Annual Report

And

Record of Research

July 1992 to June 1993

Kenya Forestry Research Institute (KEFRI)
P. 0. Box 20412,
NAIROBI

FOREWORD

This is the 7th Annual Report and Record of Research since the Kenya Forestry Research Institute was inaugurated. The report highlights the activities of the Institute from July 1992 to June 1993. Implementation of research programmes, staff growth, training and dissemination of research findings have been a major concern and are closely being appraised through evaluation of staff performance and research activities. The Institute continued to receive assistance from various donors and I wish to extend my appreciation to all of them.

The major challenge for the Institute is to achieve goals and objectives in the identified research priority areas as set up in the Institute's Strategic Plan 2000.

I wish to record my confidence that with the continued research break-throughs and support from the Government, the Institute is set to make remarkable contribution to economic, social and environmental development in Kenya.

Professor Shelemiah Keya,
Chairman of the Board of Management,
Kenya Forestry Research Institute (KEFRI)

PREFACE

KEFRI's goal and objective is to initiate and co-ordinate all aspects of forestry development in Kenya. In fulfilling this function, the Institute's Research and Development (R & D) programmes focus on developing technologies to ensure sustainable forestry development and management in Kenya.

Plantation Silviculture, Dryland Silviculture and Tree Improvement continued research on species provenance and progeny trials in various ecological zones. Experiments in Turkana, Baringo and Bura outstations continued. A study on the ecology of Arabuko-Sokoke Forest has been finalized. Considerable progress was made in tree seed production and products such as gum resin, oil, gum arabic and non-timber species like bamboo and rattan canes. Research on wood properties of non-timber species like bamboo, and charcoal production from improved earth kilns continued.

Mycorrhizal and Frankia research and Rhizobia studies to enhance tree establishment in dry areas continued. Socio-economic studies as related to forest/tree development and management continued and documentation of the data has been finalized. Social Forestry courses progressed well both at Muguga and Kitui Centres through the JICA sponsorship.

Collaborative research work continued with Forest Department (FD), Kenya Agricultural Research Institute (KARI), International Center for Research in Agroforestry (ICRAF), International Centre for Insect Physiology and Ecology (ICIPE), University of Helsinki and National Museums of Kenya. The Institute received financial support from the International Development Research Center (IDRC), Finnish International Development Agency (FINNIDA), Norway Development Association (NORAD), (British Overseas Development (ODA), International Develoment Association (IDA) and the European Economic Community (EEC). Close liaison with the Forest Department continued.

The Institute's activities continued to be disseminated through KEFRI Newsletter, KEFRI Technical Notes, local and international journals, annual reports, monographs, proceedings of various conferences and refresher courses organized for KEFRI clients. The standing monthly colloquium has continued to provide special forum for interaction among KEFRI Scientists and for exchange of ideas and experience with visiting scientists.

Prompt implementation and co-ordination of the annual workplan is accredited to the contribution, dedication to duty and commitment of all KEFRI Staff and I urge them to strive on for the benefit of current and future Kenyans.

J. A. Odera,
Director - KEFRI

TABLE OF CONTENTS

BOARD OF MANAGEMENT

1.	Prof. S. Keya	Chairman
2.	Prof. F. K. Sang	Member
3.	Prof. F. M. Muthuri	
4.	Prof. B. A. Kimeto	
5.	Prof. F. Owino	
6.	Mr. G. O. Nyabena	
7.	Mr. H. M. Ngibuini	

1.0 RESEARCH ACTIVITIES BY PROGRAMMES

1.1 AGROFORESTRY RESEARCH PROGRAMME

1.1.1 Introduction

The Programme's mandate is to develop appropriate agroforestry technologies for selected land-use systems and to develop national capacity to plan, formulate and implement agroforestry research. The R & D initiatives of the agroforestry programme concentrated on the development of a conceptual framework of agroforestry as well as technology development and crop/tree management. Crop/tree management research focused on adaptative development and testing of promising prototype technologies with potential for improving the productivity of the target farming systems. As a result of this research initiative, a number of technologies and systems embodying these general principles have been developed and are being tested. A series of basic guidelines for preventing soil degradation and sustaining soil fertility have been developed and several promising technologies are available for further testing and agronomic evaluation on farms.

On-station and on-farm trials have been established at Machakos, Maseno, Muguga, Siaya, Embu, South Nyanza and Ramogi.

The Programme's research strategy is based on a multi-disciplinary and collaborative approach with other institutions such as ICRAF, KAKI, etc. As a support programme under Alley Farming Research Network for Africa (AFRENA), Alley Farming Network for Tropical Africa (AFNETA), International Atomic Energy Agency (I 1 AEA), the Multipurpose Tree Improvement Research Project has been initiated to undertake selection of tree species, improvement and cultivation of multipurpose woody species for use in agroforestry systems.

1.1.2 Research Activities

Screening Multi purpose trees (MTPs) with a focus on:

- Matching tree species to sites,
- Studying tree characteristics to determine the agroforestry technology that fits it,

Soil fertility maintenance and improvement trials focusing on:

- Screening trees for alley cropping,
- Alley cropping supplementation with other farm inputs e.g. fertilizers and organic manure, and rotational fallow systems.

Studies on fodder production

- Screening of fodder trees and integration into the alley farming systems,
- Fodder tree/grass combination effects, and
- Feeding trials,

MPTs management trials

- Alley cropping: cutting heights and frequency,
- Spatial arrangement and densities of MPTs for specific technologies,

On farm research

- Testing various agroforestry technologies with farmers. These include; alley cropping, tree-grass combination, feed gardens/fodder banks, multistorey boundary planting, and woodlot establishment and management.

Socio-economics of agroforesty

The following are agroforestry research sites:

Muguga (Kiambu)	National Forestry Research Centre
Katumani (Machakos)	Dryland Agroforestry Research Project
Maseno	Regional Research Centre
S iaya	Mostly on-farm research
South Nyanza	Kuja River Integrated Research Project
Ramogi	Satellite Sub-centre
Embu	Regional Research Centre

On-station experiments and demonstration plots at Muguga were maintained. These included:

Alley cropping investigation with *Calliandra calothyrsus* and *Leucaena leucocephala,*
Tree/grass combination on contour bands
Multistorey boundary planting,
Fodder banks trials,
Multipurpose woodlot development.

The On-station trial was established to determine the effects of various management options to optimize the ratio of mulch application and biomass removal for supplementary livestock feed.

