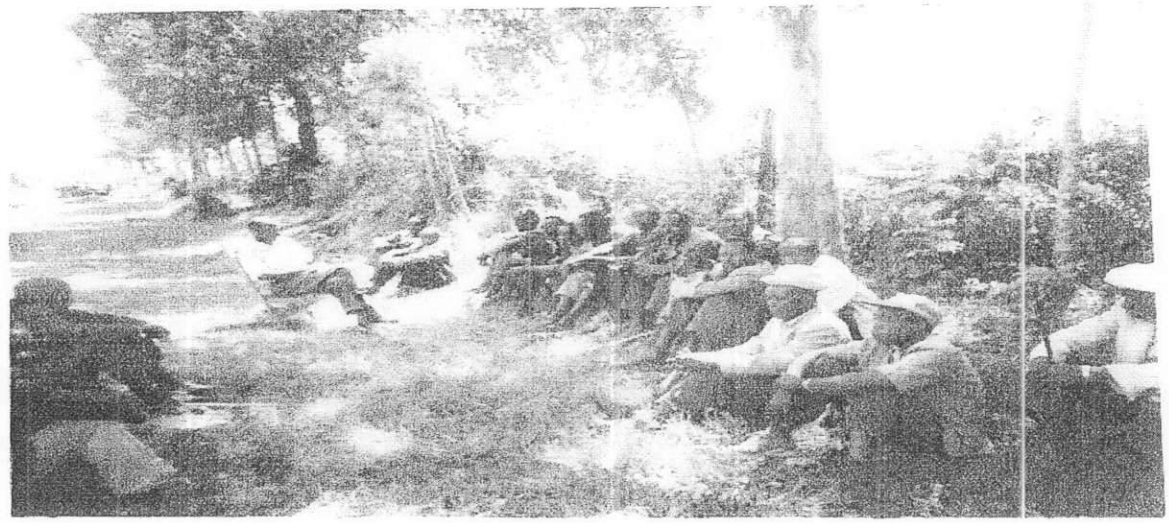


Photo5: One of the focused group discussion in progress with herbalist

Table 4: Reported parts of trees used as medicine collected from Chepalungu forest

Species name		**Parts of the plant harvested**					
Scientific	Local	Roots	Branches	Leaves	Bark	Fruits	Sap
R.natalensis	Chepngororiet	✓	✓				
D.abbysinica	Cheptuiyet	✓					
	Sosuriet						✓
Carissa edulis	Legetetiet		✓			✓	
Toddalis asiatica	Chembindorwet	✓		✓			
Trimelia grandifolia	Chepkowet	✓					
Dovyalis abbyssinica	Nukiat	✓	✓				
	Kinyelwet	✓					
	Sinetwet			✓			
	Kwambereriet			✓			
W.uganensis	Soget				✓		

According to some members of the community collection of herbal medicine is not full time activity and is only done when there is need and in most cases for domestic use.

3.2.5 Fodder resources

A typical household in Mogor sub-location has an average of 10 cows, 15 goat, 10 sheep and 3 donkeys. These animals are important to each household as sources of income or for use in domestic chores (e.g. donkeys). Most households adjacent to the forest are livestock dependent and availability of fodder resources is critical for their livelihoods. The area experiences severe dry periods between November and March and this is the time when there is shortage of fodder on farmlands- the forest is therefore an important source of fodder during normal and dry periods. The level of forest dependence for grazing is significant and for example, goats are grazed through out the year. Cattle and sheep depend on fodder resources for more than six months while donkeys are grazed for 3 months period in a year.

The local community reported the main problems facing their livestock enterprises as: Nagana (Tsetse fly attack), lack of acaricides, accessibility of veterinary officers, poaching by wild animals and the restriction on grazing rights by the forest department. Restriction of grazing inside the forest was cited by the local community as one source of conflicts with Forest Department.

Photo6: Goats grazing inside the forest- there are about 5,000-10,000 grazing inside the forest

3.2.6 HAND CRAFT

Handicraft production is one of the income generating activities local community derive from the forest. There are two categories of handicraft processors-hobbyist and full time entrepreneurs. The latter group sells their products by themselves in the nearby market of Chebunyo or through

middlemen in distant markets. These handicraft products are crafted using various tree species harvested from the nearby forest (table 5).

Table5: Tree species collected and utilized for handicraft products from Chepalungu forests by local community

Product	Species preference (in order of preference)
1.Walking sticks	*Teclea nobilis* (Kuriot) *Diopyros abbyssinica* (Cheptuiyet), *Apodytes dimidiata* (Chesimboliet), *Mimusops kummel* (Lalwat), *olea hoschterii* (Masaita) is the most preferred species for making walking sticks.
2.Clubs (Rungus)	*Teclea nobilis* (Kuriot), *olea capensis* (Emitiot) is not common now
3.Yoke	*Erythrina cymosa*(Mutereriet) ,*Diopyros abbyssinica*(Cheptuiyet), *Apodytes dimidiata*(Chesimboliet), *Ochna holstii*(Chemundugit)
4.Tools handles	*Erythrina cymosa* (Mutereriet), *Celtis africana* (Chepkeleliet)
5.Cooking sticks	*Teclea nobilis* (Kuriot), *Apodytes dimidiata*(Chesimboliet), *Euclea Divinorum* (Usuet), *Diospyros abbyssinica* (Cheptuiyet), *Olea capensis*) (Emitiot)
6.Combs	*Olea capensis* (Emitiot)

Most of the handicraft makers around this forest use 6 – 10 pieces of wood per week. These pieces are mostly extracted from the forest .The products, which are made in large quantities, are walking sticks, clubs (Rungus) and tool handles. An informal survey, which was carried at Chebunyo open-air market, revealed the products, which are sold in the market and their sale price (Table 6).

Table6: Products sold at local market (Chebunyo) and their sale prices

Product	**Species**		Unit price (ksh.)
	Local name	Botanical name	
Club (Chebunyo)	Emitiot Kuriot	*Olea capensis* *Teclea nobilis*	50.00-60.00
Tool handles (axe or hoe)	Muntereriet	*Erhythrina cymosa*	30.00
Yoke	Cheptuiyet Muntereriet	*Diospiros abbysinica* *Erhythrina cymosa*	100.00
Walking stick	Kuriot	*Teclea nobilis*	30.00
Herding stick	Kuriot	*Teclea nobilis*	20.00
Cooking stick	Emitiot	*Olea capensis*	30.00
Easy chair	Muntereriet	*Erhythrina cymosa*	200.00
Porridge / Ugali stirrer	Tangururuet	*Scolopia zeyheri*	10.00
Firewood	Assorted species		80.00 per donkey-load
Charcoal	Various species		120.00Per 40kg-bag
De-worming mix	Kibogongiik	*Rhus natalensis*	20.00/ 50gm container

Source: Market survey June 2003

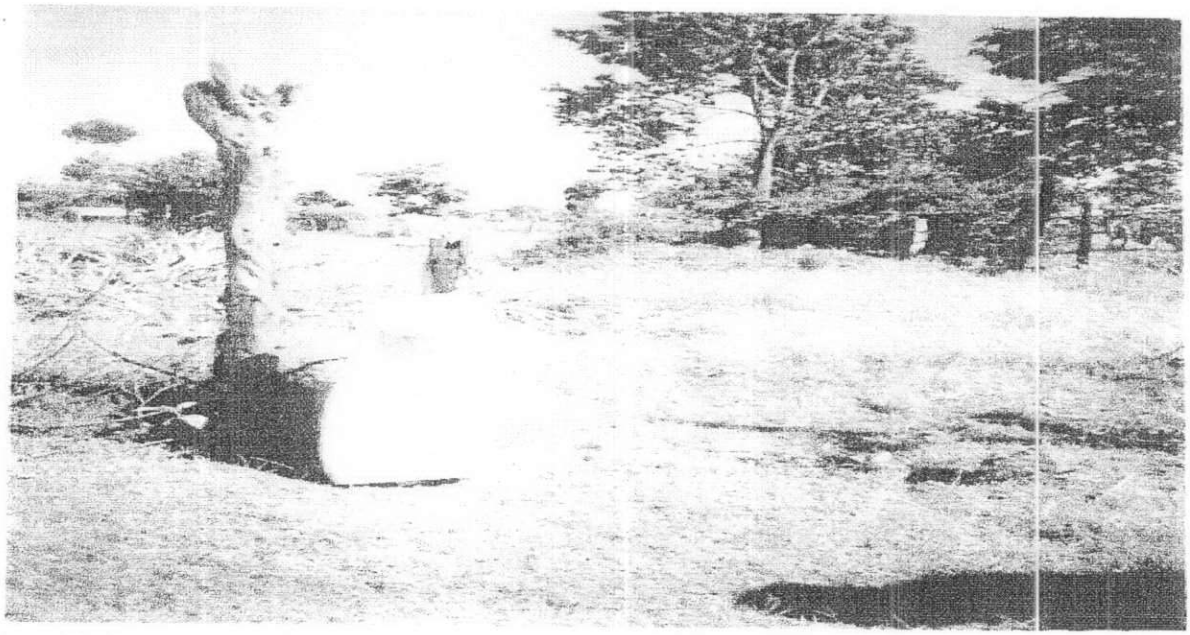
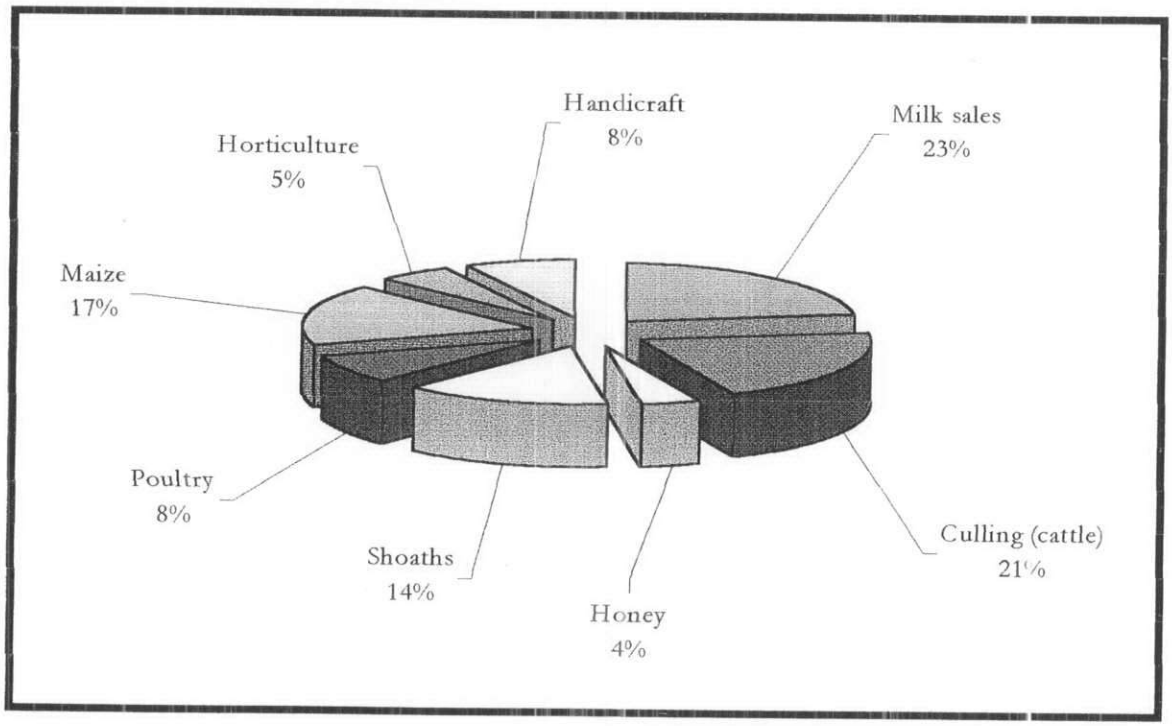


Photo 7: One of the handicraft produced by local people –cattle feeding trough using *E.buchananii*

LIVELIHOOD STRATEGIES

Sources of income in order of availability are: Livestock, maize, tobacco, vegetables, goats and sheep, poultry, honey, handwork, sweet potatoes, tomatoes, fruits and sugarcane (Fig.2.).Most people spend most of their income on school fees and procurement of food. Other expenses are on health of their livestock, land preparation, clothing and health of their children.

Fig.2. Sources of income of households in Mogor



From pair wise ranking exercise, the local people ranked Milk sales, sale of cattle and shoats as main income sources (Table 7). This in effect makes the households to be dependent on livestock for their livelihoods. Most households (58%) derived income from livestock (Fig.2)..-

Table7: Pair wise ranking of income sources as revealed by community

	Milk sale	Culling (cattle)	Honey	Vegetable	Shoaths	Poultry	Sugar cane	Fruits	Handwork	Maize	Score	Rank
Milk sales	-	Milk sale	Milk sale	Milk sale	Milk sale	Milk sale	Milk sale	Milk sale	Milk sale	Milk sale	9	1
Culling	-	-	Culling	Culling	Culling	Culling	Culling	Culling	Culling	Culling	8	2
Honey	-	-	-	Vegetable	Shoaths	Poultry	Honey	Fruits	Handwork	Maize	1	9
Vegetable	-	-	-	-	Shoaths	Poultry	Vegetable	Vegetable	Handwork	Maize	3	7
Shoaths	-	-	-	-	-	Shoaths	Shoaths	Shoaths	Shoaths	Shoaths	7	3
Poultry	-	-	-	-	-		Poultry	Poultry	Poultry	Maize	5	5
Sugar cane	-	-	-	-	-	-		Sugar cane	Handwork	Maize	1	8
Fruits	-	-	-	-	-	-	-	-	Handwork	Maize	1	9
Hand work	-	-	-	-	-	-	-	-	-	Maize	4	6
Maize	-	-	-	-	-	-	-	-	-	-	6	4

3.4 LOCAL INSTITUTIONS

In Kataret sub location; there are a number of organization/institutions, which interact with local people in provision of services or in local governance. These institutions are mainly government and church oriented and include; Education Department, Provincial Administration, Forest Department, Agriculture, Health, Local Council, Veterinary, Village Committees, SICODO and Churches. The village elders, Provincial Administration, Education and church organizations were identified as close to the local community. One local NGO- SICODO (Siongiroi Community Development Organisation is rated poorly by the local community. There were few rules governing the felling or cutting of trees except for trees in sacred places. There is one area inside(Kibirir) the forest were the local people perform traditional initiation ceremonies and trees here are protected by taboo-No women is allowed to fetch firewood or other chores in this area and sacred trees are highly protected.

BOX 2: Trees and Forests

Chepalungu and surrounding areas were once heavily forested and the Kipsigis had no clear rules or restriction on cutting down of trees, with the following exceptions:

(a) Trees near a man's hut were regarded as belonging to the householder as long as he was in occupation and were not felled without his permission;

(b) Trees marking the sites of Kokwet Councils might not be interfered with;

(c) Trees under which religious rituals were conducted were regarded as sacred. These were usually Mogoiywet amd Simatwet (both Ficus sp) .They were selected because, they provided good shade, were shapely, green, and yielded a milky sap which was considered to be good omen;

(d) Few other trees were protected by taboo e.g . a tree hosting honey barrel was not felled or interfered with

(e) Fruits were common property, even that growing on trees near a man's hut.

3.5 TIME LINES (HISTORICAL PROFILING)

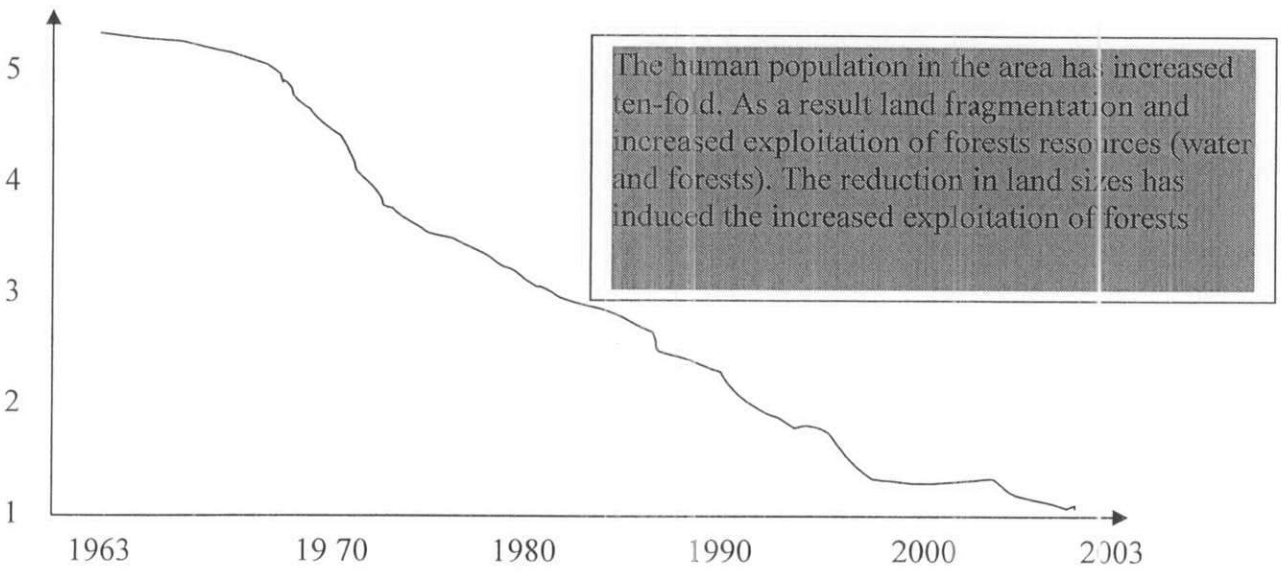
1914 –20	Introduction of Black wattle, Cypress and Mauritius thorn by a white man named Georgis
1937	Goats were introduced in the area and was followed by the grade cows in 1949.This was done by the European agricultural officers
1946	Serious drought in the area
1947	1st armyworms infestation in the area and tsetse fly traps laid by white Scientists
1948 – 1949	Locust infestation in the area
1952	Excavation of dams (water points) at Chebugon. Mogor, Kelichek, Chebunyo and Chesambai and there was eviction of local people from forest by white man named Kennedy. Forest gazetted around Bingwa and Kelichek
1953	2nd armyworms outbreak
1959	Political parties formed - KANU, KADU
1960	The registration of persons conducted at the settlement
1961	Heavy rains (El Nino) in the area for the whole year
1963	Bingwa was surveyed by white men, and each person was allocated between 22-25 acres and the first people were settled there in the same year.
1967 – 1969	There was a serious drought and an acute shortage of water in the area and people were forced to source water from Chepkulo about 20 km away.

1969	Honourable .Mr. Barmalel Member of Parliament initiated water projects
1970	There were cattle raids by the Maasai and houses were burnt.
1974	Houses were burn down by Maasai in Transmara Dikiri and Emarti –Kimunai Soi was then the MP of the area.
1979	Wild dogs (T9) from Tanzania invaded the area
1979 – 1981	Registration of titles at Bingwa settlement
1983 – 1984	There was heavy drought and hunger in the area, until people migrated to other areas.
1987	There was an out break of East Coast Fever and killed several domestic animals
1988	Good harvest of maize, which broke one store at Cheboyo and one person, died from a collapsing maize store
1989	Another serious out break of ECF
1990	Agitation for multiparty in the country
1991	Maize yields were very poor
1992	First Multiparty elections
1993	Serious out break out of malaria
1994	There was Cypress Aphid out break in the area, which attacked Cypress trees.
1995	*Teclea nobilis* (Kuriot) and *Trichoclydus ellipticus* (Parageiywet) were attacked by unknown disease, which led most of the trees to dry up.
1997	Heavy rains (El Ninno)
1999 – 2000	Serious drought where all the vegetations dried up
2003	Typhoid and reported case of milk diseases occurrence.

3.4.1 Trend lines

The settlement of Kataret sub-location started inn 1960's.The settlers were each allocated between 22-25 acres and after some years some settlers started selling part of their parcels to new emigrants and this led to increase in population with concomitant decrease in land sizes. The diagram below indicates the changes in land sizes as perceived by the local community.

(a) Trend in changes in land size over time



(b) Population changes

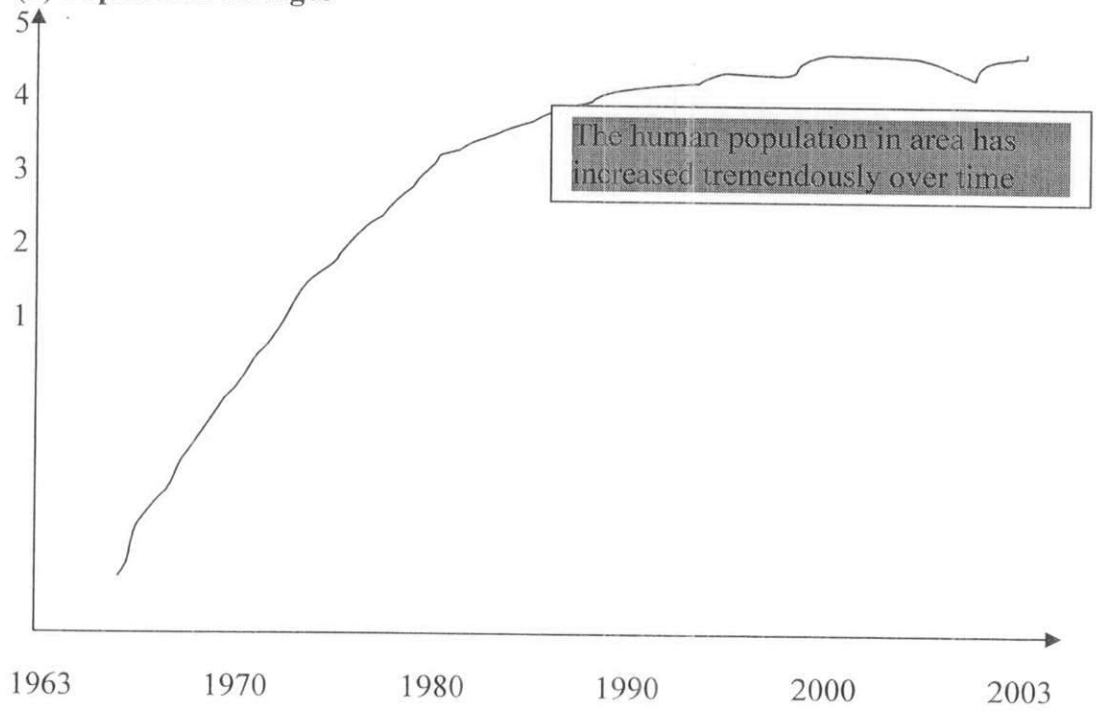


Fig.3 (a &b) trend in land size and population

(c) Vegetation cover change

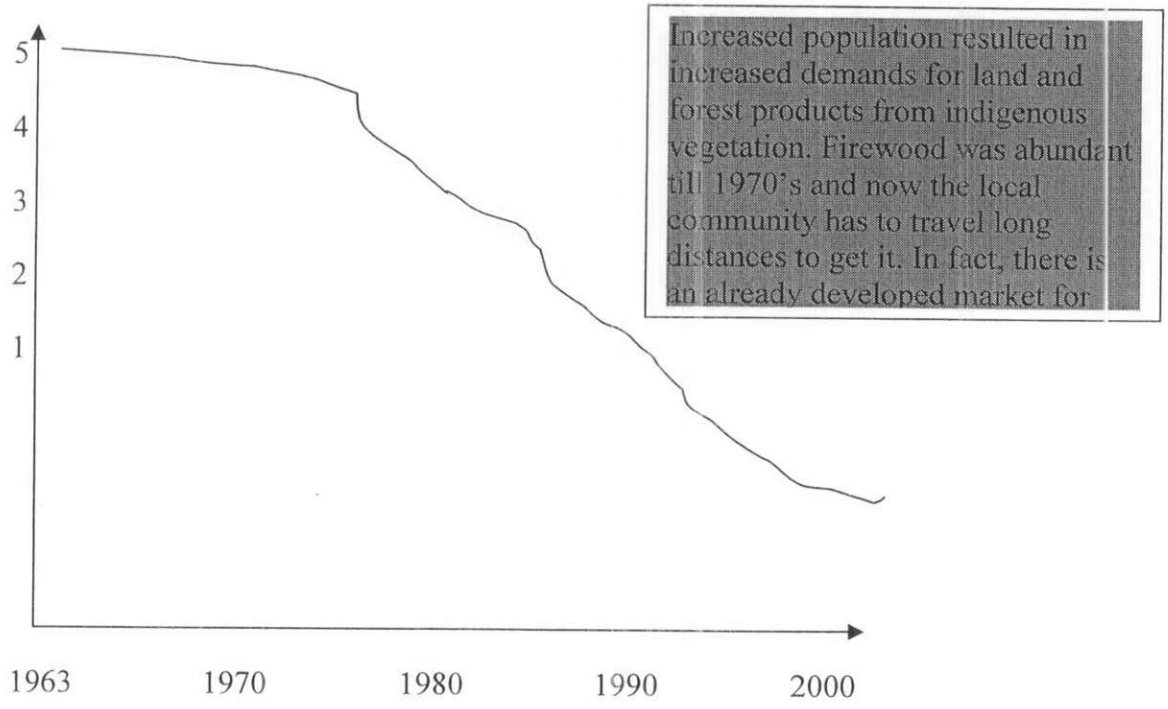


Fig 3 (c) Trend in vegetation change

The area was once forested and as the settlements build up with increasing population there was massive clearing of forests to give way for human settlement. Big trees were harvested to free land for agriculture and livestock keeping. Only few remnants vegetation was left. The change in the forest species composition is reflected in few numbers of big trees and replacement by secondary species. According to the local community, trees like Olea and Cedar are fast disappearing and are being replaced by shrubby species and climbers such as *P.stellation*(Kipkoskosit) ,Simbeywet , *Maythenus heterophylla*(Kugerwet) and *Euclea divinorum* (Fig.3(d) below).

