KENYA FORESTRY RESEARCH INSTITUTE (KEFRI)

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KENYA FORESTRY RESEARCH INSTITUTE

Kenya Forestry Research Institute

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Foreword

By Director, KEFRI

In the course of 2007/08 financial year, Kenya Forestry Research Institute (KEFRI) revised an existing strategic plan to align it with the 2008-2012 Medium Term Expenditure Plan of Kenya Vision 2030.

Our vision was slightly revised to read:
"To be a centre of excellence in forest science through technology development, deployment and dissemination of scientific information."
Our mandate remained the same as previous and is to:

- Conduct research in forestry
- Disseminate research findings
- Cooperate with other research bodies within and outside Kenya carrying out similar research and
- Establish partnership with other organizations and institutions of higher learning in training and matters of forestry research

This report covers the research undertaken in several fields, the priority of which remained farm forestry. Hard work and dedication by all staff and partners made it possible for KEFRI to make an impact in addressing the current challenges facing the forestry sector.

Action was taken to address stakeholder concerns over limited tree species diversity and availability of high quality germplasm, inadequate on-farm forestry and agroforestry management technologies as well as inadequate utilization and marketing of farm forestry products. Tree planting in the mean time continued to increase on farms as KEFRI advocated for a more clear policy on farm forestry as well as validation of traditional knowledge and practices to help increase tree cover on farmland.

Kenya's natural forests, many of which double up as water catchment areas, are threatened with encroachment and indiscriminate felling. KEFRI lead the way in developing technologies for their conservation while demonstrating it is possible to adopt participatory management approaches with communities whose livelihoods are dependent on the affected forests. Research on forest biodiversity, use and value was undertaken to generate the necessary information required to guide policy makers on importance of conserving them. Efforts were made to broaden knowledge on the range of indigenous species utilized for wood and non-wood forest products and services.

Drylands received close attention as information was gathered on their fragile woodland biodiversity. It was necessary to document the status and value of hilly watersheds which serve inhabitants of these regions with essential requirements for their survival Work continued on developing the right management technologies to tackle invasive tree species such as Prosopis. With the involvement of our donor partners, KEFRI pursued research and continued to coordinate activities in the development of non-wood products as a means of deriving sustainable economic benefit from utilization of commercial dryland plant species. Demonstrations featured technologies on how to overcome constraints associated with tree establishment and domestication in the drylands. Participatory woodland management was supported as traditional practices were validated.

Industrial plantation forests, mostly grown on government-gazetted forests but fast gaining popularity on farmland, were faced with challenges of labor costs and availability. As such, KEFRI addressed the issue of inadequate demonstration of alternative plantation establishment methods. Data was collated on growth, yield and operation costs for plantations. Efforts were intensified to supply high quality propagation material and to diversify the available tree species currently grown in plantations. KEFRI further supported these initiatives by undertaking the necessary research to protect forests from damage caused by fire, insect pests and diseases.

Tree seed research evolved into a full programme of the Institute in the course of this year. The main objectives were to address the insufficient and insecure seed sources; seed quantity, quality and diversity as well as enhance linkages with tree seed producers. Tree seed distribution was decentralized to some regional centres. Research was undertaken to provide information on handling, storage and use of tree seed.

It is the responsibility of the KEFRI Service Programme to ensure that the information generated through research is made widely available to stakeholders, in various formats. The programme coordinated Open and Field days across all regional centres, packaged information in simple leaflets or brochures and produced various technical publications. A KEFRI website was maintained and regularly updated. This Programme also enhanced the extension linkage with stakeholders by conducting various courses at the Social Forestry Training Centre in Muguga and undertook routine maintenance of research forest estates in KEFRI Headquarters.

I take this opportunity to reassure our partners that the Institute remains committed to pursuing a research agenda that is relevant to their needs and look forward to continued collaboration.

Dr. P. K. A. Konuche,
Director, KEFRI.

Contents

1.0 Farm Forestry

Research was carried out in three key projects as follows:

Project FF/01: Diversification and genetic improvement of priority tree species.

At Gede Research Centre, work was undertaken on diversification and demonstration of performance of priority tree species, focusing on promising ones. *Azadirachta indica* (Neem) and *Melia volkensii* were established in new demonstration plots in Taita Taveta District. Plots of *Gmelina arborea*, *Casuarina equistifolia*, *Neem*, *Milicia excelsa* and *Croton* spp., that were established the previous year, were maintained. Like wise, seed orchards of *Grevillea robusta*, *Markahmia lutea* and improved fallow species that were established the previous year at Turbo, Siaya, Bukura, Yala, Muguga and Kuja River sites, were maintained.

Project FF/02: Improvement of on-farm forestry, agroforestry technologies and management practices

In Kwale and Malindi Districts, improved fallows were established to determine the effect of dual inoculation and rock phosphate application on crop (maize) yield. The objective of this research was to select the best-suited improved fallow species adaptable to the Coast region in terms of biomass productivity, litter quality, maize yield and positive soil changes. Soil quality changes were monitored. The work continues.

In eastern Kenya, residual effects of integrated soil fertility management on rhizobia dynamics were tested under contrasting rainfall regimes so as to capture nutrient changes in various sites in the drylands.

In western Kenya, various sources of Phosphorus (P) were evaluated for their ability to enhance biological nitrogen fixation by improved fallow tree/shrub species under different soil conditions. A 2 x 2 x 2 factorial experiment was set up with three replicates. Phosphorus was supplied singly or in additive combinations at a rate of 60 Kg P/ha in form of Minjingu rock phosphate, fish bones and triple super phosphate. The P-sources were first analyzed to determine their content. The relationship between biomass quality, organic and inorganic plant nutrient sources was also investigated by testing the effects of different quality organic sources and urea combinations on maize productivity for two different soil types in this region. The work is still in progress.

A farmer field school approach to extension is currently advocated for by Kenya Forest Service (KFS). Factors that influence its success were documented. In related studies, the influence of institutional capacity on adoption of forest innovations in Kenya was investigated. Findings were that barriers to scaling up of agroforestry technologies in Nyanza and Western Provinces, for example, arise from a policy environment that is not conducive, inadequate extension services, lack of required inputs (especially quality germplasm for some species) and limited market information on agro-forestry products.

To improve timber recovery and surface quality, timber sawyers and extension officers based in Uasin Gishu and Elgeyo Districts were trained in integrated, cost-effective skills for small-scale processing of timber on farms. Training on improved sawing techniques covered the following areas.

1. Safety requirements for chain saw operators
2. Tree felling, crosscutting and log handling
3. Log sawing for high recovery and quality (chain saw mill frames)
4. Timber sizing for high yield and uniformity
5. Post sawing timber handling, storage and seasoning

The training was evaluated for its socio-economic impact.

Recommended Safety gear (PPE) for chain saw operators

Participants were exposed to design modifications of standard sawing equipment that make it more ergonomic and environmentally friendly. It was recommended that:

1. Follow-up evaluations be conducted after one year to measure the impact of the training on timber recovery and note any emerging issues
2. Funds permitting, training should cover all other major timber-producing areas during the current fiscal year
3. Timber sawyers organize themselves in societies to make it easier to train them, especially concerning the introduction of new sawing technologies

Efforts were also made to develop management protocols and improve the yield of Moringa oleifera products, three for which value was added. The objectives of this study were to:

- Carry out a bio- assay of the nutrients found in the local Moringa varieties
- Disclose nutritional data on product labels for marketing purposes

A product by the name Moringa Uji mix was developed and the formula made ready for packaging and marketing. A Moringa plot belonging to Bidii women group in Malindi was thinned to test the effects of spacing on seed production.

Local trade in tree products

A national study was conducted to capture the dynamics, trade arrangements and price changes affecting performance in the market of various timber products such as sawnwood of soft or hardwood origin, charcoal, construction and other poles.

North, Central and South Rift Valley regions remained exporters of tree products, mostly to Nyanza and Western provinces. Sawnwood was produced from various indigenous and exotic species including *Cupressus lusitanica*, *Pinus patula*, *Eucalyptus grandis* and *Grevillea robusta*. Construction poles and firewood were dominantly produced

from *E. grandis* and other available *Eucalyptus* spp. Charcoal that was trading in the region was produced from *Acacia mearnsii* woodlots in the North Rift districts or from woodlands in semi-arid areas of Marakwet, Baringo, Trans-Mara and Narok districts. The major market outlets for tree products in western Kenya were Naivasha, Nakuru, Eldoret, Kisumu, Kakamega, Kitale, Bungoma and Busia. Retail prices for sawnwood in the region stabilized at between Kshs. 16 to 26 per foot, depending on size, species preference and supply/demand conditions. Good quality supplies of the highly preferred cypress sawn wood were decreasing and more traders were shifting to E. grandis as it was more abundant on farms.

Charcoal prices in the region increased from Kshs. 350 to 400 at farm gate level and from Kshs. 520 to 600 at retail outlets, between 2005 and 2008 respectively. In larger markets, such as Kisumu, retail prices had reached Kshs. 600 by November 2007. Trade in construction poles was fast expanding in Nyanza, evident from an increased number of stockyards and stocks on sale in more towns. The number of stockists selling poles in Kisumu, Awassi, Ahero, Kisii, Homa Bay, Luanda and Siaya towns in Nyanza Province has been on the increase over the last 7 years. Similarly, Eldoret and Nakuru towns in Rift Valley Province recorded increased activity in construction pole trade to serve a booming commercial and residential construction sector. The prices of construction poles ranged from Kshs. 15 to 100 depending on size and supply/demand condition in the respective outlets. Apart from urban domestic markets, firewood in western Kenya was consumed by several food and textile processing industries in the region. These industries include 19 Kenya Tea Agency (KTDA)-affiliated tea factories, the Pan Paper mill in Webuye and textile and food processing industries in Eldoret. Others were sugar-processing factories in the sugar belt and chemical-processing factories in Nakuru. The potential for many farmers to enter lucrative semi-processed transmission-pole markets had resulted in 7 treatment plants being established in the region.