Calliandra calothyrsus and *Leucaena leucocephala* were planted in hedge rows spaced at 4.Om by 0.5m. Maize was used as a test crop in a split plot design. *Calliandra* produced significantly higher biomass (15 t/ha) as compared to *Leucaena* (6.5 t/ha). For both species, treatments which received greater than 5% green manure application in the soil had significantly higher maize yield. Similar, significant linear relationships were obtained between the rate of mulch application and soil organic Carbon and Nitrogen. Results on livestock performance indicated that the two species could enhance milk production and thus act as a substitute for concentrated feed to dairy animals.

On-farm studies were conducted in order to test and evaluate alley farming potential in mitigating land use problems. The trial design consisted of a prototype compared with a control of farmers' normal practice. Working with individual farmers, though slow and expensive proved to be an effective and efficient way of obtaining farmer participation. Farmers' inputs into technology design has resulted in good researcher-farmer communication and a high level of farmer interest.

Dryland Agroforestry Research Project (DARP) - Machakos

This is an ICRAF/KEFRI collaborative project with the on-station trials at Maruba and on-farm research at Kakuyuni. The Project is in its third phase: the "Technical Transfer Phase" or on-farm research. Under on-farm research, research is being conducted on:

Rehabilitation of existing species in grazing land,
Tree species screening for fodder and fuel wood production in grazing land,
Grazing land treatment/management,
Establishment of fruit gardens/orchards,
Alley cropping,
Tree nursery technology dissemination. Self-help groups were involved in the production of seedlings in the project nursery.

The FAO/IAEA/SIDA funded project at Katumani

The research with the primary objective of identifying plant genotypes which are adaptable to low Phosphorus (P) conditions and with water use efficiency traits (drought tolerant species) gave interesting results. *Acacia tortilis, Prosopis juliflora, Casuarina equisetifolia and Gliricidia sepium* provenances and genotypes were tested for their water use efficiency and adaptability to low available Phosphorus. Generally, *C. equisetifolia* proved better than *Acacia* or Prosopis and the 21 provenances interims of resistance to drought. *Casuarina* from Australia was the best drought resistant species followed by *Acacia tortilis (* Costarica) and *Acacia tortilis (* sudan, N. Khatoum).

1.1.3 ***Collaboration***

CARE/KEFRI Collaborative Research Project in Siava

Experimentation of different agroforestry interventions started in 1985 following a collaborative agreement between CARE and KEFRI.

The main objective of the on-farm research plots were to generate site specific agroforestry technologies and information to address identified specific land use constraints.

The interventions under study comprise of alley cropping, perimeter/ boarder planting, farm woodlot, living fence trials, intercropping and mulching of fruit tree gardens with *Leucaena leucocephala* leaves and how this compares with inorganic fertilizer and farm yard manure application.

These experiments are still continuing. There is a strong indication that alley cropping can improve or sustain crop yield.

AFRENA Project (KEFRIIICRAFIKARI) Maseno: On-Station and On farm Research

Work is being done on the development of priority agroforestry technologies. These include alley cropping, and production of green manure mulch and fodder for livestock. These experiments can be classified as follows:

General MPTs species screening trials
Soil fertility maintenance and improvement trials
Livestock fodder production trials

A new experiment on tree/grass combination was established. Plans for the start of formal on-farm feeding trials were completed.

Kuja River Integrated Agroforestrv Research Project: South Nyanza

The project is partly funded by Danish International Development Agency (DANIDA) and is based in an area typified by food crop-livestock based land use system.

FA O/IAEA at Amayo - South Nyanza

Research activities involve investigation of fifteen provenances of *Gliricidia sepium* in terms of phosphorus uptake as well as moisture use efficiency along the plains of Kuja River in Western Kenya. The specific objectives of the experiment are to:

identify genotypes of plants with high water and phosphorus use efficiency traits for sub-humid as well as phosphorus deficient soils
to evaluate the relationship between moisture use and dry matter yield of various genotypes
to determine correlation between dry matter production and carbon 13 discrimation as well as Phosphorus uptake by the different genotypes.

Main activities

On farm research
The project works with about 20 farmers practicing hedgegrow intercropping and border planting established in May, September and October 1992.

Research on tree/banana intercropping in Kisii as well as promotion of school and women group nurseries continued.

On-Station Research

Headgrow intercropping with *Leucaena leucocephala, Sesbania sesban* and *Calliandra calothyrsus,*
Woodlot with *Acacia auriculiformis* at different spacing,
River bank planting with *Acacias, Casuarina* and *Grevillea,*
Insect population dynamics studies under alley cropping.

AFRENA - EMBU

This is a collaborative Project between KEFRI, ICRAF and KARL It's goal is to develop country specific agroforestry technologies for the coffee based land use system of central and eastern provinces. Work is being done both on-farm and on-station.

The main activities include:

Supplementary protein rich fodder production especially during dry season through intercropping grass with fodder producing MPT along contour strips.
Improvement of multistorey home gardens of fruit trees, vegetables, grain legumes and other food crops.
Intensive boundary planting and establishment of woodlots for production of fuelwood, poles and timber.
Introduce headgrow intercropping for soil improvement through green manure production and erosion control.

Ramogi Sub-Centre

The main research activities dwell on:

Research on the management of natural forests, woodlands with emphasis on soil and water management.
Development of appropriate agroforestry systems for immediate introduction to the farming community.
MPTs and provenance research

Funding of the collaborative activities

The Projects' funds have continued to be administered by CARE- Kenya in the case of KEFRI/CARE Project, ICRAF for the KEFRI/KARI/AFRENA Project. IITA (AFNETA) has funded KEFRI/AFNETA Project, while FAO/IAEA/SIDA have funded projects in South Nyanza and Machakos.

1.2. ARID AND SEMI-ARID LANDS (ASALS) PROGRAMME

1.2.1 Introduction

The division undertakes research in the management of natural woody vegetation and provides advisory services on forestry development activities in Arid and Semi-Arid Lands (ASALs). The programme has been concerned with management of dryland vegetation, selection of appropriate tree species and shrubs, and research on tree establishment methods for the ASALS.

The programme's research sites are located in representative ecological zones of Kitui, Embu, Kibwezi, Baringo, Bura-Tana and Turkana districts.