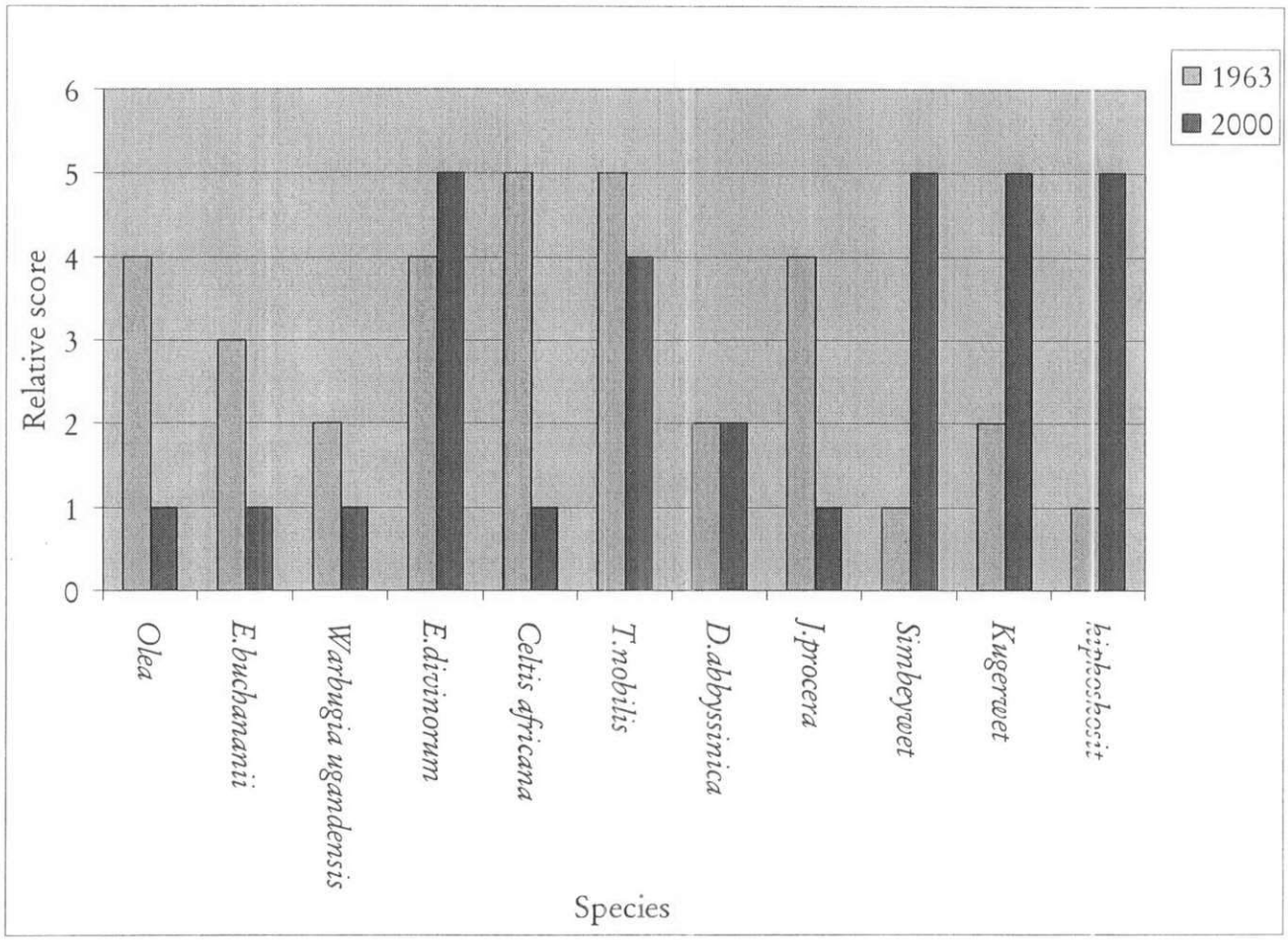
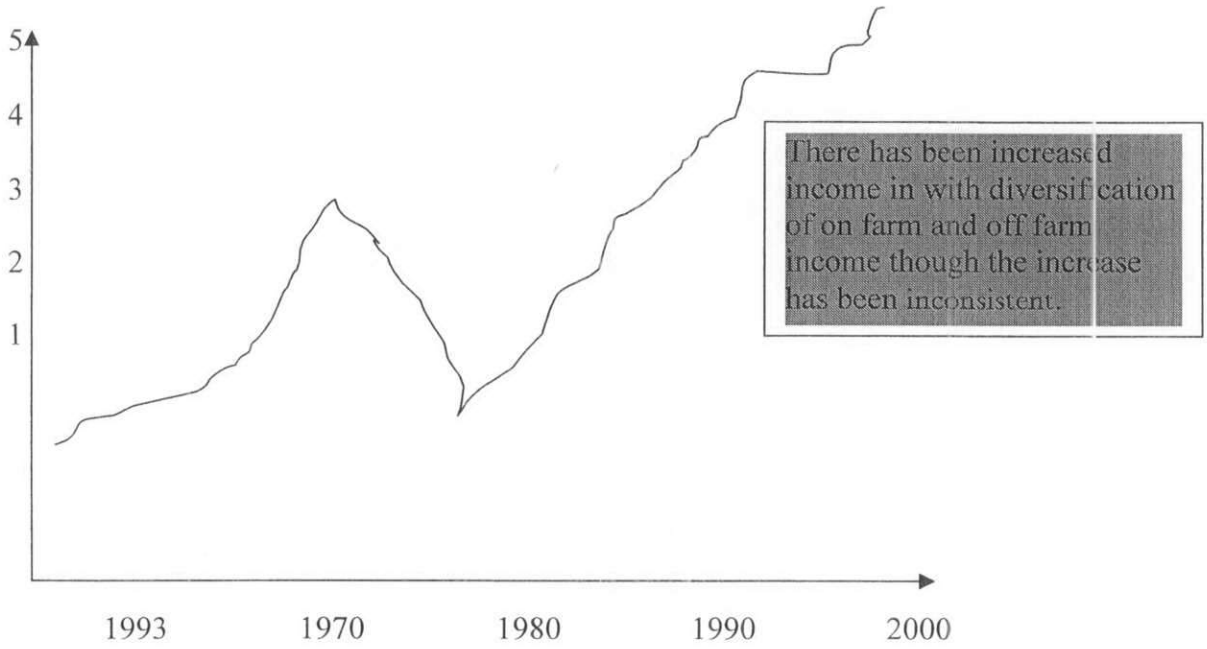


Figure3 (d): Relative abundance score of tree species in the forest as perceived by local people

(e) INCOME



(f) **Food**

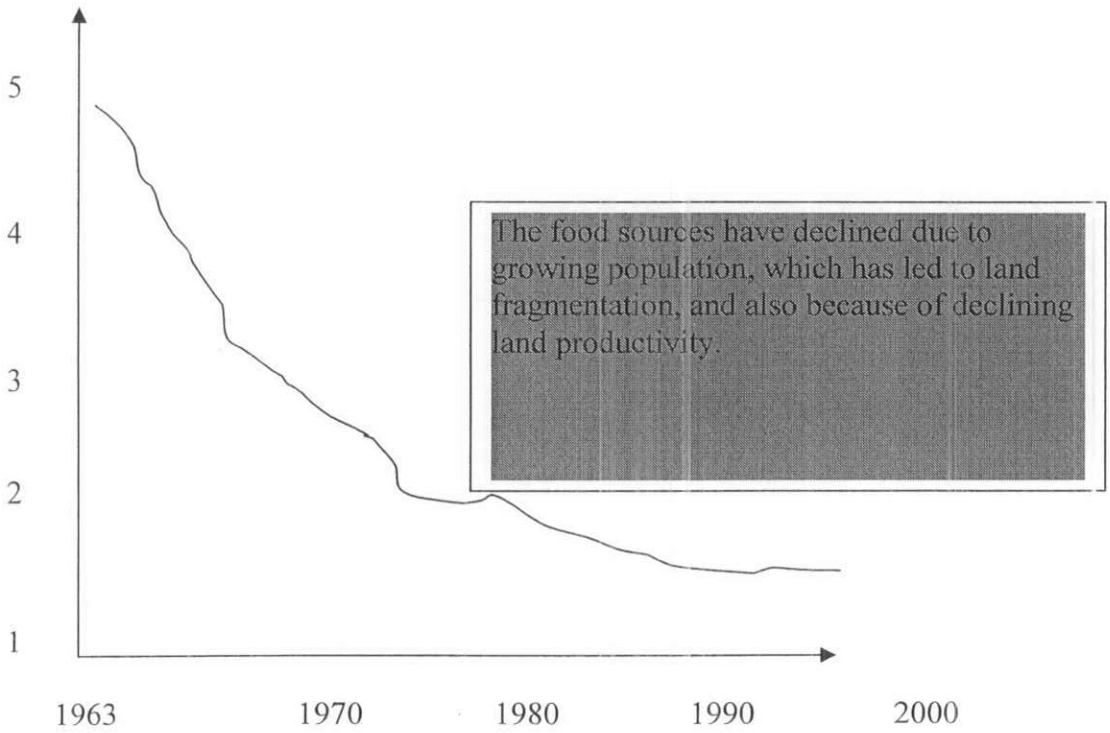
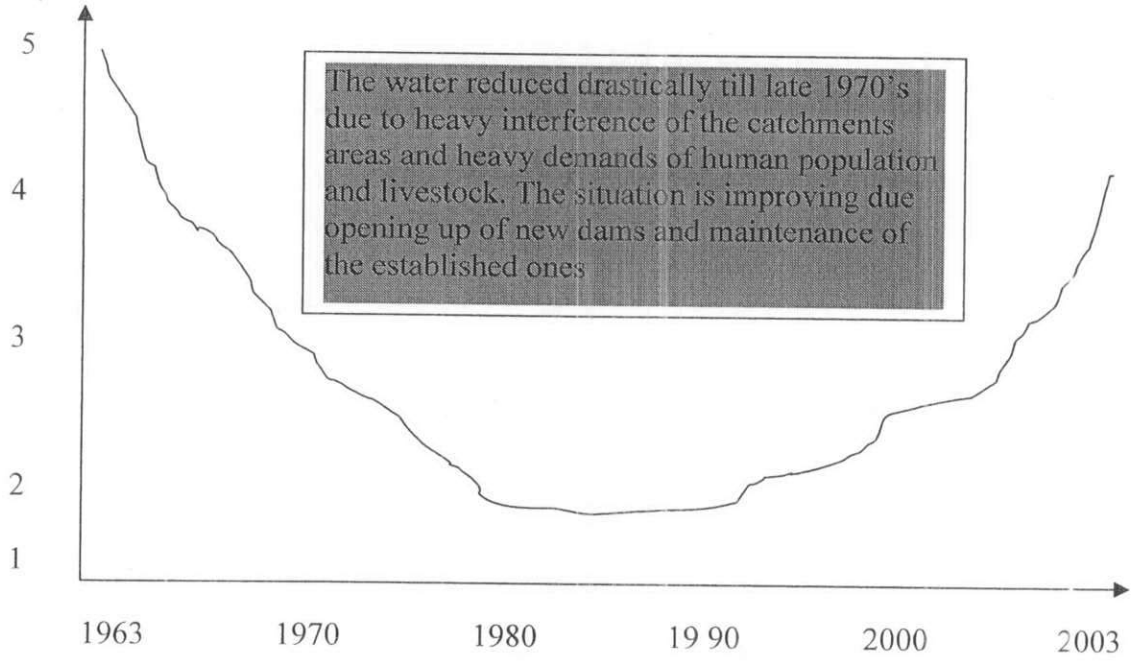
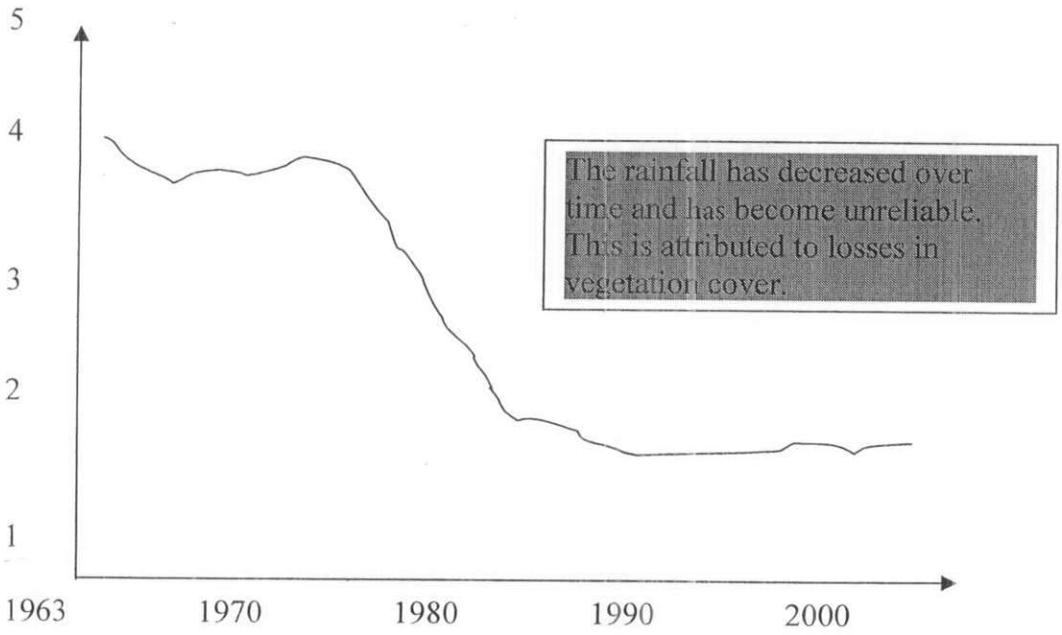


Fig 3(e), (f), (g) and (h): Trend in income, food water availability, rainfall changes over major periods

(f) Water availability



(f) Rainfall



3.4.2 TIME CHARTS (SEASONAL CALENDER)

Time charts are used to determine the sequence of forest use and the cycle of agricultural activities to understand when local people will be best able to undertake forest related activities. This is important in community participation so that timing of forest management activities is not

disruptive of farmers' activities. Below is the time chart describing all activities undertaken by the farmers on monthly and daily basis in the area.

Table9: Monthly activities undertaken by farmers around Chepalungu forest

Month	Activity
January	Weeding maize, firewood collection, schools, care of livestock, marketing of livestock, Land preparation for Wimbi
February	Care and marketing of livestock, weeding maize
March	Broadcasting sorghum, weeding maize, honey harvesting, cleaning water points, care of livestock, marketing of livestock and hunting.
April	Weeding sorghum/millet hunting, planting of tree seedlings and care of livestock.
May	Weeding sorghum, schools, building stores, planting of trees seedlings, care of livestock, and de-worming
June	Harvesting of maize, building stores and care of livestock
July	Harvesting of maize, wimbi, honey harvesting, care of livestock, repair of houses
August	Firewood collection, honey-harvesting smearing, of houses, care and marketing of livestock, and marketing of maize.
September	Land preparation, harvest of sorghum, care of livestock, schools and marketing of maize. Drying of Wimbi and sorghum
October	Land preparation, harvesting of sorghum, care of livestock, cleaning water points and marketing of maize.
November	Care of livestock, marketing of maize, firewood collection, fencing and planting of maize
December	Planting maize, fencing, firewood collection, ceremonies

Table10: Male Daily calendar from (5.30 am – 9.30 pm)

Time	Activity
5.30 am.	Waking up
6.30 am	Waking up other members of the family
6.30 am – 7. 00 am	Livestock inspection
7.00 am – 8.00 am	Tea taking
8.00 am – 9.00 am	Inspection of shamba and doing normal duties of work
11.00 am	Harvesting of nappier grass and feeding livestock
12.00	Watering livestock
1.pm -2 pm	Lunch and resting
2.00- 3.00 pm	Taking livestock to water point
3.00pm--4.00 pm	Relaxing with friends /beer taking
5.00 –7.00pm 7.00pm-9.00pm	Returning at home Relaxing at home waiting for supper
9.00 pm – 10.00 pm	Preparation to sleep

Table11: Female Daily calendar

Time	Activity
5-7 pm	Waking up, Milking livestock, Cooking tea, Preparing children to school
8.00 – 9.00 am	Preparing house and cleaning utensils (cleaning house)
9.00 10.00 am	Look for vegetables, Cooking vegetables, Collection of water
12.00-pm	Cooking food
1.00 pm	Feeding the children
2.00 – 3.00 pm	Milking livestock
3.00 – 4.00 pm	Collection of firewood and vegetables
5.00 pm	Collection of water
6.00 pm	Returning livestock to the Boma
7.00 – 8.00 pm	Food preparation, Feeding the children, Cleaning the utensils

4.0 CONLUSSIONS AND RECOMMENDATIONS

There is high level of perception of forest degradation in the surveyed areas and the forest adjacent community would like to be involved in joint forest management. The modalities of their involvement are not yet defined. There are already a group of village committees and nascent community based organization and an NGO who have established nurseries and are willing to be involved in reforestation activities. Of all institutions and organization- the local people have confidence in church organizations and village committees than government departments or NGOs. There is some level of mistrusts between the local community and government institutions and for effective involvement of all stakeholders it will be necessary to establish good working relationship as part of the initiation of community participation.

Because the forest adjacent community is highly dependent on livestock and graze their animals inside the forest-the restrictions imposed on forest grazing by Forest Department is the biggest source of conflicts between it and the community. If the community is to participate in joint forest Management mechanisms have to put in place to respect the right of locals to access the forest for grazing.

There is potential of using the local rules and institutions to protect the forest. One example is in honey production where Cedar trees hosting traditional beehives are left intact by illegal harvesters. According to the local people, it is considered a taboo to cut a tree hosting a beehive. This is one entry point for conservation of few remnant cedar trees by encouraging bee keeping in the forest however this approach has to take cognizance of the changing rules and norms as a result of external influences. The concept of sharing the responsibilities for co-managing the forest with the local people will revolve around sharing the costs and benefits among the stakeholders. These critical issues have to be made clear from the onset to avoid disappointment and discontent among the forest adjacent community-minimize the potential sources of conflicts.

Already, there is scarcity of wood products within forest adjacent areas-and there is already developed market for wood products like firewood. The areas adjoining the forest especially Transmara district are deficient in wood products. There have been reported cases of conflicts because of wood shortage. There is a case of armed poaching from by the people outside the district especially for construction materials and fencing posts.

There is declining level of tree resources in the forests and most preferred species are fast disappearing. There is some level tree growing on farms which started with the introduction of exotics during the colonial period, this evident from the growing demand for tree seedlings in the area due to perceived and experienced wood shortages. The private nurseries in the area are few and in most case, the private nurseries are lacking in technical skills .This is an area where KEFRI can train the local existing nursery owners on basic tree nursery management and provide quality seeds of the most demanded tree seeds.

To facilitate future negotiations and agreements for effective participation of the local people it is essential that the local people know the resource base of the forest they are likely to co – manage with the Forest Department and other stakeholders. It is therefore necessary that participatory resource assessment be undertaken with key resource users. This approach is intended to ease suspicions and prepare the locals to appreciate the extent of degradation and know how their extraction is impacting on the state of the forest. Participatory resource assessment will also enable Research team to capture information specific to each resource users (from discussions in the field). The information generated is to be used in Community Workshops and negotiations with resource managers (FD).

4.3 TO CONSERVE OR NOT TO CONSERVE: FOREST VALUATION OF TINDIRET NATURAL FOREST

TECHNICAL REPORT BY
David Langat and Joshua Cheboiwo

INTRODUCTION

Kenya's natural forests are threatened by the degradation resulting in the loss of biological diversity, and diminishing source of forest products and services. There is growing evidence that the continued degradation of the forests is resulting in reduced water flows in the high potential areas and may result into disruption of ecological processes important in supporting productive activities.

Forest as a natural resource in Kenya have been considered mainly as a source of fuel wood, raw materials for building, tools, medicine, forage for domestic animals and in some cases cultural values. In recent years, industrial and technical developments have resulted in forests being used extensively as sources of raw materials for wood-based industries which produce sawn timber, pulp and paper, panels and boards etc. The role of forests for the common good of all Kenyans, however, embraces a wider scope other than the supply of raw materials to industry. Lack of attention and improper management of natural forest and subsequent destruction of forests, is bound to threaten their critical functions such as carbon sink functions, prevention of soil erosion, protection of water catchments, wildlife habitat and conservation of biodiversity.

Forestry provides linkages with agriculture and livestock sectors, which are the backbone of Kenya's economy – both cash and subsistence. It supports agriculture through soil and water and economic benefits such as generation of jobs in the rural areas. The national fuel wood and charcoal demand of 31 million cubic meters per annum is met from forests and woodlands (MENR 1994). Although minor forest products have not been properly quantified, it is a fact that the contribution of forest honey, gums, food, medicine, thatching, leaves etc is significant to forests users (Emerton, 1994; Mogaga, 2001; MENR, 1994).

The importance of forest conservation in combating environmental degradation and its overall contribution to economic development caused the Kenya Government to initiate a comprehensive Forest Development Master Plan to develop a comprehensive framework for managing all forest in Kenya and most components cited in the plan have been incorporated into the new forest bill (Kenya Forest Bill April 2004) and the government is keen in integrating all forest values into the national development planning processes (Gichere ,2001).