Mt Kenya region was self-sufficient in most tree products and a surplus was exported to Isiolo Mwingi, Kitui and Nairobi regions. Major market outlets in the region included Nyeri, Embu, Nanyuki, Meru, Muranga and Mau. Saw mills in major towns were now sourcing for saw logs from middlemen or directly from farmers, who in turn were now increasingly processing trees into sawn wood at the farm level. Charcoal was sourced mostly from rangelands, ranches and small-scale land owners from semi-arid parts of the region. This commodity was generally scarce in the region due to restrictions placed on movement of charcoal between production and consumptions areas. Horticultural farming, especially in Timau, increased the demand for small poles and withies. This attracted supplies from merchants from within and beyond the region. Firewood trade had increased after most tea factories adopted a new energy policy to replace furnace oil with firewood. The change was met with a serious shortage of firewood in the region to the extent that it was now widely sourced from indigenous species, G. robusta or fruit trees all the way from Mt Kenya to the semi-arid zones.

Ukambani districts of Eastern Province reported the lowest charcoal prices in the country.

The coastal districts were net importers of sawn wood and other tree products from Tanzania, with only small quantities coming from upcountry. There was an oversupply of pine sawn wood mostly from Tanzania and prices had stabilized at between Kshs. 18-26 since 2004. Poles traded in the coastal region were mostly harvested from mangrove forests or Casuarina woodlots on farms. The region attracted charcoal supplies from the dry hinterlands such as Samburu, Baricho and Marafa divisions among others. Small imports from Ukambani districts reach Mombasa town.

In general, trade in tree products generated income worth millions of shillings for farmers, processing agents, traders, transporters and retailers in the country. It also supported several wood-based enterprises ranging from food processing, furniture and joinery, pulp and paper to chemical industries.

Opportunities for trade in tree products in East and Central Africa

The banning of timber harvesting from Kenyan public forests opened new avenues for tree products from East and Central African region to flow into Kenyan market. The quantities traded had increased and distances traveled to sources were as far as Malawi and Zambia in ECA and Guinea in West Africa. Reports from Kenya Forest Department indicated that licences were granted in 2005 to import iroko and sapele hardwood from Guinea for production of high value furniture in Lamu.

The findings from the survey indicate that the trade between Kenya and other countries is set to expand, making Kenya a regional hub for secondary wood processing and export in the region. This calls for formulation of appropriate policies to attract local and foreign investors into the sector to serve the fast growing market for high value products in the region. Trade statistics showed that in 2007 Kenya imported 85,000m3 of softwood and 21,000m3 of hardwood and 150,000 pieces of poles, mostly from Tanzania, worth a total Kshs. 3.6 billion.

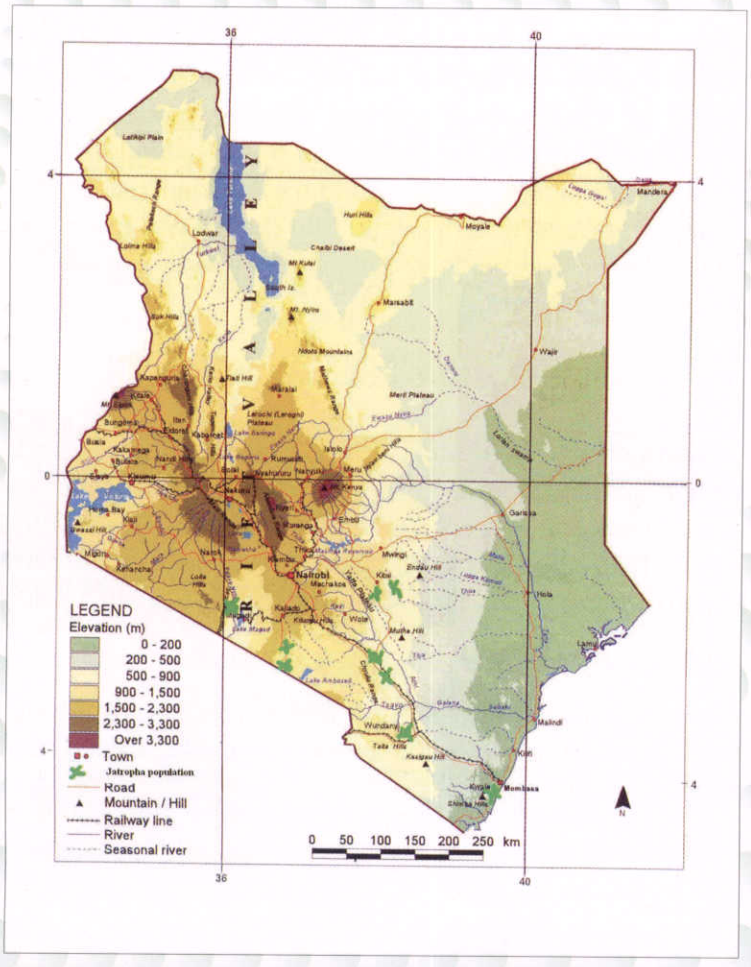
Project FF/04: Development of wood biomass energy

Woody biomass

Wood energy production was monitored at micro-level in Kiambu, Thika and Maragwa Districts in order to build the case for a decentralized wood energy plan in Kenya. Data analysis was in progress at the end of the reporting period..

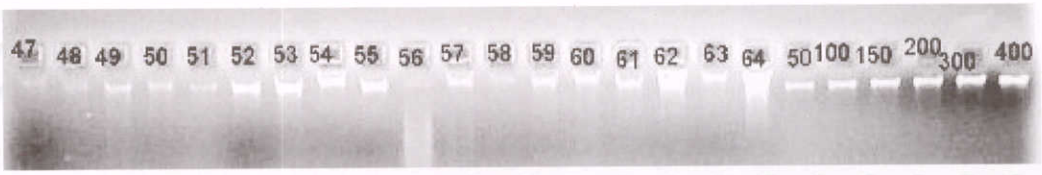
A study of genetic variation of Jatropha

Six populations of *Jatropha carcus* L were identified and mapped on a physical map of Kenya using GIS technology. They were located at Namanga, Nguruman valley, Kitui, Kibwezi, Voi and Likoni. A total of 20 samples per population were collected and stored in silica gel awaiting DNA extraction and analysis.



A physical map of Kenya showing the mapped South Eastern populations of Jatropha carcus (Green X marks).

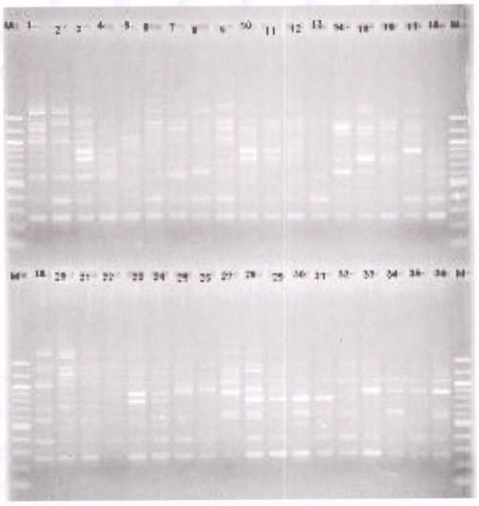
DNA was isolated from leaf material by a modified version of the method described by Edwards et al. (1991). DNA was quantified to be between 75 to 250ng/µl. A total of 40 primers were screened for results.



An Agarose gel stained with Ethidiaum bromide showing DNA isolated from Jatropha (47 – 64) against DNA standards (50 – 400)

Initial PCR

An initial PCR to screen positive RAPD primers was still under investigation with some positive results.



An agarose gel stained with Ethidium bromide showing genetic profiles of Jatropha carcus probed with a RAPD PCR primer

Production of bio-fuels

A different aspect of energy that was also investigated was the production of bio-fuels with the following objectives:

1. To produce oil from *Croton megalocarpus* seeds from three provenances (Nyeri, Kakamega, Ngong) as well as from *Jatropha curcas* from 4 provenances (Kitui, Nguruman, Maseno and Coast)
2. To analyze the oil yield from each of the provenances in terms of quantity and quality
3. To produce a bio-diesel from both species and press cake from *Croton megalocarpus* seeds

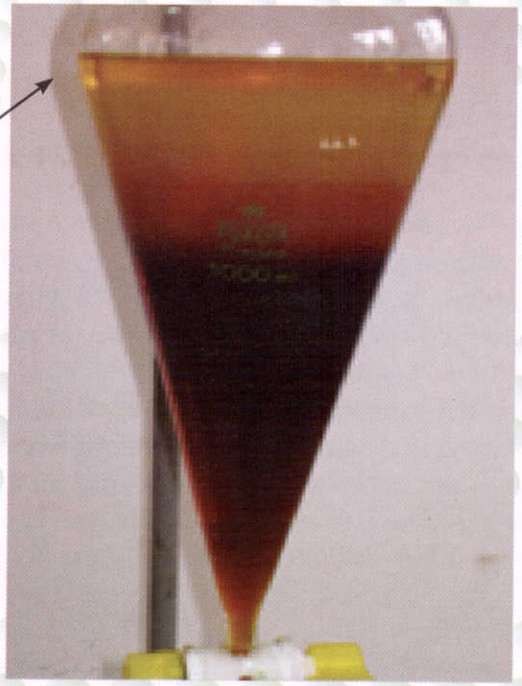
At least four outstanding provenances of *Jatropha curcas* and *Croton megalocarpus* were delineated and genetically analyzed. The selected provenances were then established and to document the variability in seed and oil as variables in productivity of potential biomass energy technologies for Coast, Nyanza, Rift Valley and Eastern Provinces. Ten (10) kg of each species was sourced from each of the provenances. The oils from the seeds were extracted using (cold press) a seed oil extractor separately according to region/provenance.

A seed oil extractor

Bio-diesel processing

Bio-diesel was made through an esterification process (where the triglycerides reacted with an alcohol (methanol) in the presence of a catalyst, the catalyst used was a strong alkaline NaOH (Sodium hydroxide). The separation takes 12- 18 hours to get the clear bio-diesel.

The biodiesel layer separated from the soaps below



The esterification process in progress, the oil has reacted with methanol (the darkest part) the soaps are the two layers below the clear bio-diesel, which is on top.

In Bondo District, six-year old Acacia xanthophloea was assessed for charcoal production, using half-orange kilns that measured 2.8 m in diameter and 1.8 m in height.