1.2.2 Research activities

Research activities include:

- Studies on regeneration and management of natural woody vegetation
- Selection of tree/shrub species and provenances for various zones in ASALS
- Studies to improve the quality of planting stock

Development of dryland tree products

Bura Research Station

Trial Maintenance

Irrigation trials were maintained. Frequent water shortages adversely affected the irrigation schedule.

Trials Establishment

The trials established during the period under review and other accomplished work include:

Australia *acacia* species and provenances trial to test three promising Australia species and provenances by irrigation.
Gene conservation in riverine areas to test methods for vegetative propagation *of Populus ilicifolia* which is facing extinction.
Weeding of a demonstration plot to test the effect of three weeding methods and three weeding intervals on early development of *Eucalyptus camaldulensis.*
Seed Bank trials.
Soil sampling in irrigated areas to determine the effect of different irrigation regimes on soil properties.

Turkana Research Station

Regeneration plots at Lorugum and Naphu set up to investigate adaptability potatential of riverine tree species and regeneration potential in areas free from livestock continued to be monitored.

Examining population of seedlings in contrasting environments was undertaken to generate information on plant population composition under Acacia species canopy in riparian areas. This was compared with grassland dominated areas at three sites. The experiment will be repeated since the few seedlings that germinated withered.

Research on fodder production with saline water aimed at establishing feasibility of using basalt affected areas for fodder production, introducing salt tolerant fodder species to meet the demand for fodder and their mass production from selected species,

An experiment on Doum palm aimed at determining the potential of regenerating doum palm from prescribed burning and to assess the rate at which doum palm clumps close up and how this relates to the number of emerging off-shoots.

Biomass studies of multi-stemmed species to estimate biomass productivity of different tree species planted within the district was undertaken.

Species trial at Kalatum and Katilu assessed site adaptability *of* potential browse species. Browse reserves were also established.

Gum arabica plots were established at Kaloyeuni to assess quality in terms of chemical composition of exudate from different trees, determine the most efficient extraction methods and variation in yield by different classes of selected trees. Interference by unknown persons have caused a major drawback.

Phenological studies of indigenous trees were done with the aim of improving seed collection activities.

Kibwezi Research Station

All the existing experiments were maintained. One thousand and five hundred *Grevillea robusta* seedlings were raised for seed orchards.

New experiments

A species trial at Dr. Mbinda's (Kasayani) farm on *Croton megalocarpus, Cassia siamea* and *Caesalpinia valutina* species was established. A trial on resistance to termites by *Eucalyptus paniculata* and *Cassia .siamea* was started.

Assessed experiments

The following trials were assessed.

Dalbergia melanoxylon espacement trial (1990)
Mixed species trial in Metava at Mr. Lazards farm (1989)
Eucalyptus species under three different pit sizes (1991).

Baringo Research Station

Several experiments were established during the period under review:

Studies were initiated on the relationship between weight and seedling size on growth of juvenile seedlings. The species used were *Balanites aegvptiaca. Terminalia mentalis* and *Dalonix regia.*

Assessment of fuelwood supply and demand around Marigat region to determine fuelwood preferences by both species and product (wood or charcoal) by the residents; source of wood used and alternative energy and the type of food cooked, stoves used and conservative measures employed on the use of fuelwood was undertaken.

Investigations on species decomposition rates examined the rate of decomposition of foliage from selected agroforestry trees and the best depth of application for effective assimilation of foliage into the soil. Species used were *Leucaena leucocephala, Cassia .siamea, Gliricidia sepium, Acacia amplicepts, Prosopis chilensis, Balanites aegyptiaca* and *Acacia holosericea.*

Seedling regeneration studies examined species in the arboretum so as to identify species that exhibit profuse regeneration. It was envisaged that species which regenerate profusely would be fenced off to foster regeneration, bearing

in mind the economics of the exercise. The following tree species were found to be abundant. A. *tortilis, L. leucocephala,* A. *indica, C. siamea, Prosopis* spp. and C. *spectabilis.*
Seedling distribution patterns in Baringo were investigated.
A survey was carried out on seedling distribution patterns in the district during the planting season to determine the extent of tree planting for all types of uses.
Gliricidia cutting experiment was to determine the most appropriate size of the shoots which yields the highest number of shoots by G. *sepium*.

Experiments maintained

ACIAR Project (1987): on Australian dryland hardwood species for agroforestry. The aim of this trial is to investigate and develop the potential of Australian dryland trees for growing in Kenya.
Eldume Rehabilitation Plot (1991): The objective of this trial is to rehabilitate seriously denuded sites by planting trees.
KEFRI/KARI Agroforestry plot (1990): The aim of the experiment is to number of Australian acacias and indigenous trees under agroforestry system.

EMI Research Project

ACIAR trials consisting of 40 species at Marimanti, Nkando and Lonchoatjiroa were maintained and assessed.

Advisory and Consultacy Services

Advisory and consultancy services were offered during the year especially on tree planting activities. The main beneficiaries were Forest Department, World Vision and Lutheran World Federation, United Nations High Commission for Refugees (UNHCR) Management, Kakuma Camp.

2.2.3 Collaboration

Baringo Station worked closely with the Forest Department in Marigat and KARL. Bura collaborated for information on irrigation and Agroforestry with the University of Helsinki and Forestry Department.

1.3. PLANTATION SILVICULTURE PROGRAMME

1.3.1 Introduction

The overall objective of the Plantation Silviculture Programme is to increase and sustain production of wood from gazetted forests through development of silvicultural technologies for sound management practices. This objective is achieved through introduction, testing and evaluation of species and provenances, development of appropriate plantation establishment methods and tending techniques.

1.3.2 Research activities

Research activities by the programme are mainly implemented in three field stations: Turbo, Londiani and Gede. Research activities for the programme are co-ordinated from Muguga and are as follows:

Gede Forestrv Research Station

Two experiments were initiated during the year under review:

A Bamboo Management and Demonstration experiment and an International Provenance Trial of *Casuarina equisetifolia.* The Bamboo experiment was established by the Ecology Division and the details for the same are covered by the Ecology Programme.

Casuarina equisetifolia International Provenance Trial (RE:425/93) established in early 1993 is a part of a 16 country series of trials of the species with 25 provenances derived from 16 countries in Asia, South East Asia, Africa, Australia and Pacific Islands.

The overall objective of the trial was to introduce and evaluate the 25 provenances of C. *equisetifolia* with the ultimate aim of improving protection of the species and production of wood for domestic and industrial use in the region.