Nature conservation and the other non use values of forests are for instance not usually valued explicitly in Kenya's forest industry. This is not because they have no value or are incapable of being valued but because they cannot be readily bought and sold as discrete items. There is therefore, no market for them as there is for personal goods and service (Pearce, 1993).The role-played by forests such, as conservation, amenity reservation and aesthetic values are positive externalities which accrue to the public in the immediate vicinity of the forest and other areas, nationally and globally.

Kenya's forests are undergoing tremendous degradation both through sanctioned excisions and illegal encroachments and poaching. Despite strong opposition to its conversion to alternative land use- natural forests are being cleared at an alarming rate. For example it is reported the present forest cover to a low level of 1.7% of the total land cover in Kenya. This scenario is worrying considering that forestry plays important roles in supporting agricultural production and other sectors of the economy.

Tindiret natural forest is one of the remaining natural forests in Kenya. This forest forms one of the important forests for water catchments protection and, feeding the major river and streams

that make up the hydrological systems of Lake Victoria. In addition, it is a reservoir of unique biological diversity and directly and indirectly supports the local adjacent communities for their needs and improvement of agricultural productivity through ameliorating the microclimate. The total forest area is estimated at 7080 ha and consists of high forests, grassland and planted forests. The continued scarcity of land in the adjacent areas is exerting pressure on this forest and there are evidence encroachments and illegal occupations.

1.1 WHY VALUE FORESTS?

'Sustainable forest management' demands that management be for the maximum benefit to society and the environment. In order to make wise decisions about the optimal allocation of forests resources or products; it is necessary that all values and services are taken into account. Multiple uses of forests require the integration of economics and biological sciences in arriving at a compromise strategy for forest management for the benefit of society and the environment. The aim of forests of forest management is no longer the simple maximization of timber alone but aggregates of forest benefits such as soil stabilization, wildlife habitat, recreation etc (Nautiyal & Rezende 1985). It is evident from studies undertaken elsewhere that the value of non timber benefits sometimes out weighs the timber value alone and its contribution to the local economies can be gauged through accurate valuation, so that information is available to policy makers and resource managers- for efficient allocation and use of forests(Tewari, 1994). A clear understanding of the values and contributions of the non timber products and services from forests to communities, resources managers will give clear signals on the appropriate mix of joint products (Godoy 1992) and can also be used for justifying more allocation of scarce public resources. The importance of forest valuation is aptly summarized by Godoy (1992) who stated thus:

> ***"Undervalued resources are misused; a proper valuation of forests should enhance forest management and lead to more sustainable income and consumption".***

Forests have in the past; have been managed predominantly for timber production but there is emerging trend towards an integrated management, which incorporates management for both timber and non timber values. More recent is the concept of ecosystem management where the emphasis is on ecosystem capabilities, system heath and sustainability (Christensen *et al.*, 1996).As new approaches to forest management are attempted there will be need for rigorous economic valuation to capture all these values to guide policy decisions.

In Kenya, there have been recent attempts to determine the total economic value of forests through various valuation approaches and there is evidence that non timber values are far higher than timber values(Mogaga,2001,Emerton ,2001,Emerton ,1996,Wass 1994). There is growing body of knowledge on the values attributed to forests apart from timber and this information is only available for some few forests. There have been attempts at computing the total values of natural forest in Kenya (Wass 1994). In order to process quality information about forests in Kenya- it is essential that valuation is undertaken for important forests areas experiencing human pressure.

Tindiret natural forest is one of the forests currently under immense pressure due to growing population and the attendant demand for more land for settlement. The study was therefore undertaken to obtain information on the total economic values of Tindiret natural forest.

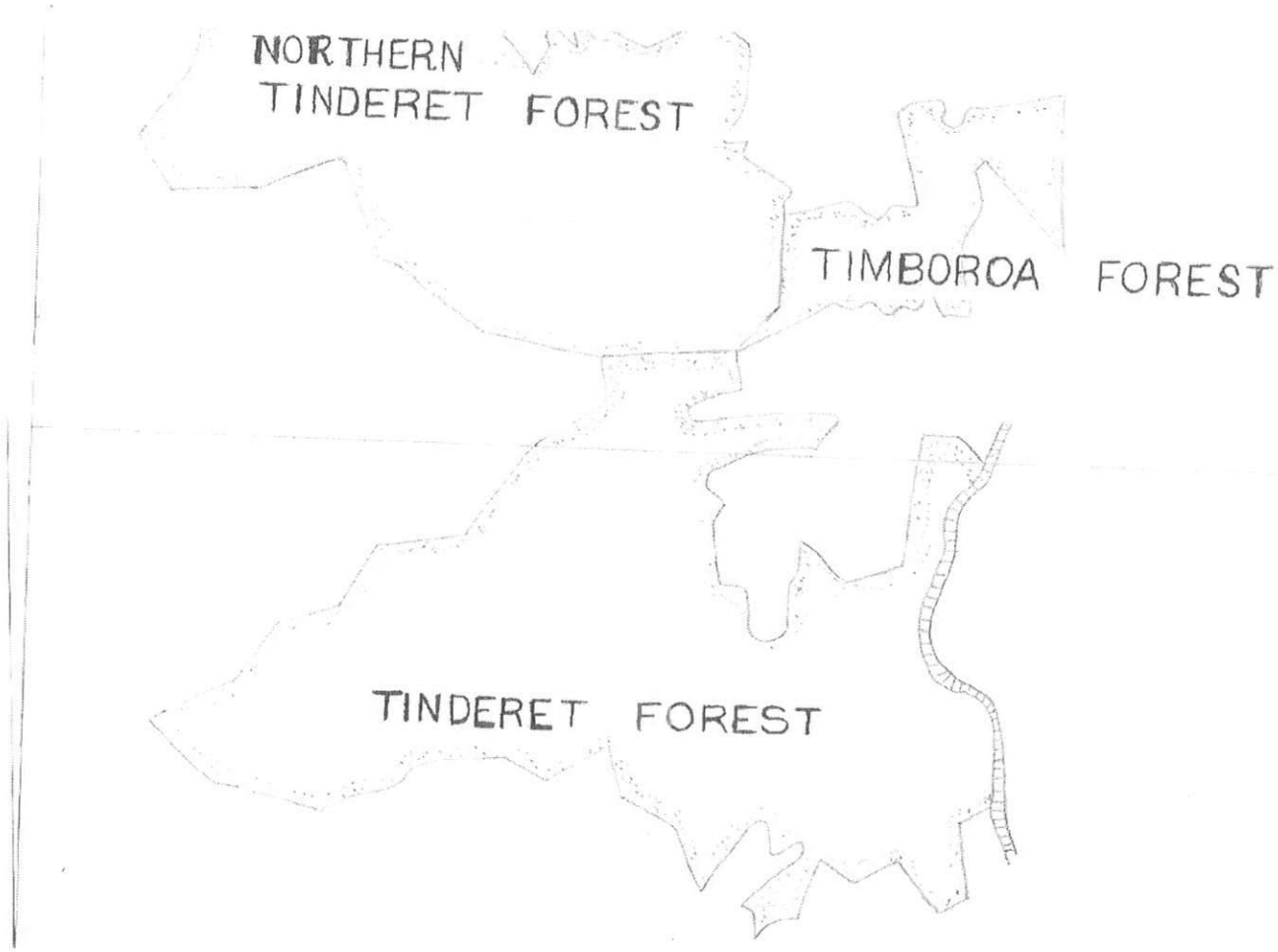
1.2 PURPOSE OF THE STUDY

- Identify forest products and services derived from Tindiret forest by the local adjacent community;
- To estimate the total economic value of Tindiret forest so a s to justify positive impacts of forest conservation;

2.0 STUDY SITE

2.1 DESCRIPTION OF THE FOREST AND ADJACENT AREAS

Tindiret natural forest is in South Nandi and parts of Kericho districts. The total forest area is estimated at 7080 ha and consists of high forests, grassland and planted forests (Forest station records, 2003). The forest is surrounded by human settlement mainly With Kipsigis on the Kericho side and Nandis and Okiek on the South Nandi and is facing high threats from excision and development (Wass, 1994). The people settled near the forest have freehold titles except for the Okieks who are settled inside the gazetted forest area of about 150 ha. The forest is situated at 35.47° East and -0.04° north.



The Map is not to scale

Fig 1: Map showing Tindiret Forest and adjacent areas

The area occupied by the forest consists of an undulating upland typified by rolling hills; mainly sharp-topped ridges. These areas have soils mainly of Basalts and biotite gneisses (Jaetzold,and R,Schmidt, 1983). The soils are represented by mollic and humic nitosols, of moderate fertility and the area is generally good for tea growing and livestock, horticultural crops. The forest is source of water for tributaries which drains and joins up to form river Nyando into Lake Victoria.

2.1.2 Climate

The areas around the Tindiret Forest receive the highest rainfall in the district averaging around 1708mm annually. Rainfall distribution is bimodal, with the long rains extending between March and June, and the short beginning in mid September to end in November, although, there is no single month without some rainfall.

The Temperatures vary between a minimum of 10°C and maximum of 26°C, annual averages is 17.40°C.

2.1.3 Socio-economic characteristics of the forest adjacent villages

The study was undertaken in three villages (Sub locations) bordering the forest namely: Kunyak –of Chilchila Location, Kipkelion Division, Kericho district and Koigener and Kipyaor of Chebangang location, Tindiret division of South Nandi district. Household surveys and participatory rural appraisal were undertaken with the assistance of local chiefs and village elders.

Table 1: General information for study villages

Sub-Location	Total Population	Number Of Households	Sample Size(N)
Chebangang(Koigener)	**1500**	**400**	**26**
Kipyaor(Chemamul)	**1500**	**500**	**22**
Kunyak	**2000**	**400**	**22**

Source: Chiefs of Chebangang ,Kunyak and Kipyaor, 2003

The residents bordering the forest are mainly agriculturalists and pastoralists. They grow maize, beans, tea and horticultural crops. Most of their income is mainly from sale of crops and livestock (Table 2).

Table 2: 1.Socioeconomic characteristic of respondents in forest adjacent areas-Kunyak,Koigener and Chemamul

Characteristic	**Village**		
	Kunyak N=32	Koigener N=32	Chemamul N=32
Number of adults in HH	5.07	3.64	4.77
Number of children in HH	5.09	4.73	5.00
Land size(ha)	1.53	1.00	1.58
Income from tea(Kshs)	1125.62		25369.23
Income from maize(Kshs)	6868.75	2677.30	2688.46
Income from horticulture(Kshs)	2472.36	200.00	3981.40
Income from cattle and products(Kshs)	10327.50	3127.40	19338.20
Income from sale of shoats(Kshs)	3002.70	800.40	1808.10
Total livestock income(Kshs)	15037.20	73452.50	22534.20
Income from business(Kshs)	1202.10		5072.40
Income employment(Kshs)	10312.40	3207.30	19615.40
Total off-farm income(Kshs)	2862.30	3012.40	4648.50
Total HH income(Kshs)	43526.50	23534.70	67657.90
School fees costs(Kshs)	2859.40	1715.45	38230.75
Crop investments costs(Kshs)	2792.80	2976.40	12292.50
Consumer goods costs(Kshs)	8615.00	5009.10	21822.60
Human health costs(Kshs)	2781.12	2178.20	7411.50
Livestock health costs(Kshs)	2181.60	644.55	3206.90
Total expenditure(Kshs)	53421.95	21893.10	82964.35

Source: Field data December 2003

3.0 CONCEPTUAL FRAMEWORK

3.1 CONCEPT OF TOTAL ECONOMIC VALUE

An un-logged forest yields many different products and benefits over time. The different products and services are available or will be available for human consumption at future date. A proper valuation of the opportunity costs of the forest must add the benefits of all products and services. The forests have potential value in terms of its growing stock and this is normally captured by timber rents or revenues from harvesting of timber as represented by the stumpage value of the stock'.

Forest can also provide non wood products which can be extracted and used by human beings- the sustainable extraction of non timber forest products (NTFPs) excluding the cost of extraction and marketing gives us the value of NTFPs (honey, medicine, fibres, fruits, dyes etc). In addition, forest also exert a positive influences on other sectors of economy e.g. agriculture, water conservation and protection. These values are aggregated to give total economic values of forests (Godoy, 1992; Pearce, 1994; Turner et al., 1994)

The Total Economic Value (TEV) of environmental assets can be broken down into a set of component parts. For a tropical forest, the TEV comprises use and non-use values. The use values include direct use values, indirect use values and "option" values while the non use values include the existence values (Turner et al 1994) (Figure 2.).

3.1.1 Direct Value

The direct value of an indigenous forest comprises the total value of all the direct uses by various groups and individuals. They include:

i) Extraction of wood and non-timber products

ii) Non-consumptive activities such as education, habitation and leisure.

These values are both consumptive and productive use values. They are concerned with the enjoyment or satisfaction received by consumers of biological resources. They are relatively easily observed and measured often by assigning monetary value to them through pricing.

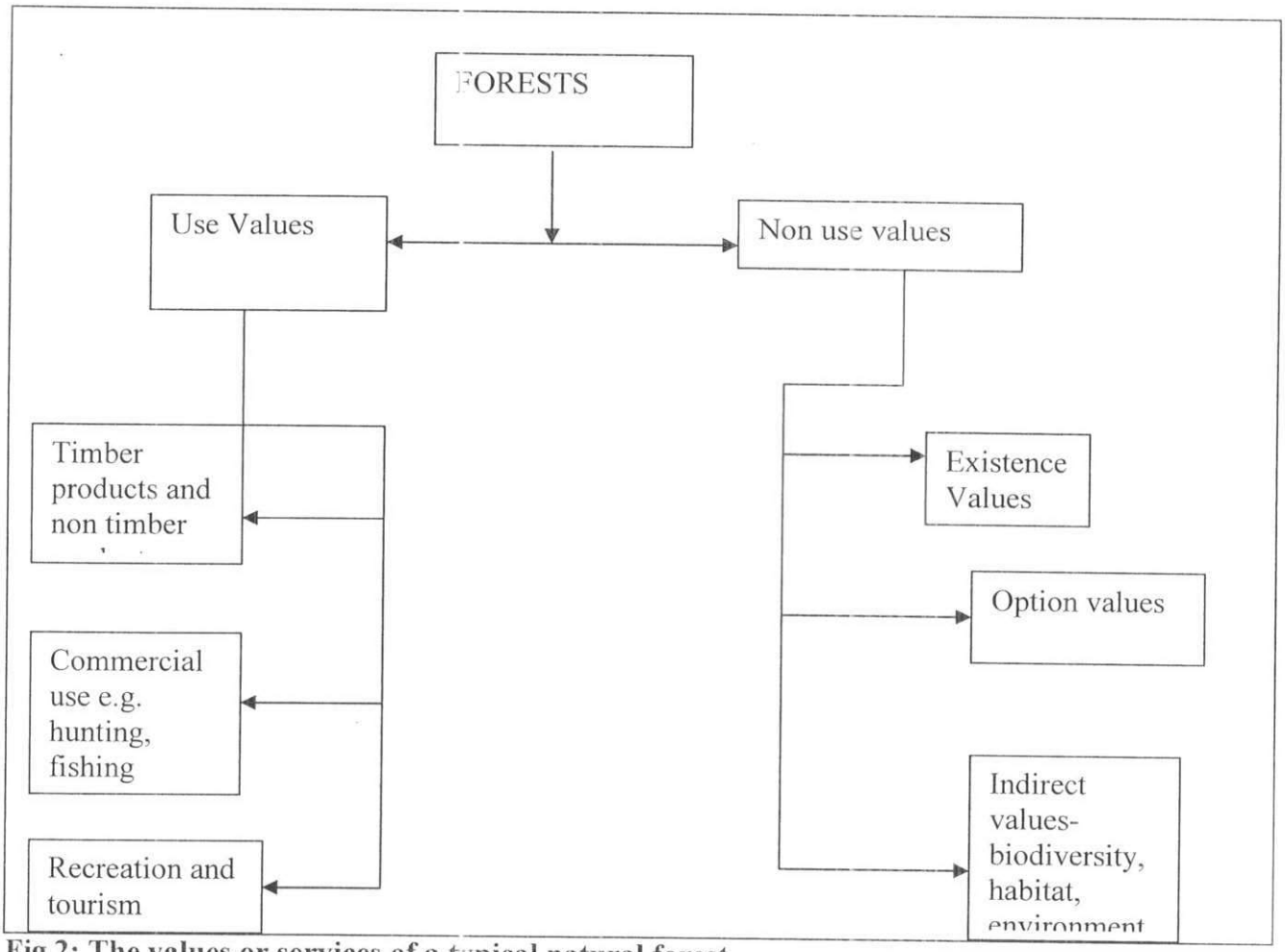


Fig.2: The values or services of a typical natural forest

3.1.2 Indirect Values

The indirect values of indigenous forests refer to the environmental goods and services that they provide. These values correspond to the ecologist's concept of "ecological functions". They deal primarily with the functions of ecosystems (environmental services) and they may by far outweigh direct values when they are computed (Jeffrey et al; 1990, Winpenny 1991., Turner et al 1994, Barbier, 1994,). These values accrue to society locally or globally rather than to individuals or corporate entities. They include

1. Watershed catchment protection
2. Carbon Sequestration
3. Photosynthetic fixation of solar energy
4. Ecosystem functions of reproduction
5. Maintaining water and nutrient cycles
6. Regulation of climate at both macro- and micro levels
7. Soil formation and protection

Forest degradation and destruction would imply a loss of many of these environmental benefits although this would depend on the subsequent alternative land use.

3.1.3 Option Value

Option values relate to the amount that prospective individual users would be willing to pay to conserve a forest for future uses that are not carried out now, but for which future opportunities would be foregone if the forests were destroyed. It is essentially an expression of preference for the preservation of an environment against some probability that it will be made use of at a later date. This value is hardly considered in forest management and its value is on account of its future use rather than the current.

3.1.4 Existence Value

This value relates to the intrinsic worth of the forests regardless of the actual use. It is the value people derive from simply knowing that a forest exists, even if one has never visited it. It includes cultural, heritage, bequest and aesthetic values. Like option values, the existence values of forests are largely unexplored in Kenya. This value may be estimated by deducting people use value from their total willingness to pay for forest conservation or retain forests in its pristine states.

3.2 MODEL COMPUTING TOTAL ECONOMIC VALUE OF FORESTS

In any attempt to give the real or comprehensive value to forests-all forms of values including direct-use value (DUV), Indirect use Value (IUV), existence value (EV) and option value (OV) should be taken into account. The total economic value of forests can be calculated from a combination of all these values by the use of the model given in the form:

$TEV = f(D_{uv}, I_{uv}, E_v, O_v)$ where, TEV = Total Economic Value; D_{uv} = Direct-Use Value; I_{uv} = Indirect-Use Value; E_v = Existence Value and O_v = Option Value

$$TEV = D_{uv} + I_{uv} + E_v + O_v \quad \ldots\ldots(1)$$

There are quite a number of methods which has been developed by economist to capture the total economic value of forests. Combinations of these methods have been used for this study. There is no one approach which can capture the forest values. In this study the following valuation techniques were used (Table 3).

3.3 RESEARCH METHODS

3.3.1 Use of our reported values

This is obtained by asking respondents (using household surveys) the quantities of good (products) extracted from the forest per period and converting these to annual values. The quantities obtained are used to (impute value) for the resource in question by multiplying it by market price of the product (Pm); the total value of the product is the cumulative (aggregate) for the total number of households in the areas surveyed.

3.2.2 Forest inventory and value

This is done to capture mensurational data for use in valuation of standing stock in the forest by use of temporary sample plots. In this study 56 circular plots of 10m radius were used to collect data for individual merchantable tree species. The diameter at breast height and height were used to calculate the standing timber volumes using a model developed for indigenous forest by Muchiri et al., (1995).

The model equation used for computing volume was a general one developed for combined species in indigenous forest in Mt Kenya.
The equation is:
Log V= -39596+1.9274 log D+ 0.7988 log H.....2, where,
V =Volume (m^3); D= Diameter at breast height (Dbh) and H =Height in (m).
The volume was calculated for individual stem and converted to per hectare basis- and this was then extrapolated for the whole forest.
The sustainable extraction volume was calculated by assuming the sustainable levels for indigenous forest is 1% and making allowance for area reduction factor of 10% (Wass 1994). The timber value of sustainable timber extraction was obtained by the volume multiplied by the current royalty rates from Forest Department (2003) and the proportion of trees falling into good quality category. The quality of the trees in the forest was assessed on a 4 point scale (See appendix).

3.3.3 Market based approaches to valuation

These are methods of assessing the value of forest products by using the market price of product; the prices people are willing to pay or sell in market place; by looking at the prices of alternative or substitutes for forest products; by their expenditure on goods and services that are directly linked to forest benefits and by the way the forest benefits affect the value of other goods.

Market prices of forest products
This happens in situation where the commodity is tradable and the human preference can be estimated using the market prices. For forest benefits, this can be assessed by looking at the prices people are willing to pay and sell forest products in the market. The total value of product can be estimated using the own reported values and use of the market price –the price of the good should reflect the net of transaction costs. The value of product is given by expression:
Tn =Q (P)-C, ...3 ,where,
Q = quantity of good extracted = the forest gate price of good (which may be equal to market price in the absence of externalities). C= Transaction costs
The above expression can only apply where the rate of extraction is sustainable. If the extraction is not sustainable it is necessary to add a depletion premium (Godoy et al., 1993).

The market prices of substitutes or proxies for forest products
These methods are used to impute value for a good or service when there is no developed market or when the market fails to capture its total value (Panoyotou and Ashton 1992, Emerton 2001, Hufschmidt et al., 1983). Example is the case of firewood in rural areas where the market is not developed, so the use of next alternative (substitute) like Kerosene or Charcoal is used to impute the value of firewood. In these cases, the price of substitute good is used as proxy for forest use values.

Market valuation of Physical effects (MVPE)-Change in productivity
Forest provide positive influences on productive sectors but it value cannot be measured directly. Examples, forest provide watershed protection and soil conservation. These services prevent downstream siltation or flooding which have direct negative impact on human activities. We can calculate the value of farm production losses resulting from flooding or reduction in yields due to soil erosion. The value in losses can be attributed to the protective function/ecological functions of the forests (.Hufschmidt et al., 1983, Winpenny, 1993).

3.2.4 Benefit transfer approach

This is a method of valuing forest values where data is not adequate or absence but estimates of the values can be deduced from studies elsewhere. The suitability of this method is questionable due or the diversity of study sites but it can give an indicative value.

Table3: Valuation methods applied in the study

Product or service	Valuation method(s)
Firewood	Own reported values(Household surveys);opportunity cost of labour; Substitution method(Charcoal);Surrogate value by use of Kerosene ; secondary data
Growing stock (Timber)	Forest inventory methods and use of Current royalty rates from FD
Timber	Survey and market approach
Thatching materials(Grass)	Replacement cost approach/substitution method
Grazing	Livestock data(HH Survey, Secondary data, Key informants)and use of proxy prices (Substitute) of the next alternative to forest grazing(Hay)
Fencing /constructions poles	Own reported values(HH surveys),market approach
Forest honey	Own reported values and use of market approach
Soil conservation	Market valuation of Physical effects(MVPE)
Water shed functions	Market valuation of Physical effects(MVPE)
Biodiversity values	Benefit transfer approach(Secondary data)
Carbon sequestration	Benefit transfer approach(Secondary data)

4.0 FOREST VALUES

4.1 THE VALUE OF THE GROWING STOCK

The value of the growing stock was computed using the method described in 2.3.3 and taking into consideration the quality of the standing tree. It was found that 20% of trees in the forests were of good quality-straight stem and without notable defects. About 75% were in fair or poor state. The total potential value of sustainable extraction from this forest is slightly **3 billion per annum** (Table 4).