There was a door at one end measuring 60 cm wide at the base and a height of 140 cm. The kiln had air-lets at three levels of the kiln; 10 air-lets at the bottom (about 2-3 cm from the ground), at 1 m high are 9 air-lets and another 9 at 1.5 m high.

A half-orange kiln constructed in Midiany Division, Bondo

The various stages of loading and firing the kiln were noted – the number people required and the time taken to complete the task. The number of bags of charcoal packed was 16.5 with an average weight of 42.5 Kg; the recovery rate was rather low (14.6%) due to over burning of the charcoal.

The average energy values for charcoal of Acacia xanthophloea obtained from Bondo compared with known data

Tree species	Moisture Content (%)	Volatile Content. (%)	Ash Content. (%)	Fixed Carbon. (%)	Calorific value (kcal/g)	Density (kg/m3)
A. xanthophloea (from Bondo)	5.79	21.15	3.46	69.6	7.914	691
A. xanthophloea	7	16	4	74	6.7	532
Recommended values for charcoal	5 -15	5 - 40	3	50 - 95	5 - 9	

More trials using the kiln are to be done to perfect the process so as to reduce over burning. The wood should also be stacked longer to dry so as to attain a moisture content of about 20%.

2.0 Natural Forests Research Programme

Project NF/01: Conservation and Management of Natural Forests

An IFRI project monitoring the impact of institutions and incentives on forest and woodland resources continued. The capacity of staff in the project was strengthened by training two of them at PhD level while at community level, 25 groups received relevant training. This was based on a manual developed for trainers in Participatory Forest Management (PFM). The manual brought about uniformity in PFM training although it requires periodic review to address emerging issues. A hand book covering the topics in greater detail is also required to guide trainers. It is recommended to cover PFM training as follows:

Module Course Content

1. **Climate Setting**
   - o Introduction –
   - o Recording Participants interest and fears
   - o Setting rules and assigning roles and responsibilities
   - o Negotiating Training Program
   - o Key note address

2. **Introductory Topics**
   - o Historical development of Forestry in Kenya
   - o Introduction to NRM Policies and Legislation
   - o Reforms process in Public Sector
   - o Land and Resource Tenure
   - o PFM- What and Why?
   - o PFM and Rural Development
   - o PFM Principles and Process

3. **Participatory Situation Analysis**
   - o Policy Analysis
   - o Feasibility Assessment
   - o Attitude Change
   - o Stakeholder Analysis
   - o Institutional Arrangement for PFM
   - o Resources Assessment
   - o PFM and Livelihoods

4. **Negotiating for PFM**
   - o Negotiation and Consensus building
   - o Conflict Management
   - o Power relationship
   - o Communication skills
   - o Facilitation skills
   - o Community mobilization
   - o Team building
   - o Management Plans
   - o Management agreements

- Governance
- Gender and Equity

5. Sustaining PFM

- Participatory approaches and tools
- Forest Extension services and PFM
- Costs and Benefit sharing
- Organizational development
- Advocacy and networking
- Institutionalization of PFM
- Resource mobilization
- Participatory Monitoring and Evaluation

6. Way Forward

- Action Plan
- Follow up
- Monitoring Impacts of PFM

IFRI /SANREM tools

A project funded by International Forestry Resources and Institutions (IFRI) supported a study on Tugen Hills forest. This was carried out using a combination of IFRI instruments and SANREM methods. The process of implementation of Participatory Forest Management was documented and knowledge gaps identified. Activities were carried out in three selected forest sites. To support reforms in the forestry sector, incentive systems were studied and documented. The organizational structures of emerging institutions (Community Forest Associations) also received attention while selected participants from key organizations were trained in policy analysis.

IFRI research instruments were used to collect both biophysical and socio-economic data. Biophysical data was collected from plots that were randomly selected using UTM grid co-ordinates. Their position on the ground was recorded using a GPS. In total, data was collected from 30 plots, all distributed within the selected IFRI forest. Tree heights and diameters were measured but for shrubs and samplings only estimates were taken.

Different IFRI forms were also used to record data on the socio economic characteristics of the site. Participatory Rural Appraisal methods (PRA) were applied to gather more socio-economic data.
SANREM data was collected from a total of 100 households that were randomly selected.

Of those sampled, 84% of the households were male headed. This had a critical effect on matters relating to acquiring assets and decision-making especially on land use and general property ownership.

Training included both community members and government officials and was conducted prior to the site visit. A total of 40 participants received this training with a major focus on the new Forest Act. A large proportion of the community in Tugen Hills had not enlisted as members of local organizations (whether forestry or non-forestry) nor had they taken part in group activities. Since groups will play an integral part of future forest governance in line with the new Forest Act, it was advisable for them to join up if they wanted to take part in such decision-making. Dealing with people in groups was also considered more effective than individuals. Some of the existing organizations had actually attracted members from outside the settlement but this proved to be a big constraint especially when trying to reach a large number of people within the settlement. They were therefore encouraged to form more local groups.

Both government and non-governmental organizations had good links with the community but there was need to form a strong umbrella association to work closely with the Kenya Forest Service in forest management, as

required by the new Forest Act. The community was highly dependent on the forest for both subsistence and cash income.

Property rights emerged as a major problem in Tugen Hills. A number of 'squatters' still lived in the forest even though they were supposed to have been re-settled elsewhere after their land was gazetted as a forest reserve. They claimed that other people were re-settled by the government instead, leaving them landless.

Project NF/02: Propagation, management and utilization of wood and non-wood products from Natural Forests

Work was undertaken on bamboo resources in order to generate information required for management and utilization. The objective of this study was to develop propagation techniques for mass production of exotic and indigenous bamboo planting material (propagules). The technologies tested involved raising exotic and indigenous bamboo seedlings using bamboo culms and branches raised in greenhouses and the open nursery.

Most exotic bamboo species regenerated well in the green house but there was limited success using this method in the propagation of Yushania alpina, an indigenous species. This was explained by the fact that the greenhouse conditions to which the indigenous species was exposed were much warmer than natural habitats.

Exotic and indigenous bamboo species under general propagation and experimentation

Exotic and indigenous bamboo species	Carried forward from 2006/7	Number raised in 2007/8	Plants planted 2007/8	Plants sold	Dead plants	Total plants	Propagation success
Bambusa dendrocalamus gigateus	65	30	50	0	2	43	40-50%
Bambusa vulgaris	2266	548	46	20	200	2548	80-90%
Bambusa vulgaris Var. *striata*	25	0	20	0	5	0	80-90%
Bambusa briamena	1280	40	30	0	50	1240	60-70%
Bambusa dendrocalamus membranese	13	20	13	0	0	20	50-60%
Yushania alpina (indigenous)	0	80	16	0	24	40	10-25%
Total	3649	718	175	20	281	3891	

The use of culms proved to be the most successful technique for raising bamboo seedlings in the nursery. A guidelines manual was under preparation.

Attempts at designing, making and improving bamboo products yielded at least three new bamboo products while improving the design of five others. Artisans drawn from stakeholders collaborating with every KEFRI Regional Research Centre received training in the making of bamboo products.
The demand for training by artisans was very high, with 45 applications made for the 12 places available. Capacity in furniture design and product costing is what remains to be enhanced through further training.

Trainees receive instructions on weaving techniques

Sample bamboo furniture made by trainees

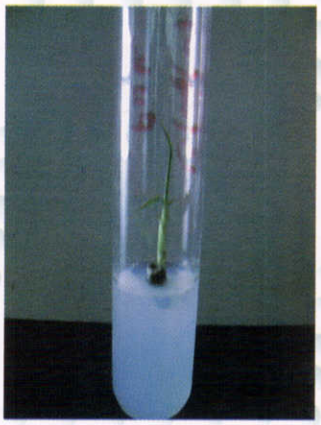
Propagation of bamboo

In-vitro methods were developed to produce bamboo plantlets in Muguga Regional Research Centre laboratories. This study attempted to develop novel techniques for rapid and mass proliferation of bamboo micro-shoots, initiate rhizogenesis and optimize acclimatization and multiplication of giant bamboo.

A

B

C



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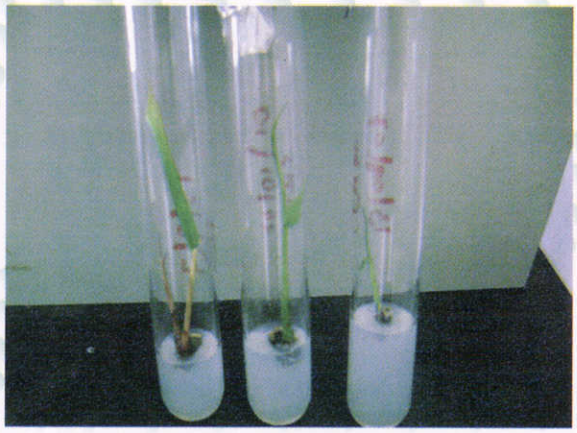


Proliferating shoots in various propagation vessels before transfer to rooting media in A) 30 ml Universal McCartney bottles; B) 1l Elemeyer flask; C) & D) 70 ml test tubes

Micro-shoots of giant bamboo were successfully established following a sterilization protocol developed under optimal cultural conditions for in vitro proliferation. However, based on the type of ex-plant used (culm-bud derived micro-shoots), this study did not optimize in vitro cultural conditions for rooting of regenerated micro-shoots. Further studies were therefore recommended to test more hormonal combinations, cultural conditions and exclusion of cytokinins in the rooting media by using activated charcoal, adding cytokinins in the rooting media or use of appropriate growth vessels.

Conservation of medicinal tree species

Activities were carried out in the propagation and conservation of selected medicinal plants. Demonstration groves of at least five plant species were planted at each of KEFRI'S six Regional Centres. Management guidelines will eventually be developed for each of the featured species.