RE: 356/72 - Constant stocking fertiliser trial

The experiment was established in 1972 as a constant stocking trial of *Brachyleana hulliensis.* The experiment involved fertilizer treatments. Singling out of stems (the species tends to be multi - stemmed), was superimposed on the already existing trial with the aim of shortening rotation period and accelerating growth.

Objectives of the trial were to evaluate growth of the species at various stocking levels and also to determine the effects of fertilizer application and various intensities of singling out stems. Interaction between the three treatments were also tested. The trial was laid down in a split-split plot design with stocking levels as the major treatment.

The results revealed no significant differences between treatments in terms of height growth whereas highly significant differences were detected in diameter at both breast height and

ground level for the stocking and singling out treatments. The fertilizer effect was significant only when considered as an interaction with other treatments.

Experimental prescriptions including cleaning, slashing, spot weeding were effected as per their respective experimental schedules.

Turbo Research Station

A total of thirteen (13) experiments were assessed at the Turbo Station as per their assessment schedules. Basic parameters assessed were height and diameter growth and survival percentage.

Experiments at Turbo are designated as Registered Experiments (Res) or Experiments (Eps). EPs are established and co-ordinated by the Tree Breeding Division and REs by Silviculture Division.

RE: 324/69 - International Provenance Trial of *Pinus oocarpa.* The trial was established at Nzoia, Turbo in 1972 with the objective of evaluating provenances of the species for suitability for pulpwood production.

The trial comprises fifteen provenances from Honduras, Guatemala, Belize and Nicaragua. The Honduras variety of P. *carribea* was also included for comparison.

RE: 321/72 - International Provenance Trial of *Pinus kesiva.* The trial was established in 1972. It comprised twenty provenances derived from the Phillipines, including two Zambian provenances.

The objective of this trial is to rank and group the provenances in order of adaptability and productivity of wood for pulp wood production. The trial also contributes data to an international network of trials of the species. It is also used as a source of material for selective breeding programme of the species.

1. 4. FOREST ECOLOGY AND HYDROLOGY PROGRAMME

1. 4.1 Introduction

The programme focuses on developing technologies for sustained yield management of natural forest resources.

1.4.2 Research Activities

Sustainable Management of lndigenous Forests

In order to obtain information on basic ecology and productive management of indigenous forests, some studies have continued to be done. One of the studies is on the ecological surveillance of sample plots. This is to increase the understanding of the ecology and silviculture of indigenous forest types. The programme maintains 29 permanent sample plots (PSPs) of different indigenous tree species.

Development Plan for Lamu Mangrove Forests

This study, which was done under an MSc. study programme, was completed during the year. The original aim was to evaluate available data relevant to mangrove inventory for Lamu, and to make recommendations for further inventory and preparation of a development plan.

Analysis of the 1981 inventory data showed that the available information can be used in some aspects of a development plan but that it lacked comprehensiveness and reliability in some areas. It was shown that some information gaps can be filled effectively by socio-economic surveys.

It was further recommended that an integrated approach would offer the most effective means of collecting multi-purpose information required for development planning. This approach is achieved by the use of cost effective inventory designs and methods, and efficient processing of data with application of Geographic Information System.

Study on the Arabuko-Sokoke Nature Reserve

No field work was carried out at Arabuko-Sokoke during the year. Comprehensive analysis of the collected data continued and this is still going on. A detailed paper will be written when analysis of data is completed. Funding was made through the Coast Survey Project by the World Wide Fund for Nature(WWF).

Rapid Landscape Assessment for Wildlife Conservation

The study evaluated the distribution of natural communities and compared these with the pre-habitat descriptive distribution. It also looked at the weaknesses of estate conservation and few options for improving the conservation estate within the identified weaknesses. Suitability of methods used for evaluating the biotic representation in the conservation areas were also

evaluated. This was analyzed and interpreted in the light of the current government of New Zealand's conservation policy.

Propagation and Establishment of Bamboo and Rattan Species

Development of techniques for mass production of planting stock of *Arundinaria alpina* and determination of its woody properties.

In collaboration with the KEFRI Seed Centre, six sites of indigenous stands of bamboo (A. *alpina),* selected the previous year for phenology studies, seed collection, testing, development of pre-treatment methods, viability and storage methods continued to be monitored. The sites are located in Mount Kenya, Aberdares, Kamae, Mau Forest Block, Timboroa and Elgon areas.
Research on macroproliferation techniques of *A. alpina* are going on at Muguga and Kamae. This has not been very successful due to shortage of wildings.
Results of short-term nursery experiments at Muguga on propagation by cuttings of *A. alpina, Bambusa vulgaris* and *Oytenanthera abyssinica* have been analyzed and a technical note is underway.
Silvilcultural and ecological management of indigenous bamboo stands continued to be carried out. The activities included:

- investigating the stature of bamboo community from four sites, namely Chogoria, Kamwe (Mt. Kenya), and S. Kinangop (Aberdares),
- investigating the growth and regeneration response of *A. alpina* to disturbance, (e.g. fire and indiscriminate clear cutting),
- monitoring the response to silvicultural manipulation, eg selective cutting at specific intensities.
- Structural properties, fibre morphology and pulping characteristics of *A. alpina* were examined in collaboration with the Forest Products Division of KEFRI. The results of physical analysis are being compiled while analysis for pulping characteristics are underway jointly with the Pulp and Paper Mills (PPM) Company.

Mass propagation of Selected Exotic Bamboo Species and Demonstration Plantation

Raising of seedlings and macroproliferation of exotic species of bamboo continued at Muguga. The species are *Basa arundinacea, Basa blundisii, Oxytenathera abyssinica and Hyrtachys siamensis.* Older seedlings continued to be multiplied by splitting (microproliferation).

Two demonstration plantation plots were established at Gede and Kakamega. The species planted in both areas were *Basa blumeana, Basa arundinacea, Dendrocalamus strictus* and *Dendrocalamus membranacea.* Macroproliferation for *Basa tulda is* on-going at Gede and the species will be planted at both sites next year.

Establishment of Germplasm Banks

New plots were planted in June 1993 with *Gatochloa aspera, Bambusa vulgaris var. striala, D. strictus* and O. *abyssinica* at Muguga. At Gede, a third plot of rattan *Calamus trachycoleus* was established. Beating up was maintained in some of the trial plots. The data collected has been analyzed and a technical report is being written.