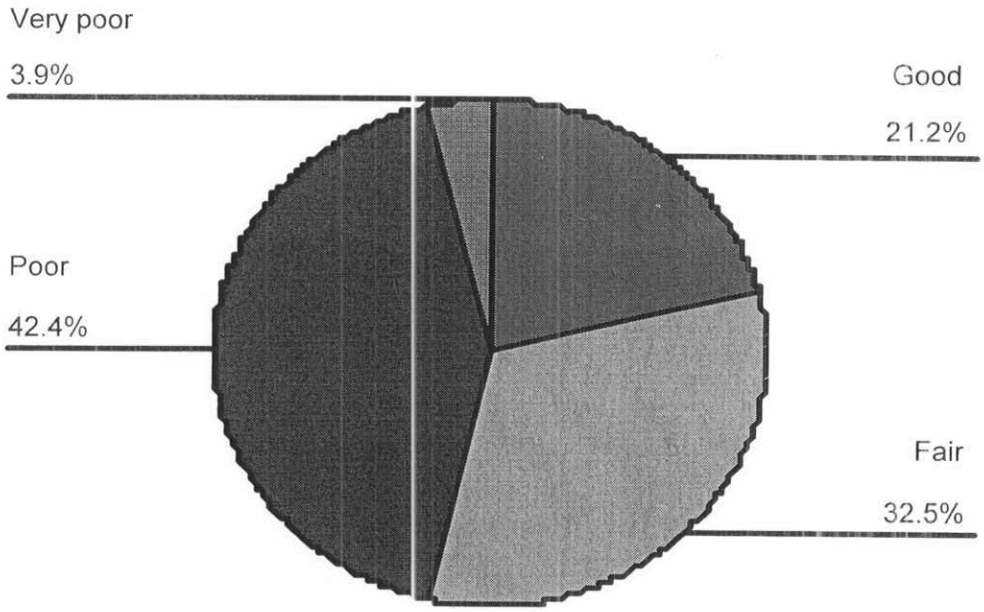


Figure 3: Proportion of tree quality from Tindiret forest

Table 4: Potential sustainable timber stock value[4]

Species	Vol/ha for good quality trees	Pot.value(Ksh s)/ha	Total pot.value Tindiret	Sustainable pot.value(Ksh)
Albizia gummifera	9.815	29141.67	204574504.59	204574.50
Allophylus abyssinica	4.160	12349.96	86696720.91	86696.72
Aningeria adoifi-friedericii	31.886	94669.43	664579432.67	664579.43
Cassipourea malosana	1.132	3361.60	23598399.60	23598.40
Cassipourea ruwensorensis	2.767	8214.78	57667771.85	57667.77
Celtis africana	4.664	13848.48	97216315.38	97216.32
Chepkorkomet local	0.747	2217.58	15567419.22	15567.42
Croton macrostachyus	2.974	7226.64	50730980.18	50730.98
Diospros abyssinica	7.607	18484.64	129762146.32	129762.15
Dombeya torida	0.979	2905.84	20399026.63	20399.03
Ehretia cymosa	0.734	2180.58	15307647.18	15307.65
Hagenia abyssinica	15.013	70273.92	493322896.30	493322.90
Lemeywet local	1.489	4419.70	31026266.36	31026.27
Macaranga kilimandscarica	2.385	7080.28	49703578.83	49703.58
Mutitiyet local	3.075	7471.97	52453227.57	52453.23
Olea capensis	0.342	1600.36	11234542.13	11234.54
Olea welwitschii	1.766	8267.94	58040903.94	58040.90
Podocarpus sp	4.862	17547.56	123183849.92	123183.85
Polyscias kikuyuensis	9.654	58353.88	409644250.69	409644.25
Prunus africana	2.432	58193.41	408517752.15	408517.75
Syzgium guineese	0.890	2641.39	18542555.30	18542.56
Trema orientalis	7.415	18017.96	126486054.93	126486.05
Tuishat local	1.331	3235.44	22712802.90	22712.80
Turraea holstii	0.062	150.03	1053241.22	1053.24
				3172022.29

Source: Field data, 2003

This value excludes the extra value likely to accrue for other products like firewood if the forest is sustainably managed.

4.2 DIRECT USE VALUES

4.2.1 SUBSISTENCE USE OF FOREST

The forest is important to the forest adjacent community for various products and services. The respondents identified the main forest products from the forest as shown in figure (4).

[4] The timber values calculated based on 2002-3 Forest Department royalty rates

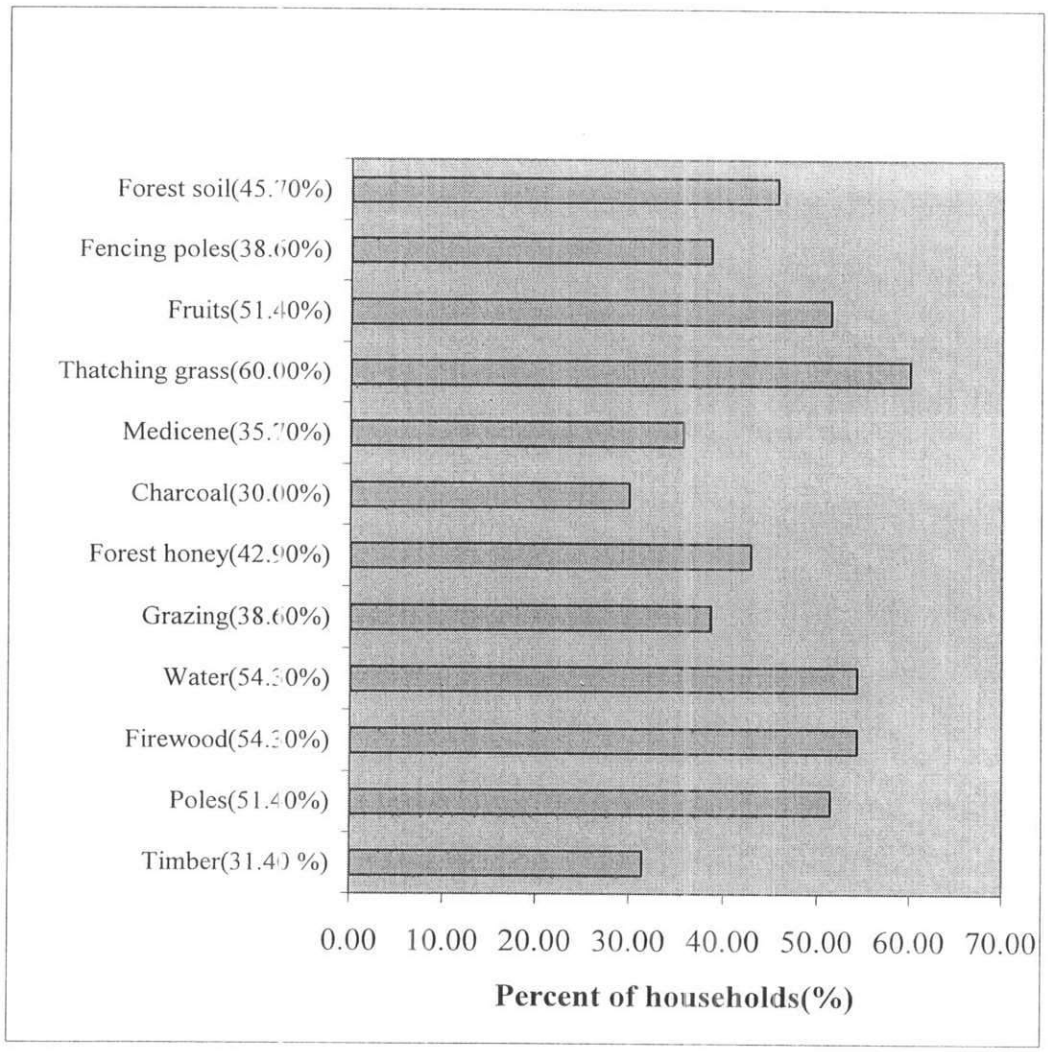


Figure 4: Importance of the Tindiret forest to adjacent households

4.2.2 Fire wood

Firewood is one of the common forest produce collected from the forest. The three adjacent villages have low level of investment in farm forestry (Personal observations). About half of the forest adjacent collect and use firewood for cooking from the forest (54.3%). Given that, there is no developed market for fuel wood in the area-an alternative approach of valuing firewood from the forest was used. Data on house hold consumption per year was obtained using – own – reported values from the household surveys. The total volume equivalent firewood was calculated for each household per annum. The total value of the firewood to the household was estimated using surrogate values such as the cost of Kerosene and charcoal equivalent. From the survey, each household on average consumes 85 back-loads per year. This comes to about 2.56m^3(85.4 *0.03[5]) of firewood per year. The value of forest as a firewood source is estimated using three approaches namely:

a. The opportunity cost of labour method and depletion adding premium for replacement cost
b. Use of surrogate price of Kerosene and

[5] A back-load is approximately 0.03 cubic meters

c. Use of charcoal as substitute and adding a depletion premium for replacement costs.
d.

(a) Opportunity cost of labour approach

The value of firewood is estimated based on the opportunity cost of firewood collection activities for domestic consumption. In the High potential areas of Kenya, it has been estimated that to collect a Kilogram of wood - collectors spend about 3.9 minutes (Hosier, 1981). If 4 minutes/Kilogram, that means 1 ton of wood requires 66.7 hours to gather (1000 * 4)/60=66.7). From surveyed areas about 1.856 tons per household is collected annually. Average wage rate in the survey areas is about Kshs 90.00 per day and therefore the effective working days is used in firewood collection 1 per ton is calculated thus (66.7/8=8.3 days[6])

Amount of wood collected by each household/yr =1.856tones); person-days spend in collection of fuel wood/per household per year is 8.3 multiplied by annual collection of firewood per household per year i.e person-days[7] =8.3* 1.856=15.40

Assuming that, the shadow price of labour equals the market wage excluding the replacement cost - the cost of firewood collection per household =15.4 multiplied by the prevailing wage rate in the area of Kshs 90.00. This calculates to Ksh. 1386.00. This value is treated as the present value of Tindiret forest as a source of firewood per household per year without the replacement costs of fire wood extraction from state forests. If this premium is added, (768.00 –see charcoal premium below) the total value of firewood collection is (1386.00+768.00) and comes to Kshs **2136.00**.

(b) Surrogate value approach

In the absence of fuel-wood, household would use the next alternative energy. In this case, Kerosene is taken as an alternative to firewood for cooking- this approach was used by World Bank (1980) for wood energy analysis for Kenya in 1980.

In order to compute the Kerosene equivalent of wood consumed per household. It is necessary to know the energy content of Kerosene (Paraffin). The calorific value of Kerosene has been estimated at 0.0351 GJ per litre (1 Giga joule = 10 joules Beijer Institute, 1982) .The Kerosene equivalent of the amount of firewood collected per household per year has been estimated as follows:

Average contained energy of 1 ton of wood = 16.3 GJ

Average GJ/m3 = 16.3* 0.725

(0 725 ton of wood = 11.8175 GJ

Kerosene equivalent of $1m^3$ =? Litres of paraffin's

Amount of paraffin with an equivalent of 11.8175 GJ is? Volume

This is given by (11.8175/0.0351) which is 336.7 litres.

($1m^3$ of wood has an equivalent of 336 7litres of paraffin's, but is known that paraffin stoves are 4 times more efficient than firewood stoves, therefore $1m^3$ equivalent of 336.7 liters is high and therefore, $1m^3$ of wood would have Kerosene equivalent of (336.7/4=84.17) liters. Markets surveys indicate that Kerosene retails for about Kshs 34.00 per liter and therefore 1 m^3 of firewood has a value of (34.00 * 84.175) which comes to Kshs 2861.95. To get the total value of firewood, it is necessary to know the amount of wood extracted annually per household. From the surveys and estimates, each household consumes an equivalent of about $2.56m^3$ of firewood. Total value = (2861.95*VH) - where VH is the volume of wood extracted by household per year.

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[6] A working day is assumed to be 8 hours

[7] in this case no distinction was made between the opportunity cost-value of women, children, un employed men and working men when calculating work-days per year required for wood gathering; all work-days are valued at the same average daily wage prevailing in the area at the time of survey

Therefore, the annual value for firewood collected is 2861.95 multiplied by 2.56 m^3 and it calculates to Ksh **7326.60** per household/year.

(c) Charcoal substitute approach

This approach assumes that in the absence of fire wood -charcoal will be used for cooking and heating as a substitute for firewood. The amount of charcoal equivalent is estimated as follows:
The calorific value of charcoal is approximately 33.1 GJ/ton roughly twice the figure per ton of wood. Under current end use conditions, charcoal stoves are approximately 2.8times efficient as wood stoves (Prasad, 1981). The charcoal equivalent of 1 ton of wood after charcoal stove efficiency factors (0.492/2.8)=0.175 tons or 175 Kg of charcoal. Therefore, for one ton of dry wood - about 175 kg of charcoal is needed to provide an equivalent amount of energy. Based on the survey estimates, an average household uses about 1.856 tons of firewood in one year. Therefore, the charcoal energy equivalent = (175X). The latest data on charcoal production indicates that charcoal is packaged in 30 - 35 Kg - and sold for (200-250.00) the approximate cost of charcoal to house holds/year = (X *175/30)* Pc); Pc =current price of charcoal per bag of 30 kg; X=amount of dry wood collected by locals per year.
From the surveys, each household consumes 1.856 tones of dry wood per year and the current price per 30-kg package is currently Ksh 250.00.therefore, the charcoal equivalent of firewood used per household per year is 1.856*175*Pc/30 and this calculates to Ksh 2706.66 If the replacement premium is added to this, the total cost is much higher. The cost of producing one cubic meter from public forests is about Kshs 300.00.therefore the replacement cost of charcoal used by households is 300.00 multiplied by 2.56 and this calculates to Kshs 768.00.The total value of firewood charcoal equivalent is 2706.66 plus 768.00 and comes to Ksh **3474.66.**
The three methods provide three different estimates of the value of firewood and the results are summarized in table below. To be conservative, the lowest value is chosen. On this basis, the value of Tindiret forest to the 3 villages is about Kshs **2000.00** per household per year.

Table 5: Value of firewood/household/year using 3 valuation methods

Method of valuation	Value(Kshs)
Opportunity cost of labour	2136.00
Surrogate approach(Kerosene)	73 26.60
Substitute (Charcoal)	3474.66

4 .2.3 Housing Materials

Most village houses were made from the materials from the forest materials such as timber; poles, rafters and thatching materials are collected as used by most households (table 1):

Table 6: Household use of building materials from the Tinderet forest

Item	% Proportion Respondents for three adjacent locations		
	Koigener	Kunyak	Chemamul
Timber	36.4	71.9	73.1
Poles	86.4	81.3	88.5
Thatching grass	63.6	59.4	69.2

Source: Field data 2003

Most respondents reported use of the forest as a source of building materials. Most respondents (64%) collect thatching materials from the forest and 7 out of ten respondents collect poles for construction from the forest. Though,the harvesting of timber is prohibited -there is still some harvesting of timber for home use and for sale. The collection of timber is more pronounced in Chemamul and Kunyak locations. The community in Koigerer the Okiek is mainly honey gatherers and not so much involved in extractive use of the forest.

VALUE OF BUILDING MATERIALS

In valuing household use of forest materials by adjacent villages it was assumed that in the absence of these materials from the forest the local people, all houses will have to be made by use of permanent materials such as corrugated iron sheets for roofing, sawn timber, stone and cement. The surrogate value of grass-thatched house was therefore equivalent to its replacement value, in other words, the combined value of sawn timber, corrugated iron, cement and other materials to make 'permanent house'[8].

THATCHING GRASS

The collection of grass for house roofing is still common in the forest adjacent communities and in the overall about 6 in 10 households collect grass for roofing in the study areas (64%-table 6). This means that – the forest is playing an important role in provision of shelter for most rural populations.

In the absence of market for thatching grass-valuation of this product is difficult. In this case, using the next substitute arrives at a surrogate value of the material. The next substitute for grass as a roofing material in the nearby areas is corrugated iron. Information from the field indicates that a moderate house with corrugated iron sheets would cost about forty thousand and would last for 30 years. The cost of replacing a grass thatched house with permanent one would be taken as surrogate value of grass thatched house. Ignoring the labour cost - the surrogate value of thatch grass house is calculated to be Ksh **1330.00** for each household/year. This was derived by dividing the replacement value or surrogate value of the grass thatch house, by the life of the 'permanent house. This approach is not without limitations since, the cost of labour which is substantial has been ignored and the residual value of the grass thatched house is assumed to be negligible. However, this is not the case in normal circumstances; remnants of the materials are in most cases used as for other farm structures. Given these limitations the value of thatching materials is an underestimate.

4.2.5 VALUE OF FENCING POLES

This is one of the products collected by the forest adjacent community for use in fencing and construction of farm structures. This is mainly done in Kunyak area and less of it is collected by the Okiek in Koigener and Chemamul. There are slightly over ten individuals who are actively involved in pole extraction from the forest (Table7).

[8] Permanent house as locally defined is at least house with corrugated iron with timber paneling or stone walling

Table 7: Basic statistic for fencing poles collected from Tindiret forest

Parameter	Minimum	Maximum	Mean	Standard Deviation
Quantity collected per year(N=12)	20.00	100.00	61.54	31.05
Market price(N=12)	30.00	50.00	48.33	5.77
Annual income/person(N=12)	1000.00	5000.00	2933.33	1656.60

Source: Field data, 2003

There are few individuals who are actively involved in pole collection. Most poles collected are for use in domestic construction. There are a bout 300 households bordering the forests from Kunyak area; if the total poles collected is estimated for the forest adjacent people-it comes to 18462 poles. If the poles were to be obtained from the market, it would cost the forest community about Kshs **892,268.00**

4.2.6 Animal Grazing

This is one of the extractive uses of forest. Many households value the forest as source of fodder for their livestock. A typical household in the adjacent area has at least 3, 3 and 2 cattle, shoats and donkeys respectively (Table8). The ownership of the cattle is highly skewed; 45% of the respondents had one to two animals.

According to local administration officials-25% of fodder is obtained from forests and the number of free ranging animals at any time is about 2,000. . -61.4% of the respondents graze their animals inside the forest (Table 9).

Table 8: Livestock information of Tindiret forest adjacent communities

Livestock	Mean (N=43)	Standard Deviation
Cattle	2.86	1.30
Shoats(Goats and sheep)	3.36	1.86
Donkey	1.67	0.81

Source: Field data, December 2003

Table 9 Do you graze animals in the forest?

Location	Do You Graze Inside Forest (% Of Respondents?) N=43	
	Yes	No
Chemamul	34.6	65.4
Kunyak	77.3	22.7
Koigener	77.3	22.7
Total	61.4	38.6

Source: Field data, December 2003

The value of the forest as a source of browse and fodder can be imputed from the net revenue of the animal products and the disposal value of the domestic animals themselves. Because, the data we collected was temporal, it was not possible to get exhaustive information and we relied in most cases on secondary data and use of substitute method in estimating the value of forest fodder. From literature, the dry fodder requirements for livestock is taken to be about 2-3% of the body weight per day (Ganesan, 1993) and the cattle in the forest adjacent areas weighs between

200-400Kg, with 300 kg taken as an average(Agriculture office, Songor 2003). The minimum quantity of fodder required for maintenance is therefore between 6-9 Kg per day. The cattle grazing within Tindiret forest is about 2000 and therefore requires 4380 and 6570 tones of fodder each year. Given that, the forest grazing is not all year round activity and provides about 25% (Pers.comm administration) -the fodder resources for cattle each year and therefore forest provide between 1095 and 1642.5 tones. To get the value of these fodder resources it is necessary to use the proxy value of alternative feed source. In this case, the value of these resources is estimated using the next alternative of hay. One bale of hay weighs about 20-30kg and it costs about Ksh 150.00. The Hay equivalent of 1095 tones from forest is equivalent to 1095 multiplied by 1000 and divided by 30 and it comes 36500 bales. This has a monetary value of **5,475,000**(36500*150). This is the estimate gross value of the forest fodder to forest adjacent communities.

FOREST HONEY

This is one of the non consumptive uses of forests. Most residents bordering the Tindiret forest get small amount of forest honey. The activity is more pronounced with residents of Koigener, who are largely honey gather community. In total, 43% of the forest adjacent collects honey from the forest.

Fig 5: Traditional bee hive placed inside the forest- this is common in most parts of the forest

ESTIMATING THE POTENTIAL OUTPUT OF HONEY

To estimate output of honey within the forests and the adjacent areas, the following information and assumptions are essential:

- The number of active bee keepers;
- The number of productive hives in a year or season;
- The productivity per hive per season.

Assumptions

- The skills of bee keepers are the same;
- Floral resources are abundant and are available through out the year;
- The bee colonies are strong;
- One-third of the beehives are dormant in a season;
- There are two possible harvests in a year.

Number of bee keepers

From the survey, it was established that there are about 50 traditional bee keepers/hunters using log hives or collect honey from the forest. In the villages, selected-few people are actually involved in bee keeping as a full-time but most are hobbyst. For this study, the number of bee keepers refers to those from Okiek community in Koigener village.

Number of hives

There are about 2 hives maintained by each bee keeper. This gives about 100 hives. If an assumption is taken, that two-thirds of these hives are productive in a year, then the numbers of productive hives are 70.

Number of harvests per year

From the survey, it is established that there are 2 major harvesting seasons in a year.
The expected productivity/hive per season is 3kg (Langat et al 2001).

Total honey production

Total honey production, can thus be estimated from the above parameters. From the above data, the total conservative estimate of honey in a year is calculated as below:
Total honey Production (Kg) = Number of productive hives/yr. x productivity per hive/season x number of seasons
Traditional bee keepers/hunters =70x3x2 = 420 Kg; therefore the total potential output of honey is about 420kg per year

Monetary value of honey

The total monetary value of honey collected from the forest is given by the market price multiplied by the total possible production in a year. From this data –the total value of forest honey is:

Tmh=Pm*Qcy,.....4;
where, Tmh –total value in Kshs, Pm- Market price per kg at the forest gate and Qcy- is quantity of honey harvested per year. The market price of honey at the time of the survey was 100kg per Kilogram. Therefore the value of the honey to the local economy is equivalent to Kshs **forty two thousand** (420*100).

4.2.8 TOURISM

The recreational value of this forest could not be estimated because; presently the forest is not in the tourist circuits and therefore data on visitors (local and foreign) are not available to capture the recreation value.

4.3 NON USE VALUES

4.3.1 SOIL STABILISATION VALUE

Forests play a major role in soil and water conservation, particularly the regulation of water flow and control of floods and erosion. There is at present little information or data to quantify the contribution of forests to soil stabilization or water catchment.

Soil conservation benefits

Soil erosion is affected by many factors and the relations are complex .Rainfall induced soil erosion is related to the intensity and periodicity of rain, soil type, slope and the nature of vegetation, and the agricultural practices prevalent within a given area. Because of the variation in these contributory factors, the extent of erosion can vary from one plot to another. Quantitative data at the moment is not available to allow for estimation of forests soil conservation benefit flow in a meaningful manner in the context of Kenya (Chartanjee 1992). In this study, the assessment is based on comparative role of forests as compared to other land use. In this analysis secondary data sources were consulted to arrive at the possible estimates. The study relied mainly on a study by FAO/IISA, 1991 (Table 10-14).