A research/demonstration plot was established at Turbo in May 2008 with an assortment of priority indigenous medicinal trees. The trees were planted in blocks of 15 trees (165 in total) at a uniform spacing of 3 m x 3 m as shown in table 3 below:

Medicinal trees planted in Turbo and Kerio Valley demonstration plots

Species	No. of seedlings at Turbo	No. of seedlings in Kerio
Polycias kikuyuensis	15	15
Dombeya burgessiae (torrida)	15	15
Prunus africana	15	15
Croton megalocarpus,	15	15
Fagara macrophylla	15	15
Albizia gummifera	15	15
Croton macrostachyus	15	15
Olea africana	15	15
Syzygium guineense	15	15
Juniperus procera	15	15
Warburgia ugandensis	15	15
Total	**165**	**165**

Thorn trees were placed around the plot to act as a protective barrier against browsing or trampling of the young seedlings by livestock.

A plot of medicinal tree seedlings established at Turbo

It was recommended that:

- Medicinal tree species adapted to the low soil water status of semi-arid areas like the Kerio valley zone should be introduced and promoted.
- Young tree seedlings need protection from livestock using low-cost methods of fencing
- Farmers/institutions should be encouraged to acquire their own planting materials (seeds, seedlings) by collecting wildlings and maintaining private tree nurseries. They should also be trained on the propagation and management of medicinal tree species, including nursery practices.

Project NF/03: Rehabilitation of natural forests and woodlands

Studies were carried out in restoration of selected degraded natural forests. Assessments were made to document the social factors behind degradation and the impact it has on vegetation composition. The impact of degradation on soil properties and functions was further quantified through studies on soil fertility and erosion. The final outputs were tools developed to enable stakeholders to make informed decisions during a rehabilitation process.

This work was complemented by expanding, maintaining and monitoring demonstration forest rehabilitation sites in several affected areas scattered around the country, that is, in Kakamega, Gwasi, Nguriunditu, Kikuyu Escarpment, Hombe, Mrima and Wire forests. A new demonstration site was set up in Homa Hills.

The impact of natural forest rehabilitation was monitored in areas cleared under Nyayo Tea Zone Development Corporation (NTZDC) program during which extensive areas were left without vegetation and in need of restoration. This could have serious environmental consequences if the deforested areas are not reforested. To successfully do this, the desires of the local communities need to be taken into consideration since different localities require unique approaches in terms of species mix and specific needs of forest adjacent communities. The potential species are a mix of indigenous trees and fast growing exotics that were suitable for each site.

Forest Site	Indigenous species
Kakamega **Madzo** **Ileho** **Jorban**	*Bridelia micrantha* *Cordia abyssinica,* *Croton megalocarpus* *Diospyros abbysinica* *Maesopsis eminii* *Olea capensis* sub spp *welwitschii.* *Polyscias fulva* *Prunus africana* *Syzygium cordatum* *Syzygium guineense*
North Nandi **Kamungei**	*Acacia lahai* *Cassipourea malosana* *Croton macrostachyus* *Diospyros abyssinica* *Fagaropsis angolensis* *Polyscias fulva* *Schefflera volkensii* *Syzygium cordatum* *Syzygium guineense*
North Nandi **Kapchekok**	*Croton macrostachyus* *Diospyros abyssinica* *Fagaropsis angolensis* *Olea capensis* *Polyscias fulva* *Prunus africana* *Schefflera volkensii* *Syzygium guineense* *Syzygium cordatum* *Zanthoxylum gillettii*
Kapchorua	Pioneer species: *Allophyllus abyssinicus* *Dombeya torrida* *Neoboutonia macrocalyx* *Solanum* spp. *Vernonia lasiopus* Other species: *Acacia lahai* *Aningeria adolfi friedericii* *Croton macrostachyus* *Diospyros abyssinica*

Kapchorua	Pioneer species: *Allophyllus abyssinicus* *Dombeya torrida* *Neoboutonia macrocalyx* *Solanum* spp. *Vernonia lasiopus* Other species: *Acacia lahai* *Aningeria adolfi friedericii* *Croton macrostachyus* *Diospyros abyssinica* *Ficus capensis* *Juniperus procera* *Olea capensis* *Polyscias fulva* *Prunus africana* *Syzygium guineense*
Tinderet Forest	*Aningeria adolfi friedericii* *Croton macrostachyus* *Ensete ventricosum* *Neoboutonia macrcalyx* *Nuxia congesta* *Olea capensis* subsp. *welwitschii* *Prunus africana,* *Podocarpus latifolius* *Polyscias fulva* *Syzygium guineense* *Vernonia lasiopus*

For use values, exotic tree species such as cypress and eucalypts were mentioned as priority tree species for planting in areas further from the ecologically sensitive areas. In the disturbed sites pioneer species like *Neoboutonia macrcalyx, Vernonia lasiopus*, Solanum spp., *Dombeya torrida, Allophyllus abyssinica* had emerged as potential species, which can be used in enrichment planting.

In collaboration with Kenya Forest Service, the impact of natural forest rehabilitation was monitored in environmentally sensitive areas in six ecological zones. Baseline data was first collected after which interventions were made in eight plots established for the purpose of monitoring developments.

Project NF/04: Propagation, assessment, rehabilitation and sustainable utilization of mangrove resources.

This activity was carried over from the previous year with the aim of conducting a resource survey so as to establish the stocking rates of mangroves and rehabilitate degraded sites at Mida Creek, Malindi and Manda Island in Lamu. It began with the development of a method for assessing the mangrove resource in stock, followed by the establishment of demonstration rehabilitation plots in Lamu, Kilifi and Vanga.

Transporting mangrove seedlings to a planting site in Lamu.

Participatory Resource Assessment

This was carried out at Matondoni, where 6 plots measuring 25m x 25m were assessed with involvement of local communities. A total of 180 trees & shrubs, 750 saplings and 1,580 seedlings were documented. All potted seedlings in the nursery were planted out during the long rain season.

Demo plot

Survival was estimated at between 45 and 50 per cent for *Rhizophora mucronata*, *Ceriops tagal* and *Sonneratia alba*. Seedlings of *Avicenia marina* and some of *Ceriops tagal* that were planted in the upper part of the beach dried up when they did not get moisture and that area would require to be beaten up during the next long rains.

Bora Maganga Nursery in Lamu

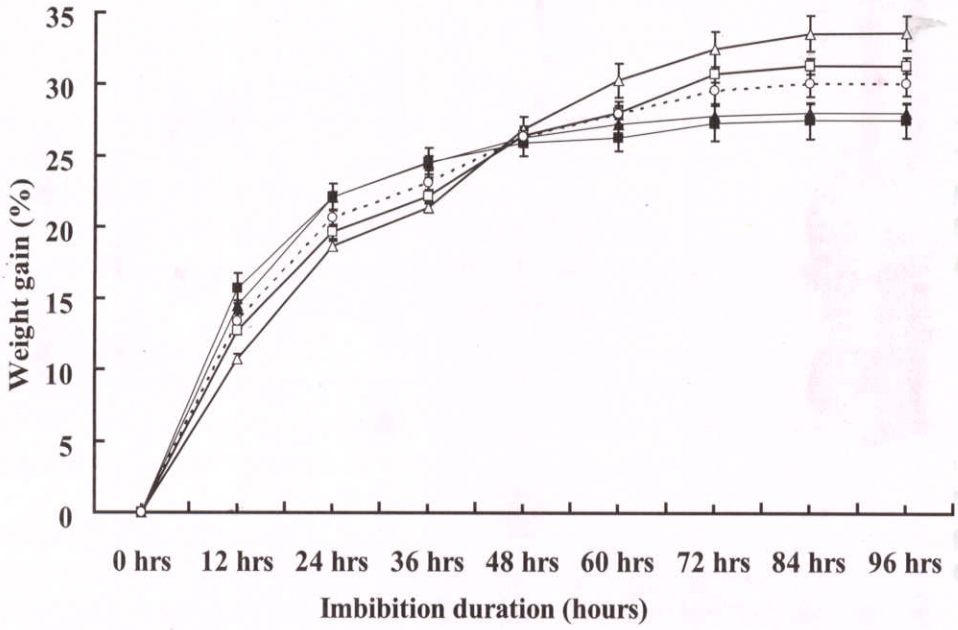
The demonstration plot at Kibuyuni, Lamu.

Guidelines were developed on more efficient utilization of the mangrove resource, including methods for firing lime with mangrove wood. A demonstration was carried out for the benefit of stakeholders.

African satinwood

Support was given to a KEFRI scientist to conduct post-graduate studies on germination, following confirmation of the dioecious reproductive nature of *Zanthoxylum gilletii* (African Satinwood). This species is found growing in Kakamega, South Mau, Nandi and on the slopes of the Aberdares and Mount Kenya forests. It is typically a tropical rainforest species, distributed at between 900 – 2300m above sea level and requiring an annual rainfall of 1200mm and above. It is an important timber species in the tropics and most members of the *Zanthoxylum genus* are recognized for their medicinal qualities that include treating stomachache, toothache, intestinal worms, rheumatism, scabies, snakebites, fever, and cholera. Zanthoxylum species are a source of essential oils and are good ornamental trees/shrubs.

This study documented the imbibition percentage of *Z. gilletii* seed over 96 hours period for unwashed and washed seed from green and red fruits as shown in the graph below:



Washed seed from green fruits (Δ), Unwashed seed from green fruits (▲), washed seed from red fruits (□), unwashed seed from red fruits (■) and average imbibition (○). Error bars represent SE during the hourly imbibition period, n = 5, (3g of seed per replicate).

3.0 Drylands Forestry Research Programme

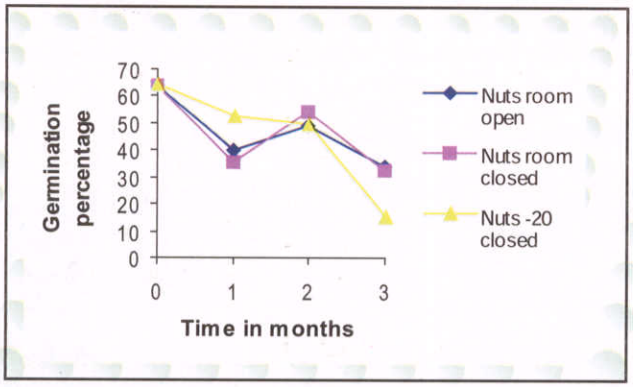
Project DF/01: Management, improvement and domestication of priority dryland plant species

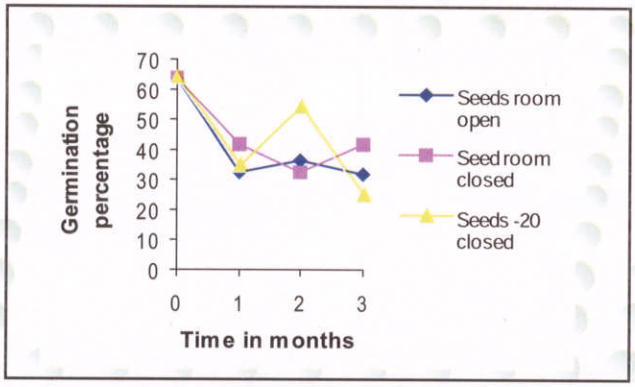
Germination studies

The good qualities of *Melia volkensii* (Mukau - Kikamba, Mpenda bure - Kiswahili), that have impressed farmers over time include wood resistance to termite attack, fast growth rate and ease of establishment with low rainfall amounts. The species is commonly used for timber, poles, firewood, fodder, handcraft, pesticides/ medicine and making beehives.