1.4.3 Collaboration

Close collaboration with other organizations and particularly with the Kenya Forestry Department was maintained. The programme worked closely with WWF, ICBP, National Museums of Kenya (NMK) on the study of the Arabuko-Sokoke Natural Reserves; IDRC, Moi University, Winrock International and IUCN and the Asian Bamboo and Rattan Research Network on the Bamboo research initiatives. The programme also worked with the KIFCON and KFMP Projects on the conversation of the indigenous forests in Kenya. Cordial relationship was maintained throughout the year with all these organizations and other KEFRI Programmes.

IDRC of Canada continued to support Phase II of the Bamboo Project in Kenya. The Programme collaborated with KIFCON in the biodiversity survey in the Shimba Hills and Kakamega forests.

1. 4.4 Training and Technology Transfer

Several farmers were anxious to participate in the bamboo on-farm demonstration activity. One farmer was invited at the Burnt Forest (Olare Settlement Scheme) and collaborative work with the farmer will start next year. Several farmers around Malindi (Coast Province) bought bamboo seedlings for planting in their farms.

Advisory services on planting of bamboo continued to be given to farmers and to interested institutions.

Collaborative initiatives with Winrock International in the development of regional bamboo research network continued. During the period, several proposals and activities were jointly drafted. These included:

- a proposal on biological support for the natural growth of bamboo in the mountain ecosystems. This was submitted to BOSTID, USA,
- a proposal on indigenous biodiversity in the Eastern Africa and Shalean Region was submitted to IDRC, and
- a proposal on regional training on the standardization of methodologies and small enterprise activities for the Eastern African region.

1.5. TREE BREEDING PROGRAMME

1.5.1 Introduction

The objective of this programme is to upgrade forest product yields and enhance quality through proper selection of germplasm.

1.5.2 Research Activities

The initial stages of breeding *Cupressus lusitanica* for resistance to *Cinara cupressi* were undertaken. This involved survey and selection of cypress trees showing some phenotypic resistance to cypress aphid in some of the cypress growing areas in the country.

The assessment and maintenance of experimental trials set under the *Pinus radiata* breeding work was undertaken. A seed orchard using the selected resistant material of this species was established.

Assessment and maintenance of the old experimental plots of species, provenances and progeny trials were done according to schedules and prescriptions. Table 1 shows the experimental plots assessed during the period under review.

Table 1: Species, Provenance and Progeny Trials Assessed

Species	E.P. No.	Title	Location	Year of Planting
Cupressus lusitanica	*102*	Provenance Trial	Muguga	*1971*
Pinus patula	*106*	Polycross Progeny Trial	Muguga	*1974*
Pinus randiala	*145*	Progeny Trial	Uplands & Timboroa	*1985*
Pinus Spp	*146*	Provenance Trial	Turbo	*1985*
Liquidamhar stvraciflua	*150A*	Provenance Trial	Kakamega	*1985*
Eucalyptus saligna	*161*	Progeny Trial	Muguga	*1988*
Pinus carihaea var hondurensis	*162*	Provenance Trial	Gede	*1988*
Pinus vunnanensis	*167*	Provenance Trial	Turbo	*1991*
Pinus kesiya	*168*	Provenace Trial	Turbo	*1991*
Pinus carihaea var hahamensis	*169*	Provenance Trial	Turbo	*1991*
Eucalyptus camadulensis	*171*	Progeny Trial	Turbo	*1988*

E.P. 146 Pinus patula Subsp. Tecunumanii, Pinus patula and Pinus oocarpa Familv within Provenance Trial

This trial was planted in 1985 at Nzoia Forest Reserve, Turbo. The objective of the experiment is to compare growth and form between provenances and also species. *Pinus patula* subsp. *tecunumanii* seedlots were obtained from Honduras and Nicaragua. Those of *Pinus* ***oocarpa*** were received from Nicaragua, Honduras and Guatemala while those of *Pinus patula* were obtained from Zimbabwe.

Assessment after 7 years indicate that *Pinus patula is* performing better than the other species for height growth with comparable diameter (DBH) to *Pinus patula* subsp. *tecunumanii. Pinus oocarpa* has the least vigor in both characters (height and DBH).

E. P. 150(A) Liquidambar stryraciflua International Provenance Trial.
This trial was planted in two locations: Turbo and Kakamega in 1986. The objectives of this trial are to determine the variation between provenances and to evaluate the adaptability of this species to local conditions. The seeds for this trial were obtained from Southern USA, Mexico, Honduras and Nicaragua.

In the Kakamega replicate, most trees were found to be drying up during the period 1990 to 1992 but they later coppiced. The assessment of heights taken in March 1993 also included the height of the coppiced plants.

The survival rate was observed to be very encouraging except for provenance Fica, Las Victoria (USA). It is unlikely that this species will do well under local conditions.

E.P. 161 Eucalyptus saligna Progeny Trial

This is a half-sib progeny trial of *Eucalyptus saligna* plus trees. It was planted at Muguga in 1988, with an aim of estimating the variation and genetic gain in half-sib progenies of three selected plus trees. The characteristics being examined are height, diameter, stem straightness, number of branches and branch angles.

Assessment at 5 years indicate that there is some difference in height and diameter between the three clones.

E. P. 162: Pinus caribaea var Hondurensis Provenance Trial

This was planted in 1988 at Gede in Arabuko Sokoke Forest Reserve. The objective of this was to compare growth between the provenances. The seeds were obtained from Australia, Honduras, Nicaragua and one seedlot from a local collection of *Pinus caribaea* var *hondurensis* at Kwale. The average heights at 4 years indicate some difference in height between the provenances, but the Hondurus provenance registered the least vigor.

E.P. 167, 168 and 169 Pinus yunnanensis, P. kesiya, P. caribaea var bahamensis

These are provenances trials planted in 1991 at Turbo.

E.P. 102 Cupressus lusitanica Provenance Trial

This trial was planted in 1971 at Muguga. Its objective is to compare the performance of six Mexican provenances and one local provenance in terms of growth rate, stem form and susceptibility to *Monochaetaia* canker. The randomized block design was used. Results after twenty one years are summarized in Table 2.