Table 10-12 shows the cover factors for different types of vegetations. In these tables the cover factors are described as "an overall factor for protection of soil from rainfall induced erosion by the vegetation canopy". The tables indicate cover(C) factors for pasture, crops, and tree and shrubs canopies and for undisturbed humid forests with little litter layer. From these tables it is evident that, undisturbed humid forest with litter layer at least 50mm thick offers the best cover against rainfall induced soil erosion. Pasture lands are better than annual crops, while protective cover provided by tree and shrub canopies depends on their average heights. Cover factor for a combination of vegetations can be estimated by multiplying their respective covers together to get aggregate cover factor (Chartanjee 1994). Table 13 shows the elation ship between top soil loss and the resultant crop yield loss. Table 14 ranks the soils of Kenya according to their susceptibility to productivity loss per unit of top soil loss. On the basis of these value and data from table 10-14 two hypothetical situations are presented to give indicative values for the intangible value of forests to soil conservation and watershed management for this forest.

To evaluate the soil conservation benefit of Tindiret forest, a hypothetical case of conversion of such lands to maize cultivation is used. The following important assumptions are made to facilitate the calculations:

a. Tindiret forest is undisturbed humid forest with litter layer of at least 50mm with a canopy 75% cover with 90 % area covered by at least 50mm of litter;
b. The above humid forest is converted to maize cultivation with 80% vegetative cover, with intermediate input;
c. The soil susceptibility to erosion is intermediate;
d. Bare ground of soil loss due to rain induce erosion is 0.5 cm of top soil per annum.

Cover facto (C) for the humid forest is 0.001 and the soil loss for this cover is 0.001 multiplied by 0.5 cm =0.005cm.

On conversion to maize with conditions stated, cover factor (c) (table 12)=0.30, soil loss per annum for this cover is 0.30 multiplied by 0.5 =0.15cm, therefore soil loss measured in terms of incremental top soil eroded due rain induced erosion is 0.145cm(0.15-0.005)

Assuming annual maize yield per hectare of 45 bags, valued at Kshs 1600/bag (2004 prices), gross yields is equivalent to Kshs **72,000.00**.

From table 13, yield loss (Y) =1.2X, where Y= productivity loss in percent; X = soil loss in cms, therefore the soil loss of 0.145cm occasioned by changed land use causes a reduction in yield of 1.2* 0.145=0.174% or Kshs **12,528.00.**

Soil conservation value of this forest, under the assumptions stated, can therefore be estimated at Ksh **12,528.00/ha**. This will however change with different sets of assumptions. Using this scenario, the estimated benefit for this forest under the above assumptions is Kshs **86,696,000.00** per annum (total forest area is about 7000ha).

Table 10: Cover factor (C) for pasture

Vegetation cover (%)	Soil loss (in proportion to loss from bare soil)
0	1.00
10	0.33
20	0.20
30	0.15
40	0.10
50	0.07
60	0.042
70	0.024
80	0.013
90	0.008
100	0.003

Source: FAO/IISA (1991) cited in Chatterjee, 1992

Table 11: Cover factor (C) for crops

Vegetation cover	Soil loss (in proportion to loss from bare soil)	
	Annual crops	Low perennial crops
0	1.0	1.0
10	1.0	0.33
20	1.0	0.20
30	1.0	0.15
40	0.86	0.10
50	0.72	0.07
60	0.58	0.042
70	0.44	0.024
80	0.30	0.013
90	0.16	0.008
100	0.02	0.003

Source: FAO/IISA (1991(cited in Chatterjee, 1992

Table 12: Cover factor (C) for undisturbed humid forest with litter layer at least 50mm thick

Area Covered By Canopy Of Trees And Undergrowth (%)	Area Covered By At Least 50mm Of Litter (%)	Soil Loss In Proportion To Loss From Bare Ground
100	100	0.0001
75	90	0.001
50	75	0.003
20	40	0.009

FAO/IISA (1991) cited in Chatterjee, 1992

Table 13: Relationship between topsoil loss and yield loss

Soil Susceptibility Ranking	Level Of Inputs	Equation
Least susceptible	Low	Y=1.0X
	Intermediate	Y=0.6X
	High	Y=0.2X
Intermediate susceptible	Low	Y=2.0X
	Intermediate	Y=1.2X
	High	Y=0.4X
Most Susceptible	Low	Y=7.0X
	Intermediate	Y=5.0X
	High	Y=3.0X

FAO/IISA (1991) cited in Chatterjee, 1992

Table 14: Ranking of soil (Kenya Soil Survey) according to their susceptibility to productivity loss per unit of top soil loss

Most susceptible	Intermediate susceptible	Least susceptible
Acrisols, except humic acrisols	Arenosols	Chemozems
Ferralsols, except humic ferralsols	Cambisols,except ferralic cambisols	Fluvisols
Ironstone soils,	Gleysols	Histosols
Lithosols	Greyzems	Humic andosols
planosols	Humic acrisols	Mollic andosols
Redzinas	Humic Gerrasols	Vertisols
Solonchaks	Kastanozems	
Solonetz	Luvisols	
	Nitisols	
	Phaeozems	
	Regosols	
	Victric andosols	
	Xerosols	
	Yermosols	

Source: FAO/IISA (1991) cited in Chatterjee, 1992

4.3.2 POTENTIAL FUTURE VALUE OF BIODIVERSITY FOR INDUSTRIAL USE

This forest is rich in flora and fauna. The future potential value o f these resources are not captured in the present study but it is estimated that as bio-prospecting picks up in the country the value of resources to the industry will be known. There are few data from Kenya, which can be used to estimate these values, and studies from elsewhere suggest that benefits are likely to be modest and difficult to measure (Ayward and Barbier, 1992). One study by Pearce et al, 1993 suggests that tropical forest have biodiversity values in the range of $0.01 and $21 per hectare and because Kenya is not well endowed in biodiversity like rainforest countries of South America or Asia, the value is likely to be low than those quoted for biodiversity rich countries.

CARBON SEQUESTRATION

The net benefits from carbon sequestered in the forests and other undeveloped areas can be expressed in terms of the damage the carbon would do if released as carbon dioxide following conversion of land, and would reflect the difference between the amount of carbon sequestered under present and future land uses. In this study, there is no data of the actual potential of forest to sequester carbon, but reliance is made of studies undertaken elsewhere, Nordhaus, (1991) and Schneider, (1991) reported a range of possible values for the carbon sequestrated in tropical forests to be between $1500-3500 per hectare per year; while Brown (1992) and Pearce et al. (1993) gives values of $320-1600 per hectare as the net global costs of converting tropical forests to agricultural use.

Though, it is not clear how such data can be applied to our situation - benefits from this function are enormous. As point of indicating the likely magnitude of the service offered by this forest, it is possible to use the lowest value of $320/hectare/year cited Brown (1992) and Pearce et al. (1993) to come up with a tentative estimate of benefits of retaining the 7000 hectare of Tindiret forest. Using these figures, the value of this forest as carbon stock is **$2,240,000**. This is a value which accrues as a global benefit and it is difficult to indicate how such global benefit can be internalized or appropriated in Kenya.

4.4 SUMMARY OF BENEFITS

4.4.1 Direct uses

An estimate was made based on the field data on the direct use benefits accruing to the forest communities and the indirect use values.

The table 15 gives a summary of direct benefits for the three adjacent villages. These values are based on the estimated household size of 1300.

Table 15: Monetary value of forest benefits to the three forest adjacent villages

Product	Benefit/Hh/Year	% Proportion Hh	Estimated Total(Kshs)
Grazing	421[illegible].50	38.6	2,080,500.00
Poles	2948.10	51.4	1,969,853.00
Firewood	2136.00	54.3	2,776,800.00
Thatching grass	1330.00	60.0	1,037,400.00
Forest honey	32.30	42.9	42,000.00
Total			7,906,553

Given the extend of the forest, the above value of Kshs 8 million is only applicable to the three villages(locations) and the total value of this forest to all forest adjacent community is much higher. If an assumption is made that, there are 5000 households adjacent to the forest, then the direct use values to the community is estimated to be Ksh 30million per year. These values exclude other important value like forest foods, medicinal plants, fibers, forest soils, and cultural uses etc which were not captured from the surveys.

4.4.2 Indirect use values

The indirect use values based on data obtained from elsewhere indicate that, the forest provide a carbon sequestration value of equivalent of about Kshs **180 million,** however, this value accrues to global community and not restricted to Kenya.
Using a hypothetical case of change in land use, this forest is worth about Kshs **87 million** in soil conservation. This value is speculative (not based on actual data) and should be used with a lot of caution.

4.5 OPPORTUNITY COSTS OF CONSERVING TINDIRET FOREST

In the absence of the forest, the forest land occupied by Tindiret natural forest could be put under human settlement and agricultural and livestock production. Therefore, the opportunity cost of the maintaining this forest is the net benefits foregone from the potential agricultural and livestock production. From the expression:

$OC_{conservation} = NB_{potential\ development}$ and

$\mathbf{NB_{potential\ development} = NR_{potential\ development} = GR_{potential\ development} - C_{potential\ development}}$

Where, OC= opportunity cost of conservation; NB= net benefits of potential development; NR= Net Revenue from development; GR=Gross revenue from development and $C_{development}$ = cost for potential development.

So the opportunity cost of conserving the Tindiret forest is then net revenue obtained when the forest is converted to agricultural production.

The value of agricultural and livestock production is a function of land potential: land with good soils and rainfall will produce more than one drier land with poor soils. The area is good for livestock production and agricultural production mainly –tea growing. For practical purposes, this study has used the tea- growing in arriving at the opportunity cost of conserving the forests. The net return from growing of tea in the area is about 30,000 per hectare (Tea Research Foundation, pers. comm.).

It is assumed, that the total area under forest can be put under tea with the best agronomic practices, the net returns are as indicated by TRF, then, the opportunity cost of Tindiret forest is Kenya Shillings two hundred and ten million (**210,000,000.00**).

4.6 NET BENEFIT OF CONSERVATION

This is the total economic values of the forest less the cost of maintaining it. These include the costs of managing the forest in a year and the opportunity cost of the forest in its present state as a conservation area. In this study, it was not possible to obtain data on operational costs from forest department but it is assumed to be negligible. Therefore, the net benefit of conservation can be summarized by the expression below:

$NB_{conservation} = NB_{direct\ use} + NB_{indirect\ use} + NB_{non\ use} - OC_{conservation}$ 5

The direct uses are from products collected by local communities; the indirect values could be soil conservation and watershed protection, carbon sequestration and potential future value for industry; the non use are for option and existence values; and the $OC_{conservation}$ is the opportunity cost maintaining the forest in its present state. The indirect use -soil conservation values is based on a hypothetical situation and this value cannot be said to be true value of soil conservation attributed to this forest; the non use value were not estimated in the study. Given that we could not realistically calculate the indirect use and non use values; the indirect use and non use values are ignored in this anlysis

$NB_{conservation}$ =30m + ($NB_{indirect\ use}$ + $NB_{non\ use}$) -210m= **-180m**.

Based on this analysis, the current benefit from this forest is inadequate to offset the opportunity cost of leaving the forest in its present state. The value of sustainable extraction of the growing stock is substantial and is estimated at **3billion**. This value is not being realized now because of the ban on exploitation of indigenous forests and if exploitation is allowed, the actual value will be dictated by market conditions and the likely social costs exerted on the forest due to harvesting (negative externalities).

5.0 CONCLUSSIONS AND RECOMMENDATIONS

Tindiret natural forest is conservation are and therefore, there is no sanctioned exploitation. Though, it is not a productive forest, the forest adjacent community extract forest products to a large extent. The forest is important is sustaining the livelihood of the adjacent communities and the value of these extraction from this analysis is about **30 million per year**. This is still a conservative estimate considering that other values were not estimated. Though, the forest is benefit the local communities through direct use there are other costs associated with bordering the forests especially on the destruction of human activities and human life by the wildlife. This is especially true in areas in Koigener village where, the lone elephant has caused immense damage to crops and human life. The monkeys have also destroyed crops.

The indirect use values are quite substantial but the problem is that most of these values are accruing to global community and Kenyans have no way of appropriating the values. The values like carbon sequestration are global values and local communities are bearing the costs of maintaining these forests. Based on the results of this analysis, the government and local communities are subsidizing the retention of the forest. This subsidy is presently estimated at **180million** through lost opportunity in settlement and income. This study reinforces what was found by Northon-Grifths and Southey (1993) that the Government is heavily subsidizing conservation In Kenya because most of the benefits accrue to global community.

The only way the local community can benefit more and appreciate the presence of the forest is to be encouraged to develop more consumptive use of the forest like honey production. The Forest Department and Kenya Wildlife Service (KWS) should also develop the area as tourist site so that revenue from recreation can offset the high costs of maintaining the forest.

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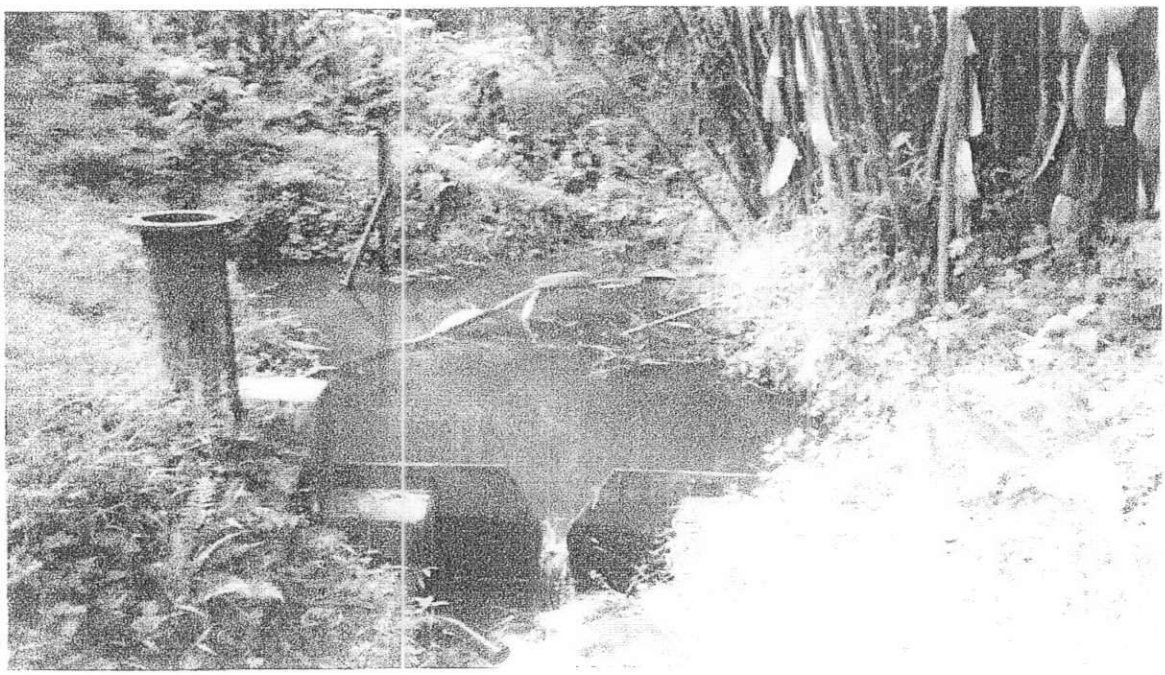
4.4 REHABILITATION /RESTORATION OF RIPCHORIAN RIVER CATCHMENT



By J.C.Njuguna and J.Mbinga

1.0 Introduction

Rehabilitation of Kipchorian river catchment is an on going project. It is a pioneer trial on restoration of the degraded environment that has been caused by the human interference through agents of destruction.

Kipchorian river is the main tributary of river Nyando which is heavily relied on by the sugarcane and rice irrigation schemes at the Nyando and Kano plains respectively. It is also the main water source for Londiani town and its environs.

Degradation of this catchment goes back in 70s when charcoal-burning operation started. This saw the clearing of the various species among them the *Oleas* and *Acacias* that occupied the catchment.

The water levels have declining with time and today the volumes have been reduced drastically.

A dam with a capacity of 40,000cubic metres per day was constructed by the Ministry of Water to supply water to Londiani and the environs. To date this volume has been reduced tremendously due to the high rate of silt deposition mainly caused by the degradation at the upper catchment.

The effect was amplified when shambas were allocated to the surrounding communities who have opened up the area to the riverbanks exposing the sites to severe erosion.

The river discharge has not only being been reduced but this has compromised the water quality at the dam which has been rendered unfit for human consumption. The water therefore requires a full chemical treatment before use.

The water flow from the catchment has been experiencing irregular trends due storms as there is very little infiltration process taking place due to the high levels of degradation.
Maintenance of the installed structures remained an important function in the flow assessment process. Current gauging is done periodically to ascertain the speed of the river for the volume computation.
Awareness campaign was done through a field day last year when the farmers were sensitized on catchment conservation, protection and management.

2.0 Objective

Rehabilitate degraded catchment in order to impound water in the forest and to conserve the vegetation.

3.0 Methodology

The study area is a degraded site in Masaita forest block which lies five kilometers north of the Research Center.
There are other two sites namely Mukuru and College catchment that are three and two kilometres west of the center respectively.
The main work undertaken at river catchment is;

Planting of desired riverine tree species.
Encourage natural vegetation through site enclosure.
Collect river flow data from the five fixed structures in the rivers.
Collect rainfall data for discharge computation.
Collect water samples for quality analysis.
Ecological assessments on the vegetation growth and development.

4.0 Activities

These are the activities that were successfully executed during the year.
Planting of trees and bamboo seedlings
Wilding collection
Assessing the discharge (flow)

4.2 Rehabilitation work

Various tree species and bamboos were planted in the site with an aim of covering the whole area with vegetation.
The exercise has been difficult in past when there was no proper collaboration between the farmers and the Center, but this year a large chunk of land was covered as the forest cultivation was stopped. The only problem we are facing is the adjacent communities grazing in the site although we have embarked on forest guard's patrol.
A total of thirty seven hectares were planted this year and with the current protection the survivals and establishment is expected to go high.
On the abandoned sites, grass has started colonizing and new species have started coming up gradually.
The bamboos introduced are aimed at closing the site faster due to their faster growth rate. This year a total of 20000 seedlings of various species were planted.
The species included:

Primus Africana, Zizygium guenesi, Olea Africana, Acacia polycantha, Juniperus procera, Arundineria alpina (bamboo), *Acacia gerandii, Acacia lahii, Zizygium cuminii, Zizygium cordata, Spathodea nilotica, Frazinus berandriana, Grivellia robusta, Bambusa vulgaris,* (bamboo), *Fagara micropylla, Terbanamontana stiphiana, Croton microphyla, Cuppressus lusitanica,* and *Essente ventricosum* (wild banana).

The rate of planting was low and could have taken more than five years to stock up the 100 hectares intended for this work but at the rate that was done this year we expect to achieve our target in three years period. Other methods of rehabilitation will be employed to speed up this operation. Natural regeneration through enclosure of the area is one of the options that is been experimented. Possibility of closing 50%of the area would accelerate natural regeneration process while the reminder would be planted with the assorted indigenous seedlings.
When natural regeneration and reforestation are coupled, the healing process will take a shorter period.

The rehabilitating material will not be exclusively indigenous species but other faster growing exotic species compatible with large amount water will be included.
Bamboo which is a well known water conservation species will be planted in large numbers in order to accelerate the hearing process. Other species will include, *Grivellia, Zizygiums, Bischoria, Cassia* spp, *Tipuana, Poplar, Phoenix* wild banana *(Esente ventricosium), Meritia dura*, various grasses and shrubs
The photograph below shows indigenous bamboo propagation.

Photo No.1: Bamboo off-set propagated for rehabilitation work

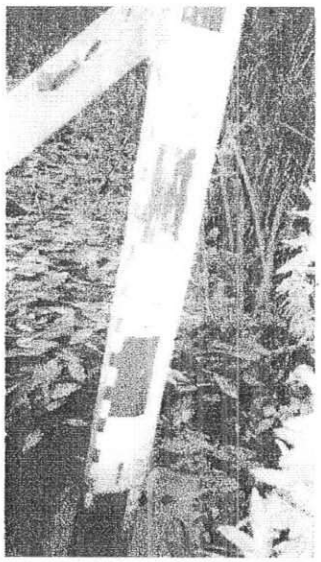
Flow assessment

River flow assessment is important exercise for the discharge computation. The study of river flow is known as hydrometry and expressed in cubic meter per second (m3/s).
In order to arrive at the above units we need to know the velocity and the cross-sectional area of the river.
We use trapezoidal rule in calculating the cross-section area with the aid of the gauging height that are read daily. The velocity of the river is measured by a current meter instrument, which is shown in photo No.2 below.
Current meter is only applicable to rivers with large volumes. For small streams, a floater device is used but this only gives speed at surface.
For large rivers, the flow is a sampling procedure while in springs and small streams accurate volumetric quantities over time could be measured. In large rivers, continuous measurement of the level is related to the discharge and is calculated by variables such as velocity and cross-sectional area (Shaw 1989).
Q denotes discharge, which is a product of cross-sectional area and velocity
Q =v * a where **(v)** is velocity and **(a)** is the cross-sectional area of the river at the gauging station Lee (1980).
The instrument for gauging water flow is known is the gauging staff for large rivers and miniature for small steams. Weirs are also used when the volumes are very small or when there is need to direct the water in a particular direction. The cover page show a weir.
Weirs can be used where people are drawing their water, and in order to know the discharge, a steel rule is used for measurement.
Photograph No. 3 is a gauging staff at Masaita River commonly known as main Githee station.

Photo No. 2

A current metre instrument used for measuring river velocity.

Photo No.3



Gauging staff for assessing the discharge

5.0 Way forward

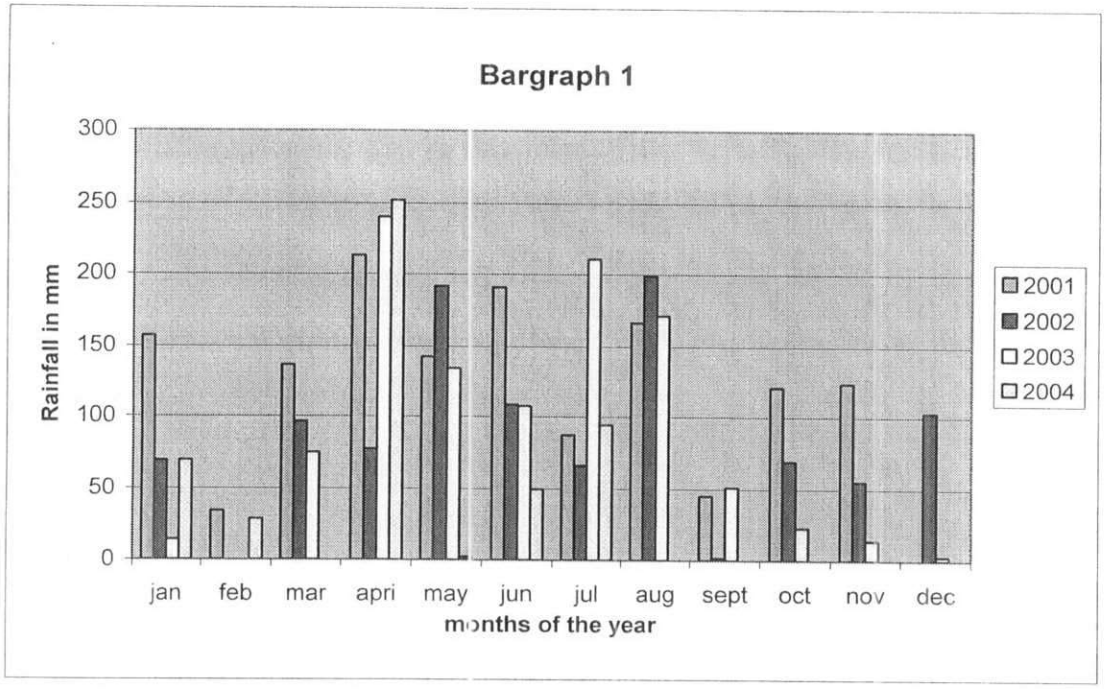
Several activities need to put in place in order to have an impact on this work. It has been noted that materials propagated from seed can only be planted when they are half (1/2) a meter tall in order for them to out compete grasses and other shrubs.
For this reason, there is need for them to stay a little longer in the nursery than exotic species. This has prompted the collection of wildings to bridge up this gap.