Research was undertaken on longevity in storage of *M. volkensii* seed. Germination tests were conducted at point of initial collection, followed by others during the first, second and third months of storage. Moisture content was determined at the time of testing initial germination. Initial seed germination was reported at 64% while the moisture content of the seeds was about 6%.

Seeds stored in nuts dropped in germination capacity after a month in storage and then germination went up the following month. It plummeted again during the third month. Seeds from nuts stored in closed containers at –20 oC displayed the largest drop in germination, from 64% to 33%. Seeds from nuts stored in open or closed containers had similar germination capacity, 33% and 34% respectively, after 3 months in storage (A).
Extracted seeds showed a similar trend when stored in open containers at room temperature or at –20 oC in closed containers. However, there was a lag in this trend for seeds stored in closed containers at room temperature, which continued to drop in their germination up to the second month but subsequently displayed a resurgence in the third month. This seed lot had the highest germination rate of 44 % (B).





Trend in germination of *Melia volkensii* seeds stored in nut (A) and as extracted seeds (B) under different temperature conditions.

The resurgence phenomenon was difficult to explain. Although the data obtained did not answer the question of whether or not seeds were recalcitrant, results suggested that Melia seeds could not tolerate freezing, whether stored in nuts or extracted. That seeds rapidly lost viability suggested that the experiments should be continued to test the trends for at least one year. This could help determine whether or not the current practice of storing Melia seeds in fruits under room temperature should be changed to storing extracted seeds in closed containers under room temperature.

Genetic diversity

The genetic diversity and variability of M. volkensii was documented, including populations in Moyale and Mandera Districts. Provenance trials were established using cuttings obtained from Tiva nursery in Kitui Regional Research Centre and located in Tiva, Kibwezi and Maseno sites. A clonal orchard was maintained in Kitui. Technologies for establishing the species were demonstrated in Makueni and Taita Taveta Districts.

3ha of M. volkensii were established but the plantation performed poorly due to a prevailing drought. Enough seedlings were raised ready for replanting in the short rains.

Mukau plot at Nguumo Primary School.

A demonstration plot was established in December 2007 on land that was formerly under cultivation with pigeon peas. 700 trees were planted at a spacing of 4m by 4m in pits measuring 45cm3. Land was prepared through slashing and oxen ploughing. The plot was fenced to keep off roaming livestock and maintained by slashing and occasional weeding to reduce competition as necessary. The survival rate was 90%.

Propagation of other dryland species

Likewise, appropriate methods were developed for propagation of *Terminalia brownii*, beginning with production of seedlings in Kitui. For *Osyris lanceolata*, it was necessary to develop a tissue-culture method suitable for raising seedlings of this species. In Kitui, about 500 samplings of Osyris were raised in the Centre green house. Research to find out the most suitable nurse plant continued.

Project DF/02: Management and control of invasive plant species

A national strategy for managing and utilizing Prosopis juliflora was given priority and at least three task force meetings took place. Other meetings were held to help strengthen the linkages between livestock feed manufacturers and residents of areas where the plant was abundant. Permanent sampling plots were established and assessed in five districts. In Baringo District in particular, stands of the species were classified by age, diameter-classes and density. Pod production levels were documented. Elsewhere in Garissa, Tana River and Baringo Districts, demonstration plots were established for the purpose of promoting integrated management and control. These efforts were supported by field days held at three of the sites.

Other related activities that were carried out during the period included determination of the genetic diversity of riparian populations as part of a study to determine the cause and effect of the upsurge of the species. An ecological impact study was conducted in River Turkwell ecosytem. Also supporting the management of Prosopis spp was a study conducted in quarantine to monitor performance of a beetle imported from S. Africa. Tests were carried out to determine if it would attack a wide range of related plant species out of which it was established that the beetle had no other hosts of economic importance.

Value addition studies

Research was conducted on drying schedules of Prosopis timber intended for woodcarving while a value chain was documented for charcoal, pods and timber. Products such as animal and human feeds were developed from seedpods, with a possibility for commercialization.

Project DF/03: Utilization and marketing of dryland forest products

Aloes

An aloe project got under way in Baringo District when an MOU was signed between KEFRI and the Baringo Aloe Enterprise. Four aloe products were developed of which one was linked to industry. A method for controlling diseases of commercial aloes was developed.

Dyes and tannins

Dryland species that produce dyes and tannins were studied in Garissa and Kitui Districts. A survey was carried out to identify plants used traditionally as sources. The aim was to domesticate and conserve them (Table 5).

Table 5: Species Producing Dyes and Tannins in Garissa District

Vernacular names (Somali)	Botanical names	% Response
Hagar	*Commiphora holtiziana*	90.0
Gollol	*Acacia bussei* Sjqsted	72.9
Ilan	*Lawsonia enermis* L.	52.9
Kuro	*Commiphora campestris* Engl.	41.4
Shoke		32.9
Hanjole	*Commiphora confusa* Vollesen	32.9
Damaja	*Commiphora candidula* /incisa Sprague	27.1
Fulai	*Acacia zanzibarika* (S. Moore) Taub	25.7
Murfur	*Boswellia neglecta* S. Moore	20.0
Lejire		7.1
Abak	*Acacia horrida*	7.1
Dibirikh	*Commiphora boiviana* (edulis)	5.7
Gundere		5.7
Waanri	*Lannea triphylla* (A. Rich) Engl.	4.3
Adhat		4.3
Daran		4.3
Durte	*Salsola dendroides* Pall. Var. Africana Brenan	4.3
Mulukisa	*Euclea natalensis*	2.9
Tarin		2.9
Eynot		2.9
Dumadere	*Cassia abbreviate* Oliv.	2.9
Gandimar		2.9
Kiteu		1.4

Muhanja		1.4
Mufati		1.4
Tuwel	*Acacia nilotica* (Forrsk) Hayne	1.4
Kumuhde	*Lannea elata* Engl.	1.4
Kura	*Acacia tortilis*	1.4
Karari	*Sterculia rhynchocarpa* K. Schum	1.4
Bura	*Erythrina melanacantha* Harms	1.4
Dengele		1.4
Gendige		1.4
Tubir		1.4
Anrequa		1.4
Jawder		1.4
Lanen	*Acacia mellifera*	1.4
Mokoli		1.4
Barara		1.4
Marer	*Cordia* spp	1.4

Propagation of Commiphora holtiziana

C. holtiziana is a decidous tree with height ranging from 3 to 10m and which occurs in Acacia –Commiphora bush lands with well drained soils. During the field survey, it was observed most of the plants of this species had been debarked in the process of obtaining dye and tannin materials. After data analysis, it was noted that it was the most highly preferred dye plant sources among all the other plants identified in Garissa. The local people also indicated that they lacked knowledge and skills to produce seedlings of this species and hence could not domesticate the plants as they wished. The need to develop an appropriate propagation method for *C. holtiziana* was thus identified.

Seeds were collected from a natural population in the Central division of Garissa District with the help of local people and Kenya Forest Service extension staff. About 10kg of bulk seeds were procured and screened before sowing. During the field visit, cuttings of different sizes were also collected in the same area for use in vegetative propagation. About 750 cuttings of different diameters were collected for vegetative propagation work.

When considering the treatments, nipping and cold water soaking for 24 hours gave the highest germination (20%). Cold water soaking and untreated seeds gave a low germination percentage of 3% and 2% respectively. Treatment of seeds using hot water or soaking them in sulphuric acid did not help germination in all the different soil types. The stem cuttings had not yet rooted at the end of the reporting period and the study continues.

Fruits

A trial on the appropriate technique for grafting Vitex payos was carried out using three types of rootstocks. These included seedlings raised from seed, wildings obtained from the field and maintained in the nursery and wildings in their original germinating site on one farm in Kitui. With the trial aiming to compare three different techniques of grafting using 9 grafts per technique and with 3 replicates, some at least 81 rootstocks were required of each type. At the end of the reporting period, over 100 seedlings and over 200 wildings were available in the nursery but had not yet attained the right size for grafting. They had an average height of 23cm and a root collar diameter of less than 1 cm. To hasten the growth of these rootstocks, they were transferred into bigger containers. They were also top-dressed with CAN fertilizer to supply nutrients.

The wildings on the farm were small in size with an average height of 20 cm and root collar diameter of slightly less than 1 cm. These were fenced off to shield them against browsing animals, especially at the height of the dry season (late February to mid March 2008). Supplementary watering was done and seedlings maintained for grafting at an appropriate future date.

Rehabilitation and management of woodlands

In Kitui District, information was compiled on indigenous fruit trees as a result of which *Sclerocarya birrea* was selected for further work on management and commercialization. A 2ha demonstration plot of the species was established at Tiva and a method of grafting developed for early fruiting.

New products

Among the new products developed and incubated for uptake by entrepreneurs in the drylands were essential oils from Commiphora, jam and wine from Baobab. These underwent quality analysis and evaluation. Likewise, jam and wine from Tamarindus were processed, tested for quality and cost of their production determined. Strategies for communication and sharing of knowledge on production and marketing of handicrafts were developed.