Table 2: Cupressus lusitanica Mean Height, DBH, Stem Form and Canker Score after 21 Years

Provenances	Mean Height (m)	Mean Diameter (DBH)	Mean Stem Form	Mean Canker Score
1336	18.49	27.11	2.73	1.99
1336	18.89	27.77	2.79	1.91
1371	18.82	27.66	2.80	2.08
1696	18.83	29.51	2.55	2.17
1702	19.80	30.07	2.22	1.96

Results show no significant difference in each character under consideration, but the provenance 1696 (De la venta) and the local provenance 1702 appear to have a slightly higher growth vigor.

E. P. 106 Pinus patula Progenv Trial

This is a polycross progeny trial, established at Muguga in 1974. The main aim is to rank the selected plus trees of P. *patula* for the subsequent improvement of the seed orchard. Estimates of specific and general combining ability will be made. The growth vigor (height and diameter) and stem straightness are the parameters being taken into consideration.

E. P. 145 Pinus radiata Progeny Trial

This trial was planted in 1985 and replicated at Timboroa and Uplands. The objective of the experiment is to introduce new germplasm which may contain resistant genes for *Dothistroma* blight. The experiment will also form a basis for comparing growth rate and resistance to *Dothistroma* between different clones and also with commercial seeds. It will also provide information for comparing growth rate and final volume of the different clones.

The experiment consists of sixty wind pollinated seedlots received from New Zealand and one seedlot from Kenya. Assessment at 7.4 years showed the average height and diameter (DBH) to be 8.95m and 9.45cm for a replicate in Timboroa, and 6.9m and 6.6cm for the Uplands replicate respectively. The average disease score were 2.90 and 3.17 for Timboroa and Uplands respectively.

The objective of these trials are to study variations between provenances within each species in addition to testing their growth suitability under Kenyan condition.

The assessment after one year, showed discouraging results, that is, the survival rate was very low in all the three trials with poor height growth. This could be attributed to lack of clean weeding and drought which followed soon after the planting of the trials. The trials will however be maintained for further observations.

Breeding of Pinus radiata for resistance to Dothistroma pinii

This is a collaborative research project between (KEFRI) and PPM. The project aims at developing *Pinus radiata* varieties resistant to *Dothistroma pinii* (needle blight disease) for re - introduction into Kenya plantations. This project started in January 1990 and is to take five years. During the period under review, the following activities were undertaken.

Vegetative propagation
Maintenance and assessment of experimental plots
Establishment of clonal seed orchard

Vegetative Propagation

Cuttings
The technique of rooting cuttings from shoots of young trees (less than 5 years) has been well developed and is now being used for mass propagation of desired resistant material. A total of 20,000 cuttings were rooted and used to establish 20 hectares pilot plantation in Penon Forest Reserve.

The average rooting percentage has been around 70%. More research work will be undertaken to develop techniques for rooting cuttings from older trees.

Grafting
The scions for this exercise are collected from resistant selections or plus trees selections. The aim of this work is to raise enough grafting material to set up clonal seed orchards. Success in grafting has varied from clone to clone, but the general rate has been around 30%. This year this rate increased to around 50%. More than 600 grafting material have been raised and most of them have been used to establish a clonal seed orchard at Penon.

Experimental plots
There are three experiments under this project. These are PR/1/90 at Kaptagat, PR/2/90 at Nabkoi and PR/3/91 at Timboroa. These are progeny trials of 35 resistant clones from New Zealand and 7 resistant clones from Kenya. Normal Management practices of clearing bushes and spot weeding was done during the year as prescribed. Measurements of height, diameter and disease score was done as per prescriptions. Early results show a significant variation between the clones in terms of height growth and resistance to disease. The best clone in Kaptagat recorded an average height of 7.18m at 3 years of age while the most resistant clone showed an average score of 1.5m on a scale of 1 - 5 (1 being healthy and 5 dead). There also

seems to be a difference in performance in various sites, with Kaptagat replicate showing the best compared to Timboroa and Nabkoi replicates.

Seed Orchard

This year, the first clonal seed orchard was established in Penon Forest Reserve. It is composed of 576 grafted ramets from 24 clones. It was established at a spacing of 5.9m x 5.9m and occupies an area of approximately 2.5 hectares. More grafting work is underway to set up a second seed orchard.

Breeding Cupressus lusitanica for resistance to Cypress aphid

The main activities under this work include:

Survey for identification of resistant/tolerant *Cupressus lusitanica* varieties,
Determination of genetic variability in C. *lusitanica* and identification of gene markers for resistance to *Cinara cupressi* using isozymes,
Progeny testing of resistant trees,
Mass propagation and establishment of clonal bank and seed orchards

Survev and selection

The on-going activity has been survey, selection and hybridization of suitable clones showing resistance to *Cinara cupressi.*

To date a total of six districts around Mt. Kenya and Aberdare region have been covered. A total of 38 trees were selected in 14 forest stations. Of these trees, 24 were resistant trees and 14 were plus trees.

From each tree, height, diameter (dbh), aphid damage scores were assessed and seed, pollen, scions and wood cores were collected from desirable trees. The pollen collected has been assessed in a six tester factorial mating design and seed obtained will be used to set up a progeny trial next season.

The effect of cypress aphid in seed orchards in Kenya and Tanzania was studied. A total of 30 clones replicated in five orchards were assessed for height, diameter (dbh) and aphid damage score. Of the five orchards, three are based in Muguga, one in Londiani and one in Lushoto, Tanzania. Most clones were of Uganda and Tanzania origin and those of Kenya were the poorest. Clones U3, T71, T72 and T73 showed the best resistance and growth vigor. On the contrary, clones K195, K165, K213 all selected within Kenya, were most susceptible and showed poor growth. These have been recommended for rouging in all the orchards.

Pollen collected from resistant trees in various sites has been crossed with the best clones in the orchards (U3, T71, T72 and K152) to yield suitable seed for breeding.

Vegetative Propagation

Vegetative propagation through grafts and tissue culture is in progress using scions and explants from the selected resistant germplasms. The propagated stock will be used to establish advanced seed orchards in the coming season.

Aphid damage on Cupressaceae

The variation of degree of attack by of cypress aphid among the species in the family of Cupressaceae was studied in the arboretum. The results (to be published in Commonwealth Forestry Review) show that *Thuya* and *Cupressocyparias cupressus* species, the old world group of species were tolerant. These are being hybridised with the less tolerant but faster growing new world group of species.

Arboretum

Muguga Arboretum contains about 240 species and provenances of various trees. These are dominated by Eucalypt (93), Pines (67), Cypress (23) and other genera with lesser number of species/provenances. It serves among other uses as species and provenance testing ground.