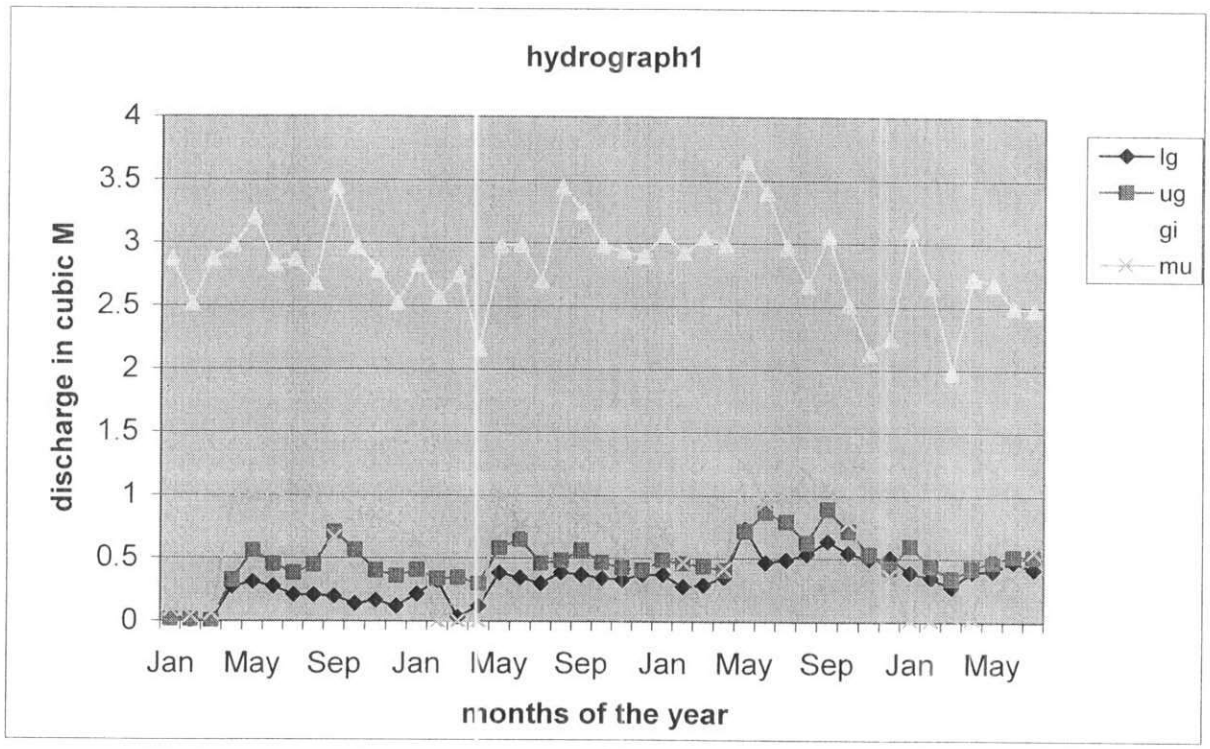
The activities that we anticipitate to do are as listed below.

1. Collect more indigenous wildings from various sites.
2. Propagate more exotic bamboos for next years planting.
3. To incorporate other exotic species such as *Grivellia robusta* to enhance growth and ground cover.
4. To ensure regular survirance at the site to discourage encroachment by animals interfering with the planted seedlings.
5. Assess the quality of water for comparison with the base –line information done four years ago.
6. Assess the regeneration rate through the ecological plots set in the site.he Centre
7. Enrich the College catchment with various types of bamboo and construct corridors for water fetching by the villagers.
8. Incorporate a senior scientist from the university in order to broaden this work.

6.0 Results and Discussion

Hydrological work is complicated and therefore requires time and patience. Tree planting on degraded sites is one among the many option of restoration. Planting alone cannot be relied on and so other methods such as natural regeneration through ground closure needs to be addressed keenly.
The up surge of discharge levels is a direct measure of restoration and therefore the monitoring of the same should not be ignored. Both quality and quantity assessment are critical for any restoration as they are the main parameters of change. Where forests are closed from any human or livestock activity, the levels of water quality and quantity for a single stream are very high.
Water quality assessment from different points along the same river varies as indicated by our baseline studies. Steady flows depict canopy closure where the river does not respond positively to the rains. This is expressed in graphical representation for Gichorio which has a third of its catchment under natural forest(see the hydrograph).
Rainfall remains the main contributor of the water in this catchment unlike the high mountainous sites where there is snow that recharges the steams and rivers during the dry seasons. Water in these rivers comes either as run off or ground seepage through the infiltration process.
The discharge in all the rivers responded positively to the storms but their water release differs.





The forested catchment continued to exhibit a unique characteristic as opposed to other catchments as seen from the graphical expression (hydrographs 1) above. The steady flows which have been reported in other reports continue to come thus confirming the hypothesis. Gichorio which eminates from a forested catchment denoted by **(gi)** has this phenomena and does not respond positively to the storm.

Although the flow peaks in other rivers are within the rainy season, forested catchment flows continue to be expressed two months later.

With the act of closing the site from animal intrusion water is seen oozing from furrow land where grass has started colonizing. With this colonization we expect other species of plants to come up and this will definitely increase the water levels in our two gauging stations at lower and upper Githee streams.

Recommendations

For any success in rehabilitation, the following need to be observed.

1) Close up the site from any human and livestock activity as these will enhance further degradation and impede any natural regeneration process.
2) Control any fires for these will destroy any reforestation and natural regeneration activity that may be in progress.
3) Allow colonization of grasses as this is the first step in natural regeneration. Grasses will come first them other species secondary.
4) Establish fast growing species to allow cover first. Grass is a good covers crop but it inhibit growth of some species due to high competition for nutrients. Species that will best fit the set up are the grass family species followed by other pioneer species.
5) Educate all stakeholders on conservation protection and management of catchments holding talks in the affected sites.
6) Assess the flows regularly to observe any changes that may occur and construct a water budgets to see the rate of infiltration.

Reference:

Richard Lee (1980) Forest Hydrology Cambridge University Press

Elizabeth M. Shaw (1989) Hydrology in Practice T. T press (pad stow) Ltd

5.0 PROGRESS REPORTS IN FARM FORESTRY PROGRAMME

5.1 PROGRESS REPORT ON PROJECT NO. FF/LN/13: DEVELOPING A PYRETHRUM AGROFORESTRY PRODUCTION SYSTEM

By Juliet Wanyondu

Collaborators: Joram Mbinga, Joseph Ikahu (Kari – Molo), Geoffrey Gathungu (Kari – Molo)

INTRODUCTION

The land use system of combining seasonal crops with the initial stages of raising trees has been used successfully in many parts of the world. In Kenya the practice which was previously called "shamba system" but has since been changed to non resident cultivation (NRC) is well known and has been practiced for a long time. The system has been used by the Forest Department to successfully establish high quality plantations and ensures high seedling survival rates at minimal loss. Under the system, non- resident farmers are rented portions of clear felled forest land to cultivate and raise agricultural crops. During the second year, farmers are supplied with tree seedlings which they plant and tend until they become too big to allow meaningful crop production. This way, the government benefits first from the rent paid by these farmers and also it succeeds in raising forest plantations without incurring any establishment and weeding costs. The farmers benefit by being self-sufficient in terms of food and the income they get from the sales of surplus food. So far, NRC has been used at subsistence level by farmers to grow food crops (Wanyiri et al 2001). The potential for the system to grow short rotation cash crops like pyrethrum on forest land does exist.

Pyrethrum (*Chrysanthemum cinerariaefolium*) is a short rotation cash crop grown for the production of flowers from which natural pyrethrin is extracted. Pyrethrin extract is important in the manufacture of environmentally friendly insecticides. Insecticides from pyrethrum are more popular than the synthetic ones especially in areas such as grain protection, home gardening and pet care because they are biodegradable and have no toxic residue like the synthetic ones. The growing conditions of pyrethrum are those found in high potential areas at an elevation of between 1500m and 3000m above sea level. The crops rainfall requirement is about 750mm and should be well spread over the season. The soil should be fertile and rich in phosphorous, calcium and magnesium in addition to being well drained with a good structure and texture (Ikahu and Ngugi, 1988).

Such high potential areas are also the ones which are suitable for forest plantations and other agricultural activities. The areas consequently support a high human population leading to very high competition for land.

Appropriate land use technologies which have been developed over the years must find a way of being transferred to points of use where they will solve problems of maintaining and ensuring productivity in the face of dwindling resources as is the case of Kenya's high potential areas.

OBJECTIVES

The main objective of this project is to investigate whether planting pyrethrum with tree seedlings has any negative effect on tree seedlings and also investigate whether growing trees in the same plot with pyrethrum has any effect on quantity and quality of pyrethrum grown under this system and to recommend appropriate agro forestry technologies in farmers' and forest lands.

SPECIFIC OBJECTIVES

i) study the effects of pyrethrum on tree establishment and growth when they are grown together
ii) Study the effects of trees on pyrethrum production by determining the quantity and quality of pyrethrum produced under the proposed agroforestry system.
iii) Identification of suitable and adapatable tree species to be grown with pyrethrum both in forest land and on farms and appropriate management techniques
iv) Study whether farmers can adopt the practice.

MATERIALS AND METHODS

This work is being carried out in collaboration with Kari Pyrethrum Research Center - Molo and a series of meetings between KEFRI – Londiani and Kari have taken place.
A stake holders workshop was held in March 2003 involving farmers, forest officers, agricultural officers, researchers and local pesticide manufacturers to share ideas and expertise in general awareness of the potential of agroforesty in pyrethrum production and. the workshop proceedings were published.

PHASE 1

Pyrethrum Agroforestry Production System Under NRC

On forest land in Masaita , which is used as a teaching block by Kenya Forestry College, suitable clear felled sites were selected. Identification of farmers to participate in the exercise under NRC was done in the selected sites with the assistance of the forester in charge of the block. A total of eight farmers were chosen for the exercise but two of them later abandoned the experiment at one site. Their pieces of land were in units of approximately half a hectare. Soil sampling in collaboration with Maseno Centre was done. Analysis was done and an interim report written.

Seedlings of common plantation species were raised in the nursery at Londiani and planted on the selected sites in a randomized complete block design. These species included *Cupressus lusitanica* and *Pinus patula* This was done in June /July 2003.
A total of eight half acre plots were planted in those two areas. Pyrethrum seedlings for the experiment were provided free of charge by the Pyrethrum Board of Kenya through Kari, Molo Research Station.
There was follow-up of experiments planted in early 2003 plus maintenance of the experiments and data collection. Due to the disruption in the shamba system, special permission was sought from the forester to continue tending the experiment. The plots which were under control were

also weeded in order that the experiment be uniformly treated. The tending that these seedlings under control would have received was still continued.

RESULTS

Preliminary results show a big difference in height growth between seedlings growing together with pyrethrum versus the control. The table below shows differences in average height growth between the two categories of seedlings.

Table 1: Height growth measurements for Pinus patula

Inter cropped with pyrethrum	Plot No 1	Mean height three months after planting (cm) 24.55	Mean height (cm) 64.46
Inter cropped with maize	2	24.21	31.7

Table 2: Cupressus lusitanica

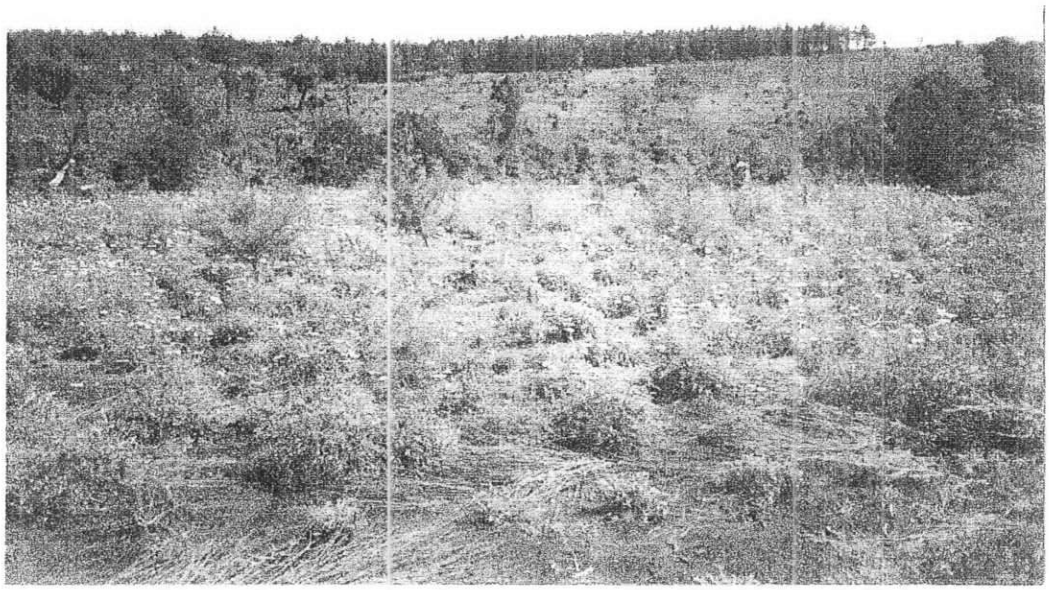
	Plot No.	Mean height (cm) three months after planting	Mean height (cm)
Interplanted with pyrethrum	1	58.90	132.45
Interplanted with maize	2	54.46	81.91
Interplanted with pyrethrum	3	53.95	114.17
Interplanted with pyrethrum	4	Nr	87.38* (neglected)
Interplanted with maize	5	Nr	73.47
Interplanted with maize	6	Nr	69.87
Interplanted with maize	7	Nr	63.23
Interplanted with maize	8	Nr	80.81
Interplanted with pyrethrum	9	51.99	122.28

Nr: Not recorded

DISCUSSION

Preliminary results show a big difference in height growth between seedlings growing together with pyrethrum versus the control. The table below shows differences in average height growth between the two categories of seedlings.

Mean height for *C. lusitanica* seedlings grown under pyrethrum was 114.07 cm while those under control was 73.85 cm while the mean height for *P. patula* seedlings grown under pyrethrum was 64.46 cm while those under control was 31.70 cm. It is thought that competition for light and competition from weeds affected growth performance of tree seedlings in the control plots which were intercropped with maize. The seedlings grown together with pyrethrum are always under continuous cultivation and are therefore free from competition for light and competition from



weeds. However data collection will continue for about three years before tangible results and conclusions are obtained.

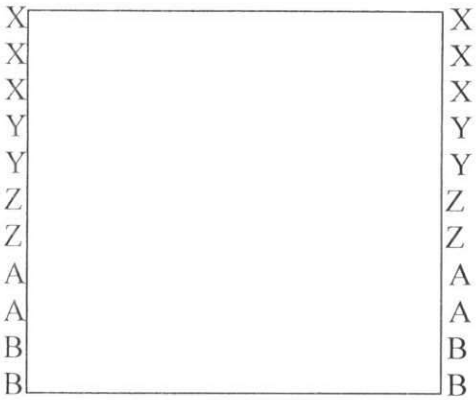
Figure 1: Cupressus lusitanica intercropped with pyrethrum at Masaita

PHASE 2
Pyrethrum Agroforestry Production System In Farmers' Lands

During the second phase of the project, the following activities were carried out:
A survey of farmers who were to take part in the next phase of the project was also done. This was done together with Officers from the Ministry of Agriculture and scientists from Kari – Molo. Interested farmers were selected based on a social economic survey carried out to identify the most suitable farmers to participate in the exercise. The qualifying criteria being a farmer who already had a pyrethrum crop and was interested in incorporating trees in the plot. The farmers' profiles and background data e.g. size of land under pyrethrum, production systems and constraints were taken.

Farmers were chosen from three sites. These were Molo, Kamwingi and Kamara. Five farmers were chosen per site. The chosen farmers were those that had similar farming practices in each

site. Nearly all the farmers chose boundary planting along their pyrethrum plots. This was done in a completely randomized block design where the farmers are the blocks and the tree species are the treatments.
Trees used are those, which add value to the farming activity and provide additional income to the farmers. The trees chosen are either, fruits, timber, fodder or fertility enhancing tree species namely; *Calliandra calothyrsus, Grevillia robusta* plus fruit trees (apples, plums and pears).
Plot appearance for each farmer's shamba (boundary planting).



Key: X and Y are tree species (*Grevillea* and *Calliadra*) while Z, A and B are fruit tree seedlings (apples, plums and pears). 0 is Control.
This design will allow for easy analysis of variance. Each group of farmers for every village will be analyzed separately.
Purchase of seeds of *Grevillea robusta, Calliadra calothyrsus* and fruit trees (apples, pears and plums) was also done.
Raising of seedlings of the purchased seeds was done in the nursery and planting out of the seedlings along the edges of the pyrethrum crop was done.
Data collection on take-off and rate of establishment, rates of growth , pyrethrin quality and quantity is to start next year. As soon as pyrethrum starts flowering, the flowers will be picked, quantified and analyzed for pyrethrin content

Problems experienced during implementation of the project:
Livestock grazing is a major problem at Kamara. It totally interfered with the experiment by cows trampling on seedlings while sheep browsed on some seedlings. Initially the experiment did not take off well because of the confusion about the shamba system.

References:

Ikahu, J.M.K. and Ngugi, C.W. (1983). Yield assessment of newly developed pyrethrum varieties in different ecological zones of Kenya. Pyrethrum Post. 17 (1): 21-23.

Wanyiri, J.M., Mwathe K., Kagombe J. and Mwangeka N., (2001). Review of the implementation and management of non-resident cultivation in Kenya.

5.2. Progress Report on Project No. FF/LN/31 - Effects Of Shade Tree Species On Yield Attributes Of Tea, Timbilil Estate, Kericho

By Juliet W. Wanyondu
Collaborator Dr Wilson Ng'etich (Tea Research Foundation)

INTRODUCTION

Tea was originally discovered growing under shade, so to simulate the natural conditions, tea was always grown under shade, even in Kenya. The use and abuse of shade trees was outlined in 1952 by Eden (Tea Research Institute of East Africa).

Many shade experiments have been done, but none has ever addressed adequately the issue of shade tree species. An experiment was started to determine the most appropriate species. The treatments are the shade tree species

Three tree species were planted on 31-05-2002 under a joint initiative of the Tea Research Foundation and KEFRI, Londiani.

Objectives

The collaborative experiment was started with the following objectives:

v) to test the effects of shade tree species on microclimate around the tea bush;
vi) to measure the effects of shade trees on the yield and yield attributes of tea and
vii) to advise on optimum tree species for interplanting with tea.

The tree species planted are as follows:

Sesbania sesban
Milletia dura
Markhamia lutea
Control

They were planted at a spacing of 10m by 10m inside the tea bushes. Most *Sesbania* species planted were at or above plucking table while the rest were below the plucking table and shorter than the *Sesbania sesban.*

This spacing was replicated thrice in field 14A. During establishment some few tree species in every treatment died and replanting was done on 25/04/03. Measurement of girth diameter and plant height were done by KEFRI and CED staff on 26/6/02, and a second measurement for the same was also done at breast heigh

The experiment had three tree species, replicated three times, with a control (no shade). All other operations went by the normal estate practice (plucking, manuring, weeding etc.) The experimental design is a complete randomized block design:

PRELIMINARY RESULTS

Shade trees

An assessment of the growth of shade trees was done and it was noted that *S. sesban* were much grown above the plucking table, while *M. dura* and *M. lutea* were at or below plucking table.

The results of these measurements are depicted in the table below.

Table 1 Mean plant height (meters)

Sesbania sesban	Rep 1	Rep 2	Rep 3
February	2.50	2.80	1.26
June	2.72	3.49	1.89
Mean monthly g/r	0.06	0.17	0.16
Milletia dura			
February	1.16	1.16	0.83
June	1.38	1.52	1.31
Mean monthly g/r	0.06	0.09	0.12
Markhamia lutea			
February	0.49	0.26	0.38
June	0.57	0.37	0.40
Mean monthly g/r	0.02	0.03	0.01

Table 2 Diameter at breast height.

Sesbania sesban	Rep 1	Rep 2	Rep 3
February	1.4	0.35	0.5
June	1.4	1.3	1.3
Mean monthly g/r	0	0.25	0.20
Milletia dura			
February	0.17	0.00	Under height
June	0.46	0.30	0.15
Mean monthly g/r	0.07	0.08	0.04
Markhamia lutea			
February	0.0	Under height	Under height
June	0.9	Under height	Under height
Mean monthly g/r	0.23	Insignificant	Insignificant

Note: Measurements were taken at breast height. The under height means those plants were below the standard breast height. Insignificant implies that those indicated measurements were not different in growth.

Yield

There were no significant differences due to shading, although the plots of *Sesbania sesban* showed higher tea yields. The tree species are still young and effects may be noticeable when there shall be appreciable cover.

Table 3: Tea yield (kg mt/ha) Jan to Dec 2002.

Shade tree species	Yield
Milletia dura	1568.8
Markhamia lutea	1453.5
Sesbania sesban	1738.4
Control	1534.6
CV(%)	17.02
LSD (P=0.05)	NS

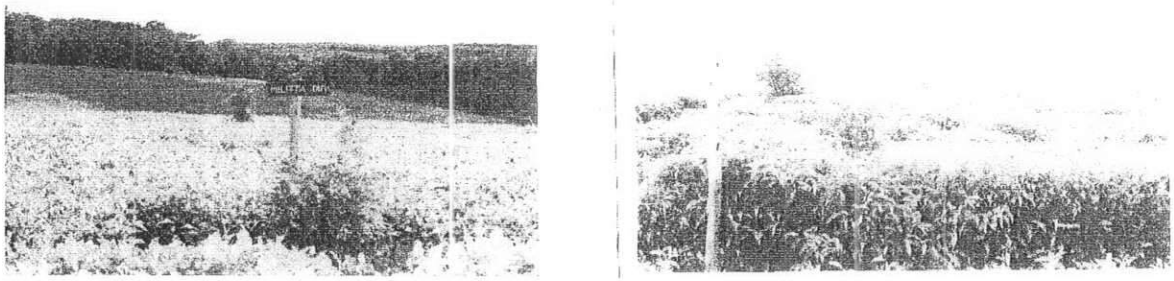


Photo 1: Photograph on left shows *Milletia dura* interplanted with tea while the one on the right shows *Sesbania sesban* and *Markhamia lutea* interplanted with tea (one year after planting).

DISCUSSION

One of the benefits of shade trees in a tea plantation was the reduction in temperatures of the tea plant, thereby reducing excessive transpiration and moisture losses resulting in wilting. By reducing temperature and the evaporative effects of wind, shade trees benefit the plant's water economy as long as the right balance is achieved between the protection given to the tea and the drain that the shade makes on the resources of soil moisture. Shade trees also reduce damage caused by hail and sun scorch, and reduce the soil temperature, thus helping the soil conserve both moisture and soil organic matter. Also roots of shade trees help to break down resistance of physical impedance in the soils and make it easier for the tea roots to penetrate.