Project DF/04: Rehabilitation and management of woodlands

Several field days were held in KEFRI Regional Centres and stations to promote *Melia volkensii*, *Dalbergia melanoxylon* (Ebony) and *Jatropha carcus* as suitable tree species for rehabilitation and management of woodlands. Indigenous fruit tree trials were maintained and assessed at Tiva in Kitui and Kerio Valley, along with *M. volkensii* and Eucalyptus hybrid clone trials.

At Kibwezi, a field day was held on a farm whose owner, Mr. Kituku Mung'alla, has collaborated with KEFRI scientists in taking up promising dryland tree-planting technologies since 2002.

A 6 year-old *Mellia volkensii* tree on Mr. Mung'alla's farm

In 2005, he planted 418 Mukau seedlings, followed by 2446 others in 2006 and 1016 more in 2007. His current standing stock was of approximately 4000 *Melia volkensii* trees, the oldest being seven years. This progressive farmer adapted several agricultural and forestry technologies that enabled him to increase his produce yearly. For instance, in 2006 when the area received minimal rainfall, he doubled his produce by taking up integrated Vallerani technology. This package is purposely meant for water conservation and tree planting in ASALS and was administered by KEFRI under Acacia Operation Project (AOP).

Mr. Mung'alla standing next to a heap of firewood gathered from *M. volkensii* prunings within his woodlot.

Coastal woodland management

To document indigenous knowledge on management of coastal woodlands, it was first of all necessary to carry out a reconnaissance survey to generate baseline information on the Dakacha and Boni Lungi woodlands. This was carried out in collaboration with Nature Kenya and the Kenya Forest Service. It was also a chance for partners to establish local contacts with stakeholders and to develop future roles. From this study, it was noted that social and ecological factors affecting the management of the forests were undocumented and there was not enough contact between organizations working in the area. Collaborators offered to help build community governance structures for sharing and storing traditional knowledge on sustainable management and conservation of the forests.

Gums and resins

With EU funding, work was undertaken to enhance the sustainable management and use of *Acacia senegal* tree resources. Gum arabic was collected and quality determined for tree populations in Isiolo and Turkana. Their genetic diversity was analyzed and the micro-symbiont status determined. A draft manual on taxonomy, ecology and distribution of A. senegal varieties in Kenya was prepared. Gum quality assessment equipment was procured. A post-graduate student conducted studies in the isolation, identification and characterization of gum resins from Commiphora holtziana (Hagar).

Variation within *A. senegal*

Within the species, three varieties are currently recognized: the typical A. senegal var. senegal, var. kerensis and var. leiorchachis. In the field, the habits of the three varieties are strikingly different and this is probably the most essential diagnostic characteristic by which the taxa are identified.

A. senegal var. *senegal*

var. *kerensis*

var. *leiorhachis*

var. *leiorhachis*

Growth habits of different varieties of *A. senegal*

Rehabilitation of degraded woodlands

Funding from the Japanese government supported the conservation and rehabilitation of degraded woodlands surrounding Kakuma refugee camp. A 3ha plot was established at Lokore and a further 3ha was fenced off for natural regeneration at Pelekech. In addition, the Prosopis-infested area around Kakuma was managed through prescribed utilization. A site that was previously rehabilitated was monitored for recovery.

Fencing of a 3ha plot at Kalobeiyei involved erecting Prosopis poles around the plot perimeter and using barbed wire to reinforce local materials against the strong winds in this locality.

Preparation of micro-catchments at Pelekech

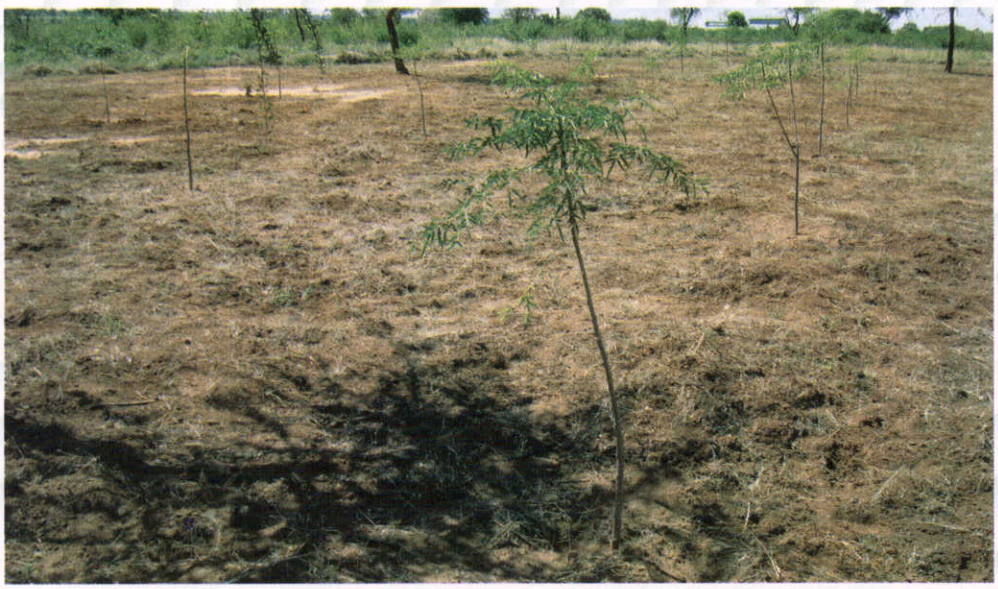
Two meetings were conducted in the project sites (Kalobeiyei and Pelekech) at which it was confirmed that structures existed at grass root level, which could allow local communities to play a bigger role in indigenous woodland management. Approaches of rehabilitation and restoration of woodlands through enclosures and active reforestation were exhaustively discussed. It was agreed to set aside ideal areas where such technologies could be demonstrated. Repair of micro-catchments was viewed as labour intensive but important for survival of seedlings. Roles were thus decided upon, with community members agreeing to be involved in fencing, preparation of micro-catchments and tree planting. Project staff was assigned logistics and technology demonstration roles. The communities agreed to collaborate with development agents and government institutions in reversing the trend of land degradation. To operationalize these agreements, two Environmental Management Committees (EMCs) were formed at both sites consisting of 37 and 39 members at Pelekech and Kalobeiyei respectively.

Acacia operation Project (AOP)

The institutions behind development and commercialization of gums and resins in Kenya include: Kenya Forestry Research Institute (KEFRI), Network of Natural Gums and Resins in Africa (NGARA), Ewaso Nyiro North Development Authority (ENNDA), CETRAD, the Gum Arabic and Resin Association (GARA), Semi Arid Lands Training and Livestock Improvement Centres of Kenya (SALTLICK) and public universities. This initiative aims at minimizing duplication of efforts, streamlining the collection and marketing of gums and resins, quality and standardization, enhancing the accuracy of the data and enhancing collaboration.

Experimental plots in the Acacia Operation Project were maintained and assessed during the bridging and consolidation phase even as a long term project proposal and plan were finalized. In addition, two local groups received training on management of gum trees and how to tap and collect gum.

Post-graduate studies were conducted on the effect of micronutrient uptake by Acacia senegal varieties and on gum arabic quality under arid and semi arid conditions. Work was undertaken on strengthening production and quality control of gums and resins in Africa, capacity development of subject matter specialists and communities in sound harvesting in addition to post-harvest handling of gum arabic and gum resins. A Food for Assets programme was initiated and the production and commercialization of frankincense in the drylands of Eastern Africa promoted, among other activities.



A recently established plantation of *Melia volkensii*

4.0 Forest Plantations Research Programme

Project FP/01: Improvement of Forest Plantations Establishment and Management

Causes of poor germination of seed distributed by Kenya Forestry Seed Centre were determined, 1500 grafted seedlings of selected *Vitex keniensis* (Meru Oak) raised and a similar number of grafted *Vitex payos* raised for establishment of seed sources.

The establishment of seed stands of major commercial forestry tree species was given priority in KEFRI Regional centres as follows:

- 2 ha each of *P. patula* and *C. lusitanica* seed orchards established in Londiani
- 2 ha of *E. camaldulensis* seed stand established at Kitui and Meru
- 1 ha of *E. regnans* stand established in Nyandarua
- 1 ha of improved *Vitex keniensis* seed stand established in Meru
- 4 ha of *E. grandis* seed stand progeny trial established at Muguga and Londiani
- 4 ha of *Cupressus lusitanica* seed progeny trial established at Muguga and Londiani
- 1 ha seed stand of *Gmelina arborea* was established at Gede after a plantation was selected and thinned.

Pinus patula and *C. lusitanica* were two commercial timber species selected for demonstrating plantation establishment by management of natural regeneration. The cost of so doing was documented. I ha plots each of both species were set up at Lorenge and Uplands in areas with old regeneration approaching ten years of age.

Project FP/02: Integrated Pest and Disease Management in Forestry Systems

The Institute continued to provide advisory services on management of forest insect pests and diseases. Databases are maintained for reference and in the course of this year, 3000 entries were made available in electronic format on a CD. A computer programme was developed for answering queries and linked to the database. A technical report was produced.

To monitor the status of forest pests and diseases, KEFRI worked closely with the Kenya Forest Service in implementing Technical Order No. 40. Farmers received advice on integrated pest management and all alerts received from stakeholders were promptly attended to. In particular, pests and diseases of Eucalyptus hybrid clones were closely monitored in 8 field trial sites. Likewise, quarterly assessments took place in 4 permanent sample plots that were set up for monitoring the dynamics of cypress aphid.

10 permanent sample plots in which the blue gum chalcid (BGC) is constantly monitored were managed and assessed on quarterly basis to determine the trend of the host tree damage against chalcid population fluctuations. The establishment of a wasp that was imported from Israel as a biological control agent was also closely monitored. The variability of BGC attack on *Eucalyptus* species and hybrid clones was determined as data for quantifying growth retardation and the economic loss associated with the chalcid was gathered.

Project FP/03: Improvement and Management of *Eucalyptus* Species and Clones

With the objective to improve *Eucalyptus* species, one hundred outstanding trees were selected and their genetic composition determined. Elsewhere, seedlings of *Eucalyptus grandis, E. camaldulensis, E. urophylla* and *E. regnans* were established in Muguga region for crossing.