During the period under review, due to scarcity of rains, it was not possible to plant additional plots as in the previous years. However, all other management practices were carried out as usual. These included general maintenance and cleaning of the plots as well as pruning, thinning, height and diameter measurement in the plots where such actions were due.

Some damage caused by either wild or domestic animals were recorded and necessary action taken.

Nursery

More than 125,000 seedlings were raised. Majority of these consisted of *Eucalyptus grandis* and *Dovyalis caffra* plus a few ornamental tree species. These were being raised for research purposes and for sale. However, due to shortage of rain, the whole stock was not used or sold.

A few grafted fruits (avocadoes and oranges) were raised and sold. We however could not meet the demand for these products due to problems of obtaining quality scions.

During the same period, about 1,500 seedlings of *Caliandra calothyrsus, Gliricidia sepium* and *Chamaecytisus prasferus* were raised for the ICRAF MPTs seed multiplication stand to be established at Muguga. Some seedlings of conifers *(Cupressus lusitanica, Juniperus procera* and *Pinus patula)* were raised for IIBC's conifer aphid research project. By the end of June 1993, more than 1,000 seedlings were sold bringing a net revenue of more than Kshs.10,000.

KEFRI Forest Estate

A total of 23.3 ha of *Eucalyptus grandis* was clearfelled for fuelwood, poles and posts. The value of this was estimated to be Kshs 56,361.50. Further, logs valued at Kshs.26,123.35 were cut mainly for thinning of the dead cypress trees due to cypress aphid. Some of these logs were delivered to Forest Products Research Programme at Karura, while the rest were either sold directly to saw millers or given out to primary schools within KARI Sub-location for construction purposes.

No new planting was done due to shortage of rain.

1.5.3 Collaboration

Research collaboration with the PPM on breeding Pinus *radiata* for Dothistroma needle blight resistance entered its fourth year. Also collaboration with Oxford Forestry Institute (OFI) in the field of establishment, maintenance and evaluation of the international provenance trials continued on a sound note. Collaboration was also initiated with ICRAF and IIBC on raising seedlings (including grafting) of multipurpose trees, cypress and pines.

1.6 TREE SEED SCIENCE & TECHNOLOGY PROGRAMME

1.6.1 Introduction

The Seed Technology Programme has made considerable progress during the period under review. In endeavoring to achieve its goals, the following objectives were set:

to facilitate and conduct studies on the flowering, seeding and fruiting of the tree species and incorporate them in the seed collection programme:
to improve the quality of seeds collected by adhering strictly to rules governing seed collection,
to conduct research work on extraction, storage and germination of all species handled by the sub-programme,
to maintain a computerized seed documentation system,
to provide training in seed collection, handling and distribution.

Organizational structure

The programme co-ordinates a number of Seed Collection Centres as follows:

Muguga:	Serves as the headquarters and conducts seed activities, i.e. seed survey, collection and extraction of seeds from outside stations before storage. Muguga covers Kiambu, Nairobi, Machakos, Nyandarua, parts of Nakuru, Murang'a and Kajiado districts.
Londiani:	Covers seed collection and distribution activities in Nakuru, Narok, Uasin Gishu, Kericho and Bomet districts.
Gede:	Serves Kilifi, Kwale, Lamu, Mandera, Wajir, Mombasa, Tana River and Garissa districts.
Kibwezi:	Serves Taita Taveta, Kajiado, Kitui and Makueni districts.
Kakamega:	Serves Kisii, Busia, S. Nyanza, Siaya, Nandi and Nyamira districts.
Nyeri:	Serves Embu, Kirinyaga, Laikipia, Nyeri, parts of Meru, Isiolo and Tharaka Nithi districts.
Kitui:	Serves mainly Kitui district.
Wamba:	This is a new station opened last year. It covers Samburu, Marsabit, Moyale, parts of Isiolo and Meru district.

1.6.2. On-going Research Activities

Long-term storage of Cupressus lusitanica

Since the Cyprus aphid poses uncertainty to the future of the *C. lusitanica* plantations, long term storage of seeds has been adopted to ensure sustainable supply. This is being done through setting of experiments. The experiments are expected to run for a period of ten years.

Development of seed handling protocol for *Azadirachta indica*

The demand for *Azadirachta indica* seeds is increasing.. The limited supply of *A. indica* is threatened by its short shelf-life. Much of the seed goes to waste due to physiological deterioration during storage. Preliminary experimental results are expected within a year.

New initiatives

Provenance trials of Grevillea robusta

Like most exotic trees, the locally grown *G. robusta* (Australian silky-oak) has no definite genetic quality. Screening of 32 Australian provenances is going on in order to widen the genetic base of the species. The experiments have been set-up in Kitale and Njukiini.

Traditional seed storage methods

The traditional knowledge and technology and use of locally available materials in seed storage have a role to play in the handling of tree seed. The programme has embarked on assessment of suitability of locally available storage material for seed storage. The materials being examined include: gourds, polythene papers, bottles, e.t.c. The local situation has been simulated through setting up traditional huts and granaries. The experiment is expected to last two years.

The programme also:

- conducted routine seed testing for all seeds collected by the Centre,
- identified new sources of indigenous and exotic species seed to provide high quality seeds,
- carried out systematic tree species survey throughout the country in an attempt to compile a tree seed zone booklet for Kenya.

In the year 1992/93, a total of 7, 692.8 kg of clean seed was collected and stored in cold rooms. The total seed issued was 8,652.4 kg.

1.6.3 Collaboration

The KFSC continued to collaborate with various government ministries and Non - Governmental Institutions on seed research and other tree seed matters. The Centre also collaborated with international institutes and organizations in the areas of research, seed procurement, training and information exchange.

1.7 FOREST SOIL SCIENCE PROGRAMME

1.7.1 Introduction

The programme continued with its supportive services to other programmes in KEFRI through sampling and analysis of soils. Similar services were extended to other Institutions and farming communities involved in tree planting activities. The research activities covered the following areas:

Soils in agroforestry systems,
Crop response to Minjingu rock phosphate,
Soil and site characterization,

1.7.2 Research activities

Collaboration

Collaborative work continued with other divisions of KEFRI. They included:

- Agroforestry Division through AFRENA, AFNETA and CARE (K),
- Socio-economics Division through the SIDA funded project on-farm seedlings production and development of a potting mixture in 11 districts of Kenya.