It has been observed that tea grown under *Grevillea robusta* shade or artificial shade recovered from pruning faster than unshaded tea. These observations were repeated even with use of banana plants. The leaf fall from shade trees also provides valuable mulch to tea (Ng'etich, 2003).

Grevillea robusta shade were compared with bamboo slats in an experiment to compare different types of shades for tea. The artificial shade of bamboo slats was found to give higher yields. An assessment of the shade tree, *Leucena* spp., common in and easily grown in Congo, was reviewed for consideration for growth in Kenya tea plantations but the use of the tree was never adopted.

In another experiment, different tree species (*G. robusta, M. dura, S. sesban* and control) were assessed for their suitability as shade trees at different rates of nitrogen application in Subukia. The shade trees did not affect yield significantly (Ngetich and Otieno 1990)

However, shade trees have some negative effect on tea bushes in some instances. It has been found that shade trees encourage the persistence of fungal diseases such as blister blight fungus (*Exobasidium vexans*) which is a source of infection by root diseases such as *Armillaria spp.* And which compete for nutrients with tea. When shade trees are too dense they reduce light intensity and thus photosynthetic rates so that lower yields are obtained.(Eden,1952). Shade was also found to reduce growth rate and shoot density (Ngetich and Otieno, 1990). Shade reduced the uptake of nutrients by tea. Excessive shade also reduced growth of tea in nurseries.

COLLABORATION BETWEEN TEA RESAERCH FOUNDATION AND KEFRI ON BAMBOO PROPAGATION

With respect to collaboration on propagation of bamboo, more materials were taken from Kakamega forest. Species of bamboo that were collected included: *Bambusa brandsii, B. tulda, Dendrocalamus membranaceae, D. hamiltonii, B. vulgaris, B. striata* and *Phyllostachys pubescens.* The materials were collected and planted directly without going through the nursery stage.

Photo 2: Some of the bamboo species planted in Tea Research Foundation in 2002 (two years after direct planting).

References:

Ng'etich, W. K. 2003 (unpublished report). Shade trees, shelter and fuel wood.
Ng'etich, W. K. and Othieno, C.O. (1990). Effects of shade tree species and rates of nitrogen fertilizer on tea yields. Tea Research Foundation of Kenya Annual Report 1990, pp127-128.
Eden T. 1952. The use and bause of shade trees in tea. Tea Reasearch Institute of East Africa, Pamphlet No. 2.

6.0 ENTOMOLOGY AND ZOOLOGY

-Regular surveillance of pest and disease in the region as well as inTurbo sub-centre continued.
-Advisory services on insects pest, management and control was rendered to among others Mr Richard Muir of Molo/rongai and Finlay Tea Estate (Kericho) concerning the control of cypress aphids in their firms. Survey of the population of aphids on cypress in their farms was done and found to be high. The parasitoid *Pauesia juniperorum* was reared and released into the plantations.
-Monthly sampling of permanent sample plots continued for pine woolly aphid at Nabkoi, for cypress aphids at Sorget, Kamara and Mt Blackett blocks. The raw data was send to Muguga for compiling with data from other stations and analysis.

7.0 NURSERY PRODUCTION

Seedlings of species listed below were raised in the nursery during the year. Most of the plantation species were for establishing demonstration trials and seed stands, while most of the indigenous species were for use in catchment rehabilitation work. Other species were raised for farmers as well as for research purpose.

Table : Nursery production at Londiani

	Species	No. of seedlings	Purpose
1	Acacia albida	400	Research
2	Bamboo (Arundinaria alpine)	240	"
3	Bottle brush (white)	1,100	"
4	Calliandra calothyrus	2,400	"
5	Croton macrostachyus	15,000	"
6	Cupressus lusitanica	4,800	general
7	Eucalyptus globulus	2,400	"
8	Eucalyptus grandis	5,200	"
9	Eucalyptus grandis - clonal	9,300	research
10	Eucalyptus regnanse	600	general
11	Fagara macrophylla	600	research
12	Grevillea robusta	2,800	"
13	Hakea saligna	600	"
14	Mauritius thorn	2,300	"
15	Ollea africana	1,100	"
16	Pinus patula	6,200	general
17	Podocarpus falcatus	150	research
18	Prunus africana	900	"
19	Syzygium quinense	1,800	"
20	Tabarnamontana stafiena	300	"
21	Vitex keniensis	150	"
	TOTAL	**58,340**	

Table : Nursery Production at Turbo Sub-centre

Species	No. of seedlings	Purpose
E. grandis	18,300	Research
P. patula	3,450	"
C. lusitanica	9,120	"
G. robusta	6,400	"
Liquidambar	3,300	"
Terminalia mentalis	100	General
Callistemon (white)	1,000	"
Callistemon (red)	800	"
Dovyalis caffra	7,500	"
Casuarina	100	"
Markhamia	900	"
Pawpaw	340	"
Bischofia	800	"
E. saligna	2,200	"
Acacia meansii	2,000	Research
Ornamentals	28	general
TOTAL	**56,338**	

8.0 SEED COLLECTIONS

Summary of Seeds collection and handling at Londiani Collection Centre

Species	Provenance	Quantity in Kg		
		Extracted	Sent to Muguga	Locally distributed
Eucalyptus grandis	Kericho Tea AHP	169.4	159.3	10.1
E. grandis	Kamara	25	25	-
E. grandis	Brooke Bond	118.2	118.2	
E. saligna	Masaita 3 (E)	166.2	121.6	44.6
Pinus patula	Narasha 7 (J)	25	24.4	0.6
P. patula	Masaita 7(F)	14	14	
P. patula	Cengalo	10	10	
Cupressus lusitanica	Molo 5 (D)	50.9	47.4	3.5
C. lusitanica	Masaita S.O.	17.4	17.4	
Podocarpus latifolia	Tenges /Kabarnet	65.8	55.8	10
TOTAL		**601.9**	**592.8**	**6.05**

Seeds collection and handling at Turbo Sub-centre

Species	Provenance	Quantity in Kg		
		Extracted	Sent to Muguga	Locally distributed
E. grandis	Turbo	66	61	5
E. saligna	Turbo	104	104	-
Prunus africana	Kapcherop	40	40	-
Cordia abyssinica	Kimilili	20	20	-
Feidhebia albida	Kainuk	37	37	-
Podocarpus falcatus	N. Mt. Elgon	50	45	5
Dovyalis caffra	Turbo	0.8	-	0.8
Casuarina	Sergoit	0.6	-	0.6
Cypress	Turbo	0.85	-	0.85
Liquidambar styraciflua	Lugari	0.45	-	0.45
TOTAL		**319.7**	**307**	**12.7**

8.1 TREE SEED PRODUCTION LONDIANI REGIONAL RESEARCH CENTRE: CURRENT AND FUTURE CHALLENGES

Joshua K. Cheboiwo And Maina Kahuthia

1.0 INTRODUCTION

1.1 GEOGRAPHICAL AREA COVERED

Londiani Regional Research Centre's Seed Unit covers mostly the West of Rift Valley region. The mandate covers vast area to include such districts as Nakuru, Kericho, Bomet, Narok, Uasin Gishu, Trans Nzoia, Nandi, Koibatek, Baringo, Marakwet, Turkana, Keiyo, West Pokot, Buret, Lugari, Bungoma and Mt Elgon. However, some district such as Kajiado, Laikipia, Isiolo that fall within our mandate due their proximity to other seed collection centers are not covered by our activities. These areas range from highland to semi arid climatic conditions. The rainfall varies between 450 mm to 1700 mm per annum. The criteria used to determine routine seed collection calendar for species in high demand is the preceding year's demand for the specified seed variety. Seed collection is normally done within the various species ecological natural setups. Kenya is classified into eight different seed collection areas based on humidity and altitude as shown in Table 1. The collection classification by regions is very important for the purposes assessing the adoptability of the specific trees and for seed distribution and interchange possibilities.

Table 1: Ecological Zones of seed collection areas

No		Rainfall	Altitude	Temperature.
1	Humid upper highland	1000-1700 mm/yr	>2400 M	12°c MA
	Humid lower high land	1000-1700 mm/yr	1800-2400 M	12°-18°c MA
3	Humid midlands	1000-1700 mm/yr	900-1800 M	18°c-24°c MA
4	Humid lowland	1000-1700 mm/yr	<900 M	24°c MA
5	Semi humid lower highlands	700-1300 mm/yr	1800-2400 M	12°-18°MA
6	Semi humid midland	700-1300 mm/yr	900-1800 M	14°-24°c MA
7	Semi humid lowlands	700-1300 mm/yr	<900 M	24°c
8	Semi arid, lower highlands	450-900 mm/yr	1800-2400 M	12°-18°c
9	Semi arid midlands	450-900 mm/yr	900-1800 M	18°-24°c
10	Semi arid lowlands	450-900 mm/yr	<900 M	724°c
11	Arid midlands	500 mm/yr	900-1800 M	18°-24°c
12	Arid lowlands	900 mm/yr	<900 M	24°c

1.2 HISTORY OF THE TREE SEED COLLECTION IN KENYA

1.2.1 Preamble

In recognition of the importance of forestry to the economic development of the country, early foresters focused on domestication and intensive management of forest resources in the country to meet the national wood resource demand. Tree propagation is possible through few techniques of which seed is the most attractive both on financial and genetic diversity consideration. Plantation development in early parts of the 20th Century made seed availability a compelling case in order to achieve the high targets for its establishment throughout the country. The availability of high quality seed was felt necessary for establishment of high productive fast growing trees species to achieve the high national demand for timber due to fast growing population and development activities. In addition sourcing of timber from natural forest became unachievable due to diminishing indigenous forest cover since the early 1960's and its inability to regenerate and achieve growth rates to equal the exotic species. To the high and growing demand for tree seeds Forest Department started some seed collection and testing unit in 1930's for the purpose supplying seed to its tree nurseries distributed in areas designated for plantation establishment. Development of high quality seed stands reached its peak during the reign of EAFRO when several seed stands and orchards were established and later reverted to the Silviculture Department of the KARI when the EAFRO collapsed. The seed section's main function was to supply seeds for raising exotic industrial plantations to include such species as cypress, pines and Eucalyptus.

In 1985 the Kenya Forestry Seed Centre (KFSC) was formed with the support of the Germany Agency for Technical Cooperation of the Federal Republic of Germany ((GTZ) as sub programme of KEFRI of the Ministry of Environment and Natural Resources. The Hqts of KFSC is in Muguga 25 Km Northwest of Nairobi and is the depository and distribution center of all tree seed collected in the country. The main client is the Forest Department that is mandates with the responsibility of establishing and managing all public forests in the country.

The KFSC is a complex institution with laboratories that handle and store seeds from satellite regional collection centers that traverse different ecological zones of the country. Initially the regional collection centers were eight but have since the reduced to those shown in Table 2.

Table 2: Regional Trees Seed Centres in Kenya and Ecological Zones.

Centre	Regional mandate	Ecological Zone
1. Muguga	Southern Central Region	High/medium plantations and farm forestry
2. Londiani	Western Central Highlands	High/medium plantations and farm forestry
3. Gede	Coastal Lowlands	Coastal humid lowlands
4. Nyeri	Central Mountain	High medium plantations and farm forestry
5. Kibwezi	Southern Semi Arid Region	ASAL's
6. Kakamega	Western and Lake Basin Region	High/medium/lowlands

The mission of the KFSC was provision of certified site appropriate high quality tree seed in sufficient quantities for forest development in the country.
In 1997 KEFRI KEFRI decided to decentralize its research programmes to regional centers. The regional seed units became satellite components of the Kenya Tree Seed Centre. Londiani tree seed collection unit, became administratively part of Londiani Regional Research Centre. Londiani Tree Seed Centre is still logistical supported by Kenya Forestry Seed Centre at Muguga.

1.3 SEED COLLECTION CRITERIA

Public land under forestry is fast decreasing and one option of maintaining desired level roundwood products is through establishment of high yielding plantation term of quality and quantity. This can only be achieved through use of high quality seed and silvicultural management procedures. KEFRI has been in the forefront in the development of high quality seeds through multi-layer process of selection and breeding activities to obtain superior trees that produce for plantation establishment. Seed quality has two dimensions, physiological and genetic and seed selection and subsequent collection and handling process has to maintain these attributes. This is done through seed source selection, labeling, processing, handling and storage to maintain its quality until the time of sowing in the nursery. Before actual seed collection, starts there are important detail planning that need doing. These include through seed survey that encompass the identification of suitable seed sources, the flowering patterns and seeding of the desired species.

1.3.1 Flowering Survey.

Flowering survey is done in order to determine whether flowers are distributed regularly within the seed source. In the case of selected single trees (SST), the number of flowering trees is important and must meet the requirements on the minimum number s to be included in a seed collection. Flower survey continues until at least pollination has taken place since there are environmental conditions that may hinder pollen production and subsequent pollination.

1.3.2 Seed Survey.

A seed survey follows the flower survey with the objective of observing the progress of maturation and to determine the right time for collection. This is done through conducting cutting test on the fruits and seeds collected from a representative number of trees regularly distributed over the seed source. Cutting test using appropriate tools allows inside examination of the seed condition. Mature seeds have a firm endosperm /embryo while immature ones have a milky endosperm. The method is used to determine whether the seeds show sign of attacks by insects or other pest. The crop size is important parameters, which influences the economics of a seed collection activity. The smaller the crop the more time and manpower it will need for the

collection of a given quantity seeds target and hence less economical the collection is. The decision to collect or not will depend on species e.g. its rareness and the frequency of seedling as well as the general situation e.g. seed demand and stock of seed in our in store.

1.3.3 Planning of Seed Collection

Flower and seed survey are not sufficient to guarantee that seed production from identified seed sources is attainable and thus the need for regular monitoring. Monitoring is particularly crucial in determining the time which the seeds are mature especially some species that have short time span between maturity and natural dispersal or deterioration e.g. *Aresvillea robusta, Milicie excelsa, ,Azandratlita indica , Prunus africana.* It is also important in assessing seeding by trees and hence the potential quantity of seeds to be collected in a calendar year. This is because seasons and allied biological activities affect seed production and hence output of seed collection operations. The planning of seed collection takes into consideration the following factors;

1. Permit/passes needed: seed sources in private land or land that belong to other departments e.g. Game parks may need prior authority.
2. Quantity to collect. The amount of seeds depend on demand the existing stock and the amount of crop in the field.
3. Costs of collection: The cost of collecting from a particular seed source will be determined by
   (i)Distance to the seed source
   (ii)Number of seed collectors
   (ii)Number of people deployed
   (iii)Their productivity.
   (iv)The amount of seeds collected

1.3. 4. Manpower

The necessary labour force for a particular collection depends on the quantity of seeds to be collected and the productivity of each individual. The individual person's productivity is measured in quantity of seed produced that also depends on several factors:

(ii)The species
(ii)The actual conditions during the collection (crop size, weather, terrain etc)
(iii)The collectors experience of the collectors.

1.3.5. Equipment needed for collection

This will depend on the species to be collected, the characters of trees to be collected from and the site conditions of the collection area. The equipments commonly used in seed collections are:

(i) Cotton bags
(ii) Sisal sacks
(iii) Canvas sheet
(iv) Hooks
(v) Climbing equipment
(vi) Descending and safety ropes

2.O Seed Collection Performance in the Last 10 Years

2.1 Criteria for Seed Collection Prioritization Criteria

Seed task prioritization is based on demand that prevailed in the previous years. However, from available records and inquiries, the demand for tree seed over the years has experienced ups and downs but with an increasing trend. Since seed production is a response to demand, the

oscillations reflect field-planting activities of both Forest Department and other stakeholders that buy high quality seed from KFSC. FD remains our main client had stagnated over the years and hence the fall in demand for seeds. However, recent development of tree planting activities outside public forests has brought companies, NGO's and farmers into our seed-planning programme.

2.2 Total seed Output

The quantity of fruits /seeds in an un extracted and extracted forms for the last 10 years in as tabulated in Table 3.

Table 3: Seed Output between 1993 to 2002 at Londiani Regional Seed Unit

Year	Unextracted	Extracted
1993	10867.5	476.2
1994	6984.5	253
1995	5154.2	135.2
1996	7625	86.5
1997	2829	98.2
1998	4486	178.5
1999	6011	239.3
2000	10231	258
2001	13062	295
2002	10276	254.5
Grand Total	**77526.2**	**2274.4**

Table 4 shows the seeds collected between 1993 and 2003 and the distribution by species. Recent seed policy analysis supports the move towards privatization. This is within the global Liberalization of several economic sectors that has thus influenced the changing status for seed users and dealers in the country. However, the current laws still recognize KEFRI as the only tree seed agent for public plantation development and export business.

The seeds of greatest demand are *Eucalyptus grandis, Pinus patula, Cuppressu lustanica.* However, enquiries and purchases of *Eucalyptus saligna* mostly from tea estates is significant and has subsequently been supplied in relative small quantities. Overally, the demand for seeds of plantation species far outstrips supplies. This is due to many factors among them being seed sources being far from central points and lack of properly trained personnel. The plantation programmes had almost fixed requirements in terms of seed quantities as per planting areas for each year. Before 1997 the entire forest department needed an average of 100 kg of *C.Lusatanica* and 50 kg of *Pinus patula.* Other seed users (eg NGO's companies and farmers) were comfortable with seedling supply from government tree nurseries. Declining forest cover and sensitization on tree planting and high demand of tree products has tripled demand for tree seeds over the last few years. The current scenario is characterized by over exploitation of forest resources with little or no replacement to commensurate with exploitation. However, recent moratoriums and banning of tree harvesting from public forests forced millers and timber merchants to source their roundwood from farms thus putting value on trees planted on farms. The demand for seed from both the farmers and Forest Department is expected to increase given the high priority being placed on afforestation. However, tree sector was adversely affected by recent wanton harvesting of trees in public forests and degazettment of forests. Currently, the sector may not be in a position to supply large amounts of high quality seed within a short time

frame. Advance demand and supply planning will become necessary to enable expansion of seed sources in time to meet expected orders from our clients both in quantity and quality.

Table 4: Break down of seed collected between 1993 and 2002 by species in kgs

	Species	Unextracted	Extracted
1	*Pinus patula*	29000	251.2
2	*Cuppressus lusitanica*	5675	567
3	*Eucalyptus saligna*	4423	207.8
4	*Eucalyptus grandis*	2278	120.5
5	*Eucalyptus maculata*	4259	50.1
6	*Eulayptus regnans*	240	8.8
7	*Eucalyptus ficifolia*	3186	7.4
8	*Dovyalis caffra*	14833	186
9	*Prunus africanum*	161	84
10	*Jacarada mimosaefolia*	597.5	37.5
11	*Acacia melanoxylon*	885.5	181.9
12	*Acacia mearnsii*	251.5	58.5
13	*Podocorpus gracillior*	1328	194
14	*Pyracantha augustiflia*	613	37.6
15	*Grevillea robusta*	40	1
16	*Dombea goetzenii*	350.5	12.7
17	*Hakea saligna*	1770.5	3.0
18	*Calitris robusta*	839.5	38
19	*Cordia abbyssinica*	458	53.9
20	*Croton megalocarpus*	364	72.4
21	*Erythrina abbyssinica*	334	1.4
22	*Juniperus procera*	512	58.5
23	*Cropton macrostachys*	75	8.2
24	*Schinus mole*	31.5	11.5
25	*Pinus radiata*	1359.5	10.7
26	*Balanites aregyptica*	119.5	93
27	*Terminalis brawnii*	75.5	35.5
28	*Fagara macrophylla*	266	24.3
29	*Phoenix reclinata*	185	40
30	*Olea hochstetterii*	144	37

2.3 Seed Preferences by species

Table 5 shows that the demand for plantations species also experienced some oscillatory pattern during the period under review. Most of the seeds for plantation species were purchased by Forest Department where KEFRI is main supplier since no other organization had the capacity to provide reproductive material for forest plantations. Besides its unlikely any other body can provide large quantities of certified seeds required for massive plantation establishment. Hence seed supply has been highly correlated to past Forest Department's planting programme, until recently, planting of indigenous species was mostly in rural farms whose seed requirements was low both in the species variety and quantity.

Table 5: Collection Trend for highly demanded tree seeds between 1993 and 2002 in Kgs

Year/Species	E. grandis	P. patual	C.lusitanica	E. saligna
1993	7.8	3.4		26.8
1994	10.7	14.6		25.4
1995		4.4	37.5	13.4
1996		18	22	10
1997		11.8	69	10.6
1998		53.5	43	31
1999	15	17	84	23
2000	7.5	15	97	23
2001		57	168	45
2002	79.5	56.5	46.5	8
Average	**12**	**25**	**56.7**	**21.6**

2.4 Constraints

One of the biggest constraints facing Londiani Regional Seed Unit is the infrastructure and resources at the disposal of the unit.

Seed collection is expensive exercises that involve labourious and sometimes-dangerous maneuvers. Some seed collections sites are impassable during the rain seasons and vehicles are needed to cover wide ranges and distances to most collections points contribute immensely to the high cost of seed collection. The collectors have to be provided with incentives in form of allowances to improve their productivity thus escalating seed collection costs.

3.0 Current Status of Seed Collection in the Region.

Recruitment of seed sources has been an ongoing activity due to rising demand and destruction of old seed sources as a result of old age or excision of forestland. The recruitment has been under way in already established stands in forest plantations although remnants seed orchards still provide some seeds. However, the existing seed orchards are few and aged implying low productivity. In addition the size of orchards measure only few hectares and cannot sustain the current high tree seed demands.

3.1 Current Status of Seed Stand and Orchards

The urrent number of seed stands/orchards that exist, their status and its productivity in the regional mandate is presented in Table 6 below. The records indicate that despite the large number of seed sources their seed production capacity cannot be realized due to various reasons. Some of the reasons include lack of silvicultural treatments mostly thinning to increase the crown size and thus high seed outputs. Thinning operations were affected by the moratorium on tree harvesting in public forests and thus many of the seed stands that were recommended for thinning was not been done. Another factor has been loss of high quality seed stands and orchards through degazettment or illegal harvesting. Ageing seed orchards that were not replaced coupled with human interferences has lowered seed outputs from the few that still exist. Losses from fires are also significant for seed stands were partially or completely lost through arson or accidental fires. In general, seed production capacity loss through the various factors has been enormous and has been responsible for high cost seed collection in the region.

Table 6: Current Seed sources for various species in the region and their status.