A complete study on growth, yield, wood properties and the economics of growing Eucalyptus got under way for clones that were recently introduced in Kenya. In particular, their growth and performance were monitored and wood properties determined for 15 eucalyptus hybrid clones. Diseases and pests of the clones were documented and genotype interactions with the environment reported.

Several clonal trials have been set in different parts of the country. The clones were introduced from Mondi forests, South Africa in 1997. Subsequently several other clones, have been introduced and established in other trials in various parts of the country. These consist of mainly GC clones (*E. grandis x E. camaldulensis*). Pure species of *E. camaldulensis, E. tereticornis, E. grandis*, and *E. saligna* have also been included in the trials. In a few trials GU clones (*E. grandis x, E. urophylla*) have also been included. KEFRI has been involved in the establishment and assessment of these trials for performance and monitoring of pests and diseases. The latter is presented in this report for the year.

Eight Eucalyptus clonal trials were assessed for pests and diseases. These were Turbo, Yala, Kuja River, Kabage, Meru, Gede, Sokoke and Msambweni. The assessments of the trials are done annually in order to detect any new pests or diseases.

Table 1. Blue gum chalcid infestation in five clonal trials.

Germplasm	Sites				
	Gede	Sokoke	Msambweni	Yala	Turbo
E. camadulensis	+	+			
E. tereticornis	+				
E. grandis					+
E. urophylla	-				
GC3				+	+
GC10					+
GC12				+	+
GC14	+	+		+	+
GC15					-
GC167	-	+		-	+
GC514	+	+	+	+	+
GC522					-
GC540	+	+			
GC564				-	
GC581	-		+	-	-
GC584	+			-	+
GC642				-	+
GC784	+	+			
GC785	-	-			+
GC796	+	+		+	+
GU7	-	+		+	+
GU8	-	-		-	+
GU21	+	-			

Key: + blue gum chalcid present - blue gum chalcid missing

The most common insect pest was blue gum chalcid. It was mainly confined to areas where the pest spread mainly in Nyanza, Western, Rift valley and Coast provinces. From the assessments carried out in the Eucalyptus clonal trials Botryosphaeria canker disease is the most common on clones GC 581, GC 540, GC 514, EH and ES. These appear to be more susceptible to the disease in several sites. The disease has subsequently spread to sites where it was not present such as Kiutine (Meru), Turbo and Msambweni. In some sites more clones had been attacked since the last assessment. This showed that the disease was spreading, thus the need for further monitoring.

Gonipterus scutellantus was found on ET, GC 581, and *E. urophylla* in Gede, GC 522 in turbo, GC 581, GC 785 and *E. camadulensis* in Sokoke. *Apion* spp. was found on GU 7 in Gede, EU in Msambweni. Scale insects were found on GC 540 in Gede. White flies on GC 581, GU 8, GU 7, EU and GC 785 in Msambweni

The yield and economics of growing eucalyptus were further investigated by gathering data to determine costs and benefits of growing them. In total, 3 new trials were established and 10 others that already existed were assessed.

A well performing demonstration plot of *Eucalyptus* sp.

5.0 Service Programme

A number of projects were carried out in the course of the year, which included editing 28 KEFRI publications for production. A web-AGRIS database was updated and posted on the Institute's website (www.kefri.org), itself updated on monthly basis. A database on experimental trials and studies was likewise updated. To improve access to the internet, technical specifications were developed for Gede, Londiani and Kitui Research Centres while staff at headquarters received training on CISCO and the Linux operating system.

The coordination of information and dissemination was part of the Programme's activities. Two meetings were held with KEFRI Dissemination Officers and information personnel from the KEFRI headquarters joined them in conducting Open and Field Days. A short course was conducted to build capacity in publishing while scientists and technical support staff in two Regional Centres received further training on data anlysis, management and IT.

Several courses were conducted at the Social Forestry Training Centre in KEFRI Headquarters. They included the Forest Resources Officers' course, attended by 160 participants from the Kenya Forest Service (KFS) and a Timber Grading and Promotion Course, which attracted 10 participants. The annual Regional Training Course on Enhancing Adoption of Social Forestry in Africa brought together 22 participants from 18 countries in the target region.

The Service Programme also coordinated KEFRI/KFS Policy and Technical Liaison meetings as scheduled on half yearly or quarterly basis respectively.

Throughout the year, over 6 tonnes of seed from more than 50 tree species were collected and extracted. Seed storage facilities were improved at the Kenya Forestry Seed Centre in Muguga where worn out refrigeration equipment in 3 cold rooms was replaced and an automatic voltage stabilizer device installed. Seed processing units in Gede, Londiani and Nyeri were renovated. The Seed Centre actively participated in KEFRI publicity events, including exhibiting at several ASK Shows. Seed supply advertisements also featured in the print media. In Muguga, Kakamega, Nyeri and Turbo, 22 seed sources were maintained by undertaking thinning, cleaning and/or labeling.

Meeting all the set targets for revenue generation by the Service Programme helped the Institute to raise over Kshs. 30 million from sale of tree seed and seedlings, fees charged for training courses, sale of publications, wood products and furniture from Karura workshop and treatment of wood on request.

6.0 Partnership and Networks Programme

KEFRI maintains close contact with various key stakeholders and mutual activities are regulated through Memoranda of Understanding (MOU). Partnerships with Kenyatta University and Jomo Kenyatta University of Agriculture and Technology were formalized in the 2007/08 reporting period by signing of MOUs. The one existing with KFS was revised. Ways of enhancing collaboration with other Institutions with which KEFRI already had MOUs were explored, resulting in jointly monitored implementation activities with Moi University, KWS, KIRDI, ENDDA and KVDA.

Networks whose activities KEFRI coordinated included NGARA, AFREA. FORNESSA, AFORNET and Acacia Gum Project. Requests for partnerships were promptly attended to and a survey undertaken to identify key competitors in the field of Forestry Research in Kenya and East Africa.

Growing of bamboo starts with raising healthy seedlings.
KEFRI has developed technologies that make it easy for stakeholders to establish bamboo on commercial scale.

Appendix 1

Board of Management

BOARD OF MANAGEMENT

Appointed Members:

Mr. Patrick M. Mung'ala	-	Chairman
Prof. Florence Lenga	-	Member
Dr. James M. Onsando	-	Member
Dr. Winston Mathu	-	Member
Dr. Fridah Mugo	-	Member
Mr. D. S. Mohammed	-	Member
Dr. Paul K. A. Konuche	-	Director, KEFRI and Secretary to the Board

Ex-Officio Members

The Permanent Secretary – Ministry of Environment and Natural Resources
The Permanent Secretary – Ministry of Finance
The Secretary – National Council for Science and Technology
State Corporations Inspectorate

Appendix 2
Reports and Publications

Books and manuals

1. **Eastern Africa Bamboo Project, 2008.** Bamboo mat weaving techniques and applications. Cottage Industry Manuals. UNIDO, CFC, INBAR, Ethiopia Ministry of Agriculture and Rural Development and Kenya Forestry Research Institute (KEFRI).

2. **Eastern Africa Bamboo Project, 2008.** Raw materials and tools for bamboo applications. Cottage Industry Manuals. UNIDO, CFC, INBAR, Ethiopia Ministry of Agriculture and Rural Development and Kenya Forestry Research Institute (KEFRI).

3. **Eastern Africa Bamboo Project, 2008.** Three dimensional woven bamboo products. Cottage Industry Manuals. UNIDO, CFC, INBAR, Ethiopia Ministry of Agriculture and Rural Development and Kenya Forestry Research Institute (KEFRI).

4. **Eastern Africa Bamboo Project, 2008.** Techniques for making bamboo furniture. Cottage Industry Manuals. UNIDO, CFC, INBAR, Ethiopia Ministry of Agriculture and Rural Development and Kenya Forestry Research Institute (KEFRI)

5. **Eastern Africa Bamboo Project, 2008.** Techniques for plane woven bamboo products. Cottage Industry Manuals. UNIDO, CFC, INBAR, Ethiopia Ministry of Agriculture and Rural Development and Kenya Forestry Research Institute (KEFRI).

6. **Kenya Forestry Research Institute, 2008.** Status of Bamboo Resources Development in Kenya. KEFRI, Muguga, Kenya.

7. **Ndufa J. K., Cadisch G., Poulton C., Noordin Q and Vanlauwe B. 2007.** Integrated Soil Fertility Management and Poverty Traps in Western Kenya. In: Bationo A., Waswa B., Kihara J and Kimetu J. (eds.) Advances in Integrated Soil Fertility Management in sub-Saharan Africa: Challenges and Opportunities. pp 1061-1075.

Journal papers

8. **Kiptot E., 2008.** Adoption dynamics of *Tithonia diversifolia* for soil fertility management in pilot villages of Western Kenya. Expl Agric. (2008), volume 44, pp. 473–484. Cambridge University Press.

9. **Mugendi D. N., Mucheru-Muna M.W., Waswa B. and Mugwe J. N. 2007.** Agroforestry for Land and Water Management and Kenya. In: Waswa F., Otor S., Olukoye G. and Mugendi D.N. (eds.). Environment and Sustainable Development, A Guide for Higher Education in Kenya Volume II. School of Environmental Studies and Human Sciences, Kenyatta University. pp 122 – 138.

10. **Mugwe J., Mugendi D., Mucheru-Muna M., Merckx R., Chianu J. and Vanlauwe B. 2009.** Determinants of the decision to adopt integrated soil fertility management practices by smallholder farmers in the central highlands of Kenya. Expl Agric (2009), volume 45, pp. 61-75.

11. **Mugo J. M. and Kigomo B. 2007.** Effects of forest cover types on streamflow components and groundwater recharge in Kimakia forest catchments, Kenya. East African Agricultural and Forestry Journal. Volume 69 Nos. 3 and 4. Pages 255 – 265. Kenya Agricultural Research Institute.

12. **Mutitu K. E., B. Otieno, V. Oeba, P. Nyeko and R.K. Day. 2007.** Farmers' knowledge and perceptions on management of *L. invasa* on *Eucalyptus* species in Western Kenya. Discovery and Innovation Journal, Volume 19 (AFORNET Special Edition No. 4). Pages 277 – 407. African Academy of Sciences, Kenya. Pp 287 – 293.

13. **Nyeko P., Mutitu K. E. and Day R.K., (In print).** Eucalyptus infestation by Leptocybe invasa in Uganda. Accepted by African Journal of Ecology.