No	Species	District	Provenance	Seed source category	Area ha	Year of planting	Remarks
1	**A. melano xylon**	Nakuru	Sokoro 7(H)	SSS	11.0	1986	Excised do not exist any more
2	*Callitris robusta*	Koibatek	Esageri	SSS	4.5	1967	Existing once burnt about half area exists
3	*C. Lusitanica*	Kericho	1© Masaita	SSS	2 Ha	1970	Existing
4	*C.Lusitanica*	Koibatek	Maji mazuri2(D)	SSS	10.8	1975	Clear felled
5	*C.lusitanica*	Kericho	Kampi Kongoni 4(A)	SSS	12.9	1986	The actual plantation in 4(F)Kampi Kongeni thinning stopped mid way due to moratorium
6	**C.lusitanica**	Kericho	Lalaikwen	SSS	56.8	1985	Existing: thinning done halfway due to moratorium
7	*C. lusitanica*	Koibatek	North molo	SSS	12.5	1983	Require thinning to allow production
8	*C. lusitanica*	Kericho	North molo	SSS	20.5	1978	Proposed excision to date: plantation clear felled
9	*C.lusitanica*	Kericho	Sorget 10 (N)	SSS	20	1985	Thinning done halfway due to moratorium
10	*E. grandis*	Kedowa	Masaita	SSS	2	1989	1/3 poached and the rest partially burned not stable as realizable seed source
11	*E.maculata*	Uasin Gishu	Kedowa	SSS	10	-	Very old: status not known No information that it was recorded as a seed stand.
12	***E. Regnan***	Koibatek	Timboroa	SSS	0.6	1962	No proper records available was cut in 2002- does not exist.
13	**J. procera**	Kericho	Kiptiget	SSS	5	-	Does not exist on the ground
14	*E grandis*	Kericho	Masaita 12 (M)	SSS	2	1989	Completely destroyed by fire and poaching
15	*P.patula*	Nakuru	Dundori 1(D)	SSS	30	1954	Does not exist
16	*P. patula*	Koibatek	Narasha 2 ©	SSS	9.9	1972	Was recommended to be handed over to the forest Department. Due to the poor nature of the stand
17	*P. patula*	Koibatek	Narasha 2 (G)	SSS	7.3	1972	Was recommended to be handed over to the forest Department. Due to the poor ature of the stand
18	**P.patula**	Uasin Gishu	Nabkoi (6B)	SSS	43.2	1978	Half of the stand cleared on selected areas which were marked for thinning. Requires reselection and thinning.
19	*P. patula*	Uasin Gishu	Nabkoi 2V	SSS	12.4	1983	Marked for thinning which did not take off due to moratorium
20	*P. patula*	Uasin Gishu	Buret 1(D)	SSS	31.2	1981	Part of the stand completely burnt: at most the area can

							be 5 ha . marking for thinning done but stopped due to moratorium
21	*P. patula*	Koibatek	Nai vasha 7(J)	SSS	32.2	1983	Thinning was to be done but didn't take place due to moratorium
22	**P. patula**	Kericho	Lal ikwen 3 (D)	SSS	18.1	1983	Previously heavily thinned: requires removal of dead for tidiness
23	*P. patula*	Kericho	Mas aita 7(F)	SSS	7	1974	Poor production of cones ;50 ha of the trees are dying naturally
24	*P. patula*	Koibatek	Nor h molo 8 (A)	SSS	2	1984	Not productive: dying out: seeds can only be collected for research work
25	*P. patula*	Koibatek	Nor h Molo 5(A	SSS	2	1979	Clear felled on alleged excision
26	***P. patula***	Kericho	Mas aita 3 ©	SSS	0.8	1966	Over 90% destroyed on the ground.

3.2 Current status of other Seed Sources.

All other seed sources that are no classified under permanent source category is referred as general collection. They are identified and all other rules pertaining to seed collection are applied. However, the sources fall under shrubs with unique (occasional) demand hence irregular demands. These sources are normally recorded in seed source information sheet that is updated every time there is a new source or one or two old sources have been removed as a source. See appendix list 3.2.

3.3 New Development in Seed Sourcing

The seed unit has embarked on expansion of seed sources to cope with the increasing demand through selection of new seed stands. Despite the new initiatives, the seed unit has not been able to meet the regional and national high demand for some specific tree seeds for reasons specified in the previous subsections. The increased demand for seeds by many stakeholders in forestry sector recently has aggravated the already exiting challenges in supply of seed in the region. Most of the newly selected seed stands were previously managed for timber production and need some manipulation of crown form to increase their capacity to produce large quantity of seed. KEFRI has also entered into collaborative arrangements with other stakeholders mostly tea estates and farmers in the region for access to high quality G. robusta and E. grandis trees for seeds collection. KEFRI has initiated establishment of high priority seed species in both Londiani and Turbo mostly E. grandis, C. lusitanica and P. patula. There are more efforts being directed to the establishment of more seeds stands and orchards within the neighbourhood of the seed collection centres to reduce seed collection, management and collection costs.

4.0 Seed Production Challenges in the 21st Century

4.1 Seed Supply and Demand

The current strategy of basing seed collection plan on current demand is fraud with uncertainty when emerging demand for most stakeholders is not known in advance and incorporated into routine planning projections and pooling of resources for the purpose. The information deficiency handicaps the seed unit's ability to plan for the collection of various seed needs and annual adjustment to cope with emerging demand centers. There is need for aggressive networking

among stakeholders in the sector to ensure that demand for seeds from diverse ecological and geographical are known in advance and hence bulking to meet such anticipation. Such development ensures that collection efforts match the demand without comprising the quality of seeds on offer. The erratic demand some for some specific seeds has made past efforts to identify and mark seed sources futile and some had to be abandoned for lack of demand. Table 7 shows some of the abandoned seed sources due to lack of sufficient demand for their seeds.

Table 7: Some of the seed sources that have been down graded

No	Species	Districit	Provenance	Seed source category	Area ha	Year	Remarks
1	*Aningeria aldobii tiendnce*	Baringo	Talai Kabarnet	SST	12	1990	Low demand and no remarking. Cannot be traced: unless remarking is done. No maps or records available
2	*Cassiporea mallosana*	Nandi	N . Tinderet	SST	60	1990	Low demand and no remarking. Cannot be traced: unless remarking is done. No maps or records available
3	*Cordia africana*	Kericho	Masaita block	SST	15	1990	Low demand and no remarking. Cannot be traced: unless remarking is done. No maps or records available
4	*Diospyros abbysinica*	Nandi	Tinderet	SST	15	1990	Low demand and no remarking. Cannot be traced: unless remarking is done. No maps or records available
5	*Diosypyrus African*	Baringo	Talai Kabarnet	SST	20	1988	Low demand and no remarking. Cannot be traced: unless remarking is done. No maps or records available
6	*Olea africana*	Kericho	Masaita	SST	23	1993	Low demand and no remarking. Cannot be traced: unless remarking is done. No maps or records available
7	*Olea hschstetenii*	Nandi	N Tinderet	SST	35	1990	Low demand and no remarking. Cannot be traced: unless remarking is done. No maps or records available
8	*Olea welnitschii*	Nandi	N Tinderet	SST	8	1990	Low demand and no remarking. Cannot be traced: unless remarking is done. No maps or records available
9	*Podocarpus falcatus*	Baringo	Tailai /Kabarnet	SST	25	1988	Low demand and no remarking. Cannot be traced: unless remarking is done. No maps or records available
10	*Podocarpus latifolia*	Nakuru	Keringet	SST	21	1992	Low demand and no remarking. Cannot be traced: unless remarking is done. No maps or records

							available
11	*Sysyfium guinensee*	Baringo	Talai /Kabarnet	SSTA	20	1988	Low demand and no remarking. Cannot be traced: unless remarking is done. No maps or records available
12	*Warbugia ugandesii*	Baringo	Talai /Kabarnet	SST	20	1988	Low demand and no remarking. Cannot be traced: unless remarking is done. No maps or records available
13	*Jacaranda*	Nakuru	Township	General	-	-	
14	*D .Caffra*	Njoro	Biabi	General	-	-	

4.2 Quality and quantity of seed output

4.2.1 Quality

Sometimes seeds are moved over long distances and variable time scale such as exchanges of seed on regional, national and intercontinental scales. Such seeds are moved from their natural habitats and hence subject to adaptability assessment under new site conditions. History of origin may remain the only reference until proven under new conditions and thus good record keeping is an important exercise the seed producer must undertake.

Freshly harvested seeds have high moisture content ranging from between 15% orthodox seeds and 50 % (recalcitrant). The higher the moisture content and the temperature, the higher the risks of damage from over heating, suffocation and fungal attack if appropriate care is not taken from the time of harvest to sowing. This is more critical with recalcitrant seeds and a balance between moisture content, temperature and ventilation must be kept. In the field where collection is done this may not be practical.

After collection, orthodox seeds/fruits need to be stored in a cool shady place and in well-ventilated containers. Some seeds have peculiar characteristics such as pulpy fruits that may need to be removed as soon as possible to avoid triggering dormancy mechanisms. Examples include seeds of some species such as *Olea spp, Podocarpus facaltus, Fagara macrophylla.* If kept in bulk until extraction, the fruit has to be turned over and over to improve ventilation and to avoid overheating and fungal attack. The same can be achieved if the fruits are spread on a canvas in thin layers.

4.2.2 Quantity

Expanded tree planting activities has increased demand for various types of seeds. The collection, handling seed and distribution of such large quantity of seed is a challenge to seed producers. The seed collection unit has the responsibility of ensuring that the seed collected is of good quality, the same applies to seed distributors that have to ensure that the seed quality is maintained from seed dispatch to consumption points However, there is no such functioning distribution system in place in the country now. Despite that shortcoming, seed providers have the obligation to supply their clients with sufficient seeds to meet their different purposes. Since seed procurement is an expensive exercise, the best strategy is to supply seeds to match the demand and avoid unnecessary collections.

4.3 Policy and Legal Directions into the Future.

Tree seed sector is an important sector in forestry development. However, the sector is not regulated and the players that are likely to enter into it have no guiding principles except for the seeds and plant varieties Act (1972). The forestry sector in various forms such as agro forestry and social forestry need enormous amounts of tree seeds that has stimulated a steady increase

trade in seed within the country and import and export of tree seed on international level. The increased demand of seeds and inability of formal institutions to meet the demand has created space for new players to enter into the sector. These new informal players don't have adequate training and information in tree seed matters and lack basic aspects of tree seed production, procurement and distribution. The risks of inferior quality seeds entering the market place are so real now and will become more critical into the future. Such development results in variety of problems such as supply of seeds of insufficient genetic variation within the seed or plant material, site appropriateness and low germination of seed lots due to low germination percentage or low purity etc.

KEFRI's intention in initiating the revision of the seed and plant varieties act (1972) into tree seed legal document was intended to regulate the forest reproductive material to promote stability and sustainability in the sector. The aim is to insure that seed buyers are supplied with high quality from from well documented and professionally managed seed sources. The legislation was to protect seed users from being supplied with inferior quality by unscrupulous seed merchants. Unfortunately, the tree seed and variety act is yet to be published and may take some time if no urgent measures is taken. Thus in the mean time seed sector may remain unregulated like agricultural commercial seed commodities.

9.0 TRAINING, CONFERENCES, SEMINARS AND WORKSHOPS

Joram Mbinga, Research Officer, attended a short course on Tree Breeding in South Africa from 10th to 22nd August 2003. He also participated in a 2 day workshop on Eucalyptus chalcid (a new eucalyptus pest in Kenya) held at Busia Kenya from 14th to 16th June 2004.

Joshua Cheboiwo and David Langat, Research Officers, organized and conducted a 2 day workshop on Adding Value to *Juniperus procera*, at Kapsowar – Marakwet district from 11th to 12th May 2004.

Boaz Otieno (technologist), Richard Siko (forester) and Benson Ongudu (technician at Turbo) attended the Regional Workshop for Technical Staff on Tree health in Agroforestry fron 14th. to 18th June 2004 at Kisumu. The workshop was organized and conducted by ICRAF, KEFRI and Maseno University.

Joice Musah, copy typist at Turbo sub-centre undertook a computer course and completed successfully.

10.0 COLLABORATIVE LINKAGES

	Collaborating Institutions	Area of collaboration
1	Forest Depertment (through DFOs)	-Identification of research problems -Forest extension -Protection of experiments
2	Kenya Forestry College	-Student training in Tree Breeding, Seed collection, Water catchment, and cost benefit analysis.

3	Moi University	-Student attachments and field activities -Library access for reference materials -Training and research
4	Egerton University	TEAL Library – Rockefeller -Propagation of *Prunus africana*
5	Maseno RRC-Kefri	-Nyando River catchment -Markets and marketing of farm forestry products -Vauatin and degradation studies in Tinderet forest.
6	KARI-Molo Pyrethrum Research Station	-Trees/pyrethrum cropping systems
7	Tea Research Fou ndation	-Shade/shelter trees in tea -Pests and diseases
8	Tea Estates in Kericho and Nand	-*Eucalyptus grandis* selections and improvement -*E. grandis* seed collection -Pests and disease monitoring
9	Baraka Agricultural College-Molo	-Farmers training Demonstratio/field days
10	Provincial Administration (at Districts)	Membership if District Environmemt Committees
11	Panafrican Paper Mills (PPM)	-*Pinus radiata* improvement research and housing the Kaptagat sub-station nursery -Clonal forestry initiative -Large scale nursery Turbo
12	FOMAWA (Friends of the Mau Watershed)	-Farmers training -Mobilization of tree growers -Cost benefit analysis of tree enterprises -Cypress aphid monitoring
13	Marakwet Community Development Trust Fund (MCDTF)	-Natural Resource Management and Farm forestry action plans -Farmers mobilization in conservation and utilization of on farm forestry products

11.0 DEVELOPMENT PROJECTS

Facilities And Infrastructural Development

Buldings and office space.
Renovation of most buildings at the old college site was completed. This created enough office space for research scientists. The only group that is still sharing office space are foresters and technicians. Other sctivities initiated during the year were establishment of perimeter fence, drainage, pit latrine car pack and main gate.

Computors and electronics
Two computers were purchased for scientists and a digital camera.

Vehicles
Two double-cabin pick up vehicles were purchased through the headquarter office. This increased the Centre vehicles to six in addition to a tractor and two motor bikes, to serve both the regional office and the sub-centres.

12.0 WEATHER

The record of rainfall at the centre during the year was as shown in the table below.

Table 1(a). Mean monthly rainfall at Londiani between July 2003 and June 2004

Year	2003						2004					
Month	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Rainfall (mm)	210.6	171.4	51.1	22.6	14.8	3.0	69.6	28.4	-	251.9	2.3	49.7
No. of rainy days,	21	13	4	5	7	3	5	5	-	17	1	3

Total amount of rainy days was 875.4 mm over 84 days

Table 1 (b). Number of rainy days at Turbo Research Sub-centre

Year	2003						2004					
Month	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
No. of rainy days,	14	12	10	3	-	1	2	1	5	19	11	2

Total amount of rainfall was 266.8 mm only over 80 days

13.0 STAFF

13.1 Summery of Staff strength during the period was as below:

Category	**Londiani Regional R. Centre**	**Turbo Sub-centre**	**Kaptagat Sub-centre**	**Total**	**Remarks**
Research officers	6	0	0	6	Inadequate
Foresters	3	1	0	4	Inadequate
Technologists/technicians	11	3	1	16	Adequate
Administrative	6	1	0	9	Inadequate
Drivers/mechanics	6	2	0	7	Adequate
Subordinate staff	43	50	5	90	Adequate
Total	**75**	**57**	**6**	**138**	

13.2 Categorised Staff is as Follows

Scientific And Technical Staff

Name	Qualification	Designation	Research area
Joshua Cheboiwo	Bsc., Msc/Phd	SRO, Centre Director	Forest economics
Juliet Wanyondu	Bsc., Msc.	RO1	Forest Ecology/Tree Physiology
Joram Mbinga	Bsc., Msc.	RO1	Plantation Silviculture/Tree improvement
David Langat	Bsc., Msc.	RO1	Sociaeconomics
Jonathan Njuguna	Dip. Forestry, Bsc.	RO	Forest Conservation
Michael Okeyo	Dip. Forestry, Bsc.	ARO	Silviculture/Mensuration
Maina D. Kahuthia	Dip. Forestry	Forester 1	Seeds
Joseph Kioko	Dip. Forestry	S. Forester	O-i-C Turbo
Richard Siko	Dip. Forestry	Forester	Entomology/Silviculture
Thomas Kundos	Dip. Forestry	Forester	Nursery/Silviculture
William Bii	Dip.	Technologist	Technology transfer
Boaz Ongonga	Dip	Lab. Technilogist	Pathology
Fanuel Wesonga	Dip.	Lab. Technilogist	Pathology Turbo
Benson Ongudi	Dip	Technician	Entomology-Turbo
Peter Koech	JLT	Technician	O-i-C Kaptagat
Rebecca Omoro		Technician Trainee	Pathollogy lab.
David Kitur		Tech. Trainee	Entomology lab.
Shadrack Omambia		Tech. Trainee	Seeds
Flora Koris		Tech. Trainee	Seeds
David Wanyonyi		Tech. Trainee	Nursery
Charles Kiptoo		Tech. trainee	Nursery
Administratio, Finance and Others			
Steven Milimo		Supplies Ass.	Centre Admin. officer
Joel Nganga		Accounts Ass.	Centre accountant
Shem Achia		HCO	Accounts
Philis Cheruto		CO	Accounts
Javan Kavuka		CO	Admin. Registry
Joyce Sayah		Typist II	Turbo Office
Prisca Sang		Copy typist	CD Office
Gervas Otieno		Electrician	Maintenance
Elijah Odhiambo		Plumber	Maintenance
Jeremiah Nyatangi		M.V. Mechanic	Transport
Peter Abiri		S. driver	Transport
Alexander Ndombi		Driver	Transport
Johana Biomdo		Driver	Transport
Paul Langat		Driver	Transport
Maurice Oketch		Driver	Transport

13.3Transfers and postings

During the period of the report the following transfers and postings took.

Name	P/No.	Designation	From	To
Steven N.Milimo	6428	Adm. officer	Maseno	Londiani
Michael M.Okeyo	6029	R.O	Maseno	Londiani
Joyce Cottina Owiti	5968	S.S	Londiani	Maseno
James Maina Boithi	5002	Adm. Officer	Londiani	Muguga
Fredrick M. Amolo	6289	Lab Tech	Londiani	Maseno
Shem Achia Nyakure	5845	HCO	Muguga	Londiani
Paul Langat	6379	Driver	Turbo	Londiani
Mohammed Kiplagat	6207	S.S	Turbo	Londiani

13.5 Retirement

John W. Ateko P/No. 5152, the artisan-in-charge of maintenance section retired in April 2004. Jonathan Nzabanyi P/No. 5373 and Abysai Mukhwana P/No. 5433 both SS at Turbo.

13.6 Death

George Ogada P/No. 5403, the higher clerical officer-in-charge of stores at Londiani passed away on 19th June 2004 while Mr Nathaniel Yego P/No. 6610, a technician at Turbo passed away in February 2004. May the almighty God grant their souls eternal rest.

14.0 VISITORS TO THE STATION WERE AS FOLLOW

Date	Name	Address	Comments
14/7/2003	Prof. F.K Sang , 2 others & 20 students	Moi University Box 1125	With student for practical
12/8/2003	Robert Nyambati	KEFRI/Maseno	Discussion on research activities
27/8/2003	S . M. Mutari & 8 officials and farmers	Deputy DAO Box 42 Makueni	On a farmers education visit
3/9/03	Ibrahim Mumanyi	Box 20412, Nairobi	
3/9/03	Fredrick A. Okello	Box 20412, Nairobi	Routine audit
4/9/03	Joseph M.K.Ikahu	CD-NPRC-Molo	Discussion on collaborative project
4/9/03	Gathugu Geofrey K	NPRC – Molo	
10/9/03	Cllr. Kiprotich Rop & env. officer	Kericho Municipal Box 44 Kericho	Follow up of the partnership and MOU
16/9/03	Steven Milimo	Box 5199 Kisumu	Reporting
8/10/03	K.E.Mutitu & L. M. Mwangi	Box 20412, Nairobi	Starting IPM activities at the region
22/10/03	A.G. Karani	Box 20412 NRB	To inspect the soil drainage pipes work in the college

			site
31/10/03	Prof. LM Muner James T. Mumbee & Gitau Njoroge	Egerton University Box 536 , Njoro	To install TEEL & Phora
14/11/03	C . Kirinya & T . Omenda	Kefri Hqts	Survey experiment plots for experiments
21/11/03	F . Ochung & Susan Musandu	Kefri Hqts	Accompanying Board during visit
25/11/03	Prof . F.K Lenge	Box 62000 NRB	Official-Board visit
25/11/03	Mr.R.O Onyuma	Box 54457	Official-Board visit
25/11/03	Prof . R.K Mibey	Chiromo Campus Univer. Of NRB	Official-Board visit
25/11/03	Benard Kigomo	Kefri Hqts	Official-Board visit
25/11/03	Patrick M. Mungala	Kenyatta Univer. Box 35449 NRB	Official-Board visit
25/11/03	Paul Konuche	Director Kefri	Official-Board visit
25/11/03	Beatrice Njenga	W.Y.O.C.C Kefri Board	Official-Board visit
25/11/03	H.M Ngibuini	Box 3006 Nairobi	Official-Board visit
25/11/03	N.N. Walene	MENR HQs	Official-Board visit
25/11/03	Margaret W. Maimba	NCST Box 30623 NRB	Official-Board visit
25/11/03	K.E.Mutitu	Kefri Hqts Box 20412 NRB	Courtesy call
5/12/03	Godon Sigu	Kefri Hqts Box 20412 NRB	Bamboo Propagation
13/1/04	Emilio Kinyua	Kefri Hqts Box 20412 NRB	Imprest guidelines
14/1/04	Stephene Mitimba	Box 76406 NRB	Charcoal discussion
21/01/04	Fredrick Owino	Box 13762 Westlands	External review mission
21/1/04	Robert Oyalo	Box 13762 NRB	External review assignment
26/1/04	Catherine N.Wachira	Kefri Hqts Box 20412	Official duties
2/6/04	S. Kariuki	Kefri Hqts Box 20412	Official
1/3/04	James O.Maua	Kefri Hqts Box 20412	Visit trees seed stand
23/3/04	Michael Maina	Kefri Hqts Box 20412	Official
1/4/04	K.E. Mutitu & L.M Mwangi	Kefri Hqts Box 20412	Clonal psp assessment at Timboroa
5/4/04	Joseph K. Terer	Box 59 Olenguruoni	Seed attachment
7/4/04	Phanuel O. Oballa	Kefri Hqts	Official work
7/4/04	Charles O. Wandere	Kefri Hqts	Official work
21/4/04	Dr. M.N Muchiri	Kefri Hqts	Review plantations work
21/4/04	Dr. M Jahiraddin	Bangladesh Agri University	Discussion about forest & Management
22/4/04	Richard O. Abiri	Kefri Hqts	Official duties.
11/5/04	DC/Markwet	Markwet Box 11 Kapsowar	Opening forestry workshop
11/5/04	J.L.Silingi	DDO Marakwet Box 116 Kapsowar	Attending workshop on cedar adding value
11/5/04	F.N. Nganga	D/DAO Marakwet Box 104 Kapsowar	Attending workshop on cedar adding value
11/5/04	S.K.Rotich	D.L.P /Marakwet Box 11 Kapsowar	Workshop
11/5/04	David K. Kerich	D.C.O Box 131 Raps	Workshop

12/5/04	Robert Nyambati & Charles Koech	Kefri Hqts Box 20412	Tindiret survey
13/5/04	Michael Maina & Sophia W. Mburu	Kefri Hqts Box 20412, NRB	Official duties
31/5/04	J. Cheche	Kefri Hqts	Official duties
15/6/04	R.Chepkwony-Chief	Lemotit Location Box 44	Courtesy
15/6/04	Richard Rono	Sugutek Water Project	Courtesy
16/6/04	John N.Kimathi, Caleb S. Otura & Pinus Chepkwony	KCB Kericho Box 43 Kericho	Official duties
16/6/04	CHC Okongo, John Nyandiko, & Mary W. Matuara,	Kefri Hqts Box 20412, NRB	Official duties
17/16/04	Julius Cheche	Kefri Hqts	Coordination
17/6/04	J S Musah	Kefri Hqts	Stock taking supervisions
21/6/04	L.M Mwangi	Kefri Hqts	NF Programme concepts
21/6/04	P.O.Oballa	Kefri Hqts	FF Programme concepts
21/6/04	M. N. Muchiri	Kefri Hqts	PF Programme concepts
22/06/04	Ibrahim O.Momanyi	Kefri Hqts Box 20412, NRB	Audit