14. **Nyeko P., K. E. Mutitu, B. Otieno, V. Oeba, and R.K. Day. 2007.** Farmers' experiences on the blue gum chalcid, *Leptocybe invasa*, infestation on *Euclayptus* species in East Africa. Discovery and Innovation Journal, Volume 19 (AFORNET Special Edition No. 4). Pages 277 – 407. African Academy of Sciences, Kenya. pp382 – 388.

15. **Mugwe J., Mugendi D., Odee D. and Otieno J. 2007.** Evaluation of the Potential of Using Nitrogen Fixing Legumes in Smallholder Farms of Meru South District, Kenya. In A. Bationo (eds.) Advances in Integrated Soil Fertility Research in Sub-Saharan AFRICA: Challenges and Opportunities. pp 503 – 510.

16. **Munyi P. and Mutta D., 2007.** Protection of Community Rights over Traditional Knowledge: Implications of Customary Laws and Practices in Kenya. icipe Science Press, Nairobi. ISBN 92 9064 198 3. 31pp.

17. **Mukonyi K.W., Owuor B., Chikamai B., and Wabuyele E. 2007.** Status of Aloe exploitation, conservation and its contribution to communities' livelihoods in Kenyan drylands. Discovery and Innovation Journal, Volume 19 (RPSUD Special Edition No. 2). Pages 117 – 275. African Academy of Sciences, Kenya. pp231 – 241.

18. **Mukonyi K.W., Situma C.A., Lusweti A., Kyalo S. and K. Erik. 2007.** Commercial wild aloe resource base in Kenyan and Ugandan drylands as an alternative livelihoods source to rural communities. Discovery and Innovation Journal, Volume 19 (RPSUD Special Edition No. 2). Pages 117 – 275. African Academy of Sciences, Kenya. pp220 – 230.

19. **Mukonyi K.W., Wachira N. and Jack A.** 2007. Novel Natural UV-shielder of Baculovirus biopesticides used against *Plutella xylostella* (Diamondback moth, DBM), notorious Brassica crops pest. Discovery and Innovation Journal, Volume 19 (RPSUD Special Edition No. 2). Pages 117 – 275. African Academy of Sciences, Kenya. p220 – 230.

20. **Muok B.O., Matsumura A., Ishii T. and Odee D.W., 2007.** Genetic diversity within *Sclerocarya birrea* populations in Kenya. Journal of Arid Lands Environment 71(2007) 1-11.

21. **Muok B.O., Mwamburi A.M., Kyalo E.M. and O Auka S., 2007.** Propagation, establishment and management of *Melia volkensii*. Kitui Forestry Research Centre, KEFRI. 18pp.

22. **Muok B.O., A. Matsumura and T. Ishii. 2007.** The effect of intercropping *Sclerocarya birrea* (A. Rich.) Hochst., millet and corn in the presence of arbuscular mycorrhizal fungi. Discovery and Innovation Journal, Volume 19 (RPSUD Special Edition No. 2). Pages 117 – 275. African Academy of Sciences, Kenya. pp251 – 257.

23. **Muok B.O., A. Matsumura and T. Ishii. 2007.** Amelioration of the activities of reactive oxygen species in water stressed *Sclerocarya birrea* (A. Rich.) Hochst., seedling in the presence of arbuscular mycorrhizal fungi. Discovery and Innovation Journal, Volume 19 (RPSUD Special Edition No. 2). Pages 117 – 275. African Academy of Sciences, Kenya. pp258 – 262.

24. **Wamalwa L., Odera-Chagala E., Oeba V. and Oballa P. 2007.** Adaptability of four-year old Eucalyptus species and clones in Kenya. Discovery and Innovation Journal, Volume 19 (AFORNET Special Edition No. 4). Pages 277 – 407. African Academy of Sciences, Kenya. pp326 – 334

Technical notes and guides

25. **Mutitu K. E., Mwangi L., Otieno B., and Minjire M. 2008.** Pests and diseases associated with Eucalyptus in Kenya. KEFRI Research Note No. 7. KEFRI, Muguga, Kenya. 14pp.

26. **Githiomi J. K. and Muthike G. 2008.** Guidelines to Air-drying of Timber. Low Cost Timber Drying Method for Sawyers, Merchants and Other Users. KEFRI Guideline No 6. Karura Forest Products Research Centre. Kenya. 6pp.

27. **Njuguna J. C. and M Kigomo B.N. 2008.** Raising bamboo from stem cuttings: A guide for extension and bamboo growers. KEFRI Guideline No 7. Kenya Forestry Research Institute. Muguga, Kenya. 11pp.

28. **Mukonyi K. W., and Oduor N. M., 2008.** Guidelines for growing aloes: A guide for farmers and extension workers. KEFRI Guideline Series No 8. Kenya Forestry Research Institute. 28pp

29. **Oduor N. M. and Githiomi J., 2007.** Guidelines for wood preservation using sap displacement method: A low cost method for on-farm application. Guideline No. 3. Forest Products Research Centre, Karura. 8pp.

30. **Githiomi J. K. and Onchieku J. 2008.** A Checklist of Kenyan Timber and Biocomposite Standards for Structural Engineers, Architects and other Timber Users. Timber Information Bulletin No. 4. Karura Forest Products Research Centre, KEFRI, Kenya. 9pp.

Miscellaneous Reports

31. **Kariuki J., Machua J., Luvanda A.M., Kigomo J.N., Muindi F.K. and Macharia E. W. 2008.** Baseline Survey of Woodland Utilization and Degradation around Kakuma Refugee Camp.

Proceedings

Ongugo P. O., Kagombe J. K., Wandago B.O., Gachanja M and Mbuvi M.T., 2008 (eds.) Better Managed Forests and Improved Livelihood. Proceedings of the 1st National Participatory Forest Management Conference. June 6 – 8, 2007. KEFRI, Muguga, Kenya.

Leaflets and posters

1. **Kenya Forestry Seed Centre** – Profile

2. **Tree Seed Information Leaflets** – *Eucalyptus grandis* (re-prints)

3. **KEFRI, 2008.** Blue gum chalcid: a pest of Eucalyotus in Kenya. Information leaflet. Pest update. KEFRI, Muguga.

4. **KEFRI, 2008.** Eucalyptus trees in Kenya. Information leaflet. KEFRI, Muguga.

5. **KEFRI, 2008.** The threat of invasive Prosopis and how to minimize its effects in Kenya. Information leaflet. KEFRI, Muguga.

6. **KEFRI, 2008.** Aloe domestication and utilization. Information leaflet. KEFRI, Muguga.

7. **KEFRI, 2008.** Bamboo domestication and utilization. Information leaflet. KEFRI, Muguga.

8. **KEFRI, 2008.** Bio-fertilizer production. Information leaflet. KEFRI, Muguga.

9. **Mugwe J, Mugendi D. and Mucheru-Muna M, 2007.** Increase crop productivity using Tithonia green manure. Poster. KEFRI/KARI/Farm Africa/TSBF of CIAT.

10. **Mugwe J, Mugendi D. and Mucheru-Muna M, 2007.** Increase crop yields using Calliandra and Leucaena. Poster. KEFRI/KARI/Farm Africa/TSBF of CIAT.

Appendix 3a

Balance Sheet

KENYA FORESTRY RESEARCH INSTITUTE
BALANCE SHEET AS AT 30TH JUNE 2008

	Notes	2008 Kshs.	2007 Kshs.
ASSETS			
Non-Current Assets			
Property, Plant & Equipment	2	1,005,382,191	988,874,599
Intangible Assets	14	3,462,191	3,029,339
Current Assets			
Inventories	3	25,707,123	16,894,152
Receivables	4	8,038,694	6,130,949
Investments: Treasury Bills/FDRS	5	-	34,424,950
Cash at Bank	6	116,018,990	74,072,497
Total Assets		1,158,609,190	1,123,426,486
CAPITAL GRANTS AND LIABILITIES			
Capital and Reserves			
Government Grant for Capital Assets		1,069,871,419	1,053,869,167
External Grant for Research	7	31,306,664	28,303,118
Sinking Fund	26	6,090,393	32,398,516
Revaluation Surplus Reserves		131,442,930	131,442,930
Accumulated Deficit		(95,925,321)	(139,243,205)
		1,142,786,085	1,106,770,526
Current Liabilities			
Payables and Accruals	8	5,547,131	5,194,863
Medical Scheme Funds	31	10,275,975	11,461,097
		15,823,106	16,655,960
Total Capital Grant and Liabilities		1,158,609,190	1,123,426,486

Chairman .....
Patrick Mung'ala
Date: .....

Director .....
Paul K. A. Konuche (Dr.)
Date: .....

Appendix 3b

Income and Expenditure

KENYA FORESTRY RESEARCH INSTITUTE
INCOME AND EXPENDITURE FOR THE YEAR ENDED 30TH JUNE 2008

	Note	2008 Kshs.	2007 Kshs
Income			
Government Grants	9	639,849,679	547,592,532
External Grant for Research	7	45,662,109	38,580,002
Interest on TB,FDR and Savings A/c	10	581,457	653,507
Other Income	11	32,846,640	30,300,755
Insurance Compensation	27	-	1,476,500
Gain on Sale of Fixed Assets	12	3,909,887	2,241,978
		722,849,771	**620,845,273**
Expenditure			
Staff Cost	27	(481,578,070)	(451,383,206)
Operating Expenses	13	(176,863,957)	(163,579,962)
Financial Expenses	23	(854,515)	(792,976)
Establishment Cost	24	-	(1,000,000)
		(659,296,542)	(616,756,143)
Surplus before Depreciation & Deferred Income		63,553,229	4,089,129
Depreciation	2a	(49,660,313)	(45,125,223)
Amortization for Intangible Asset	14	(865,548)	(757,335)
Deferred Income	2b	22,442,022	24,055,404
Changes in Inventories [Forestry Plantations & Seedlings	21	7,848,494	(1,948,310)
Surplus/Deficit for the Year		**43,317,884**	**(19,083,126)**

Distribution of KEFRI's Research Centres

Regional Centres Contact Details

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P. O. Box 1078 Malindi - 80200
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