Divisional research

Evaluation of availability and uptake of Phosphorus from Rock Phosphate with mycorrhizae inoculation by agroforestry tree species on two soils in Kenya. Soils collected from Gituamba (Murang'a District) and Kakamega had low pH values and a high Phosphorus absorption capacity. These soils were classified as andosols and acrisols respectively (FAO-UNESCO Classification). The tree spp. used were *Cassia siamea, Grevillea robusta* and *Eucalyptus grandis.* The preliminary report on the experiment is due for publication.
Soil characterization and mapping of Kitui-Tiva Pilot Forest Reserve.

Advisory services

The programme continued with its supportive services to other KEFRI programmes through collection and analysis of soils. Similar services were extended to other institutions and farming communities involved in tree planting activities.

Soils of the Pilot Forest Reserve - Kitui

Several soil profiles were dug in the already classified soil types: Acrisol, Luvisol; Plinthic acrisol, and Vertisols. Samples were taken to KEFRI's laboratories for physical and chemical analysis.

Luvisols (colour code 5 Yr - 2.5 Yr) are widely distributed in the pilot scheme and occupy most of the plains. The Acrisols (colour code 5YR) were not widely distributed and are mainly found on hill tops and slopes. The vertisols were only found along river beds and plains.

Physical analysis showed that both Acrisols and Luvisols were sandy loam to sandy clay loam and the vertisols were classified as clay loam to silt clay.

A new soil type which has a murram red characteristic and murram deep red characteristic was found. This was named mixed red soil (colour code 7.5 YR-5.OYR). The results are summarized in Table 1.

Table 1: Results of physical analysis for Kitui Pilot Forest Reserve

Characteristics	Luvisol	Vertisol
Bulk density	134-150	142-147
Texture	Loam	Clay Loam
Hardness (kg/cm2)	27-30	32-40
Porosity (%)	45	15
Percolation (mm/ml)	8.3	0.5
Solid %	55	64
Liquid %	8	28
Gas % 134-150	37	8

Chemical analysis indicated that the soil in the pilot scheme is low in nitrogen and phosphorus. This corresponds quite well with the low organic carbon (Table 2).

Table 2: Results of Chemical Analysis for Kitui Pilot Forest Reserve

Characteristics	Acrisols	Luvisol	Vertisol
pH	5.5-6.1	5.9-61	6.9-8.2
Total N (%)	0.09-9.2	0.06-0.4	0.03-0.84
C%	0.70- 1.62	0.56-1.85	0.35-0.93
P (ppm)	0.01 -0.11	0.01-1.10	0.93 -2.10
BS%	37	63	78

1.8 FOREST BIOTECHNOLOGY PROGRAMME

1.8.1 Introduction

The programme emphasizes scientific development of farm forestry and agroforestry systems for ASALs through refinement of existing tree improvement and the incorporation of symbiotic micro-organisms to increased productivity per unit area of land.

It has three research components namely:

Biological nitrogen fixation (BNF),
Plant tissue and cell-culture,
Wood biodeterioration.

1.8.2 Research Activities

Research undertaken by the division during the year includes studies on Nitrogen fixing trees (NFT), plant tissue and cell-culture and studies on low-cost treatment of wood using diffusible preservatives and creosote mixtures.

Biological Nitrogen Fixation (BNF)

Broad Objectives

to study and assess factors responsible for effective N2-fixing tree symbioses, their microbial symbiont and the associated vascular plant communities for sustainable water use efficiency, and re-vegetation in dry areas of East Africa and;
to describe the temporal and spatial patterns of natural abundance levels of stable isotope signatures, leading to a characterization of plant - water relations and patterns of N2 disposal:

The specific objectives are:

to select the most effective rhizobia strains in nitrogen fixation symbioses under the arid and semi-arid conditions of Kenya;
to introduce these effective Rhizobia strains in different ecosystems of Kenya
to assess relative competitiveness against soil endemic strains.

The following activities were undertaken:

Screening of rhizobia stains for effectiveness in Nitrogen fixation,
Enumeration of rhizobia population resident in soil,
Inoculum production and quality control (culture storage),
Chemical and physical analysis of soil from field sites,
Inoculation and nodulation trials,

Evaluation of biological nitrogen fixation under glass house and nursery conditions,
Sites selection, characterization and preparation for field out planting,
Analysis of natural abundance levels of 15N, 130 isotyopes to determine nitrogen fixation and water use efficiency (WUE).

Achievements

Isolation and screening effective strains for several species including MPTs namely, *Acacia polvacantha, Acacia tortilis, Faidherbia albida, Leucaena leucocephala, Calliandra calothyrsus, Sesbania sesban,*
Improved MPTs establishment in the nursery and greenhouse through rhizobia inoculation,
Improved culture storage at -70°C and inoculum packaging in "Filter mud" packets. Various equipments have been obtained through collaboration with the EEC.

Studies on low-cost timber treatments using diffusible preservatives and creosote mixtures

Introduction

The study aims at developing simple and cheap methods for wood protection. The concern for developing low-cost treatment methods and possible effects of using toxic chemicals has led to search for alternative wood treatment techniques which are effective but less toxic compared to Borates which have been found to have low mammalian toxicity.

Objectives

To test the usefulness of the method in treating commercial spp. and less utilized species from Kenya
To develop low-cost treatment methods for Kenyan timber

Activities

The Dip-diffusion experiments on both *Cupressus lusitanica* and *Pinus patula* have been done. The absorption data available shows that adequate absorption of preservatives can be obtained at 15% B.A.E. for both spp. Penetration tests have not been possible due to lack of an essential chemical: Tumeric powder.

Traditional wood preservation technologies

The aim of the study is to document and test the indigenous wood preservation technologies in Kenya. Survey has been done in three areas of Kiambu District. The study will be extended to other areas of the country.

Hot-Cold Baths Treatment Method

- To continue refining the treatment parameters with the aim of reducing costs.
- Improve the durability of perishable timber.

Activities

The treatment plant at Muguga was discontinued but the Turbo plant continued.

Plant tissue and cell culture

The practical significance of plant and cell culture in tree improvement is rapid clonal propagation. This is important especially for indigenous tree crops which are threatened with over-exploitation, seed dormancy, seed-lessness, and recalcitrant seed.

Broad objectives

In vitro rapid clonal propagation of tree crops which are endangered, difficult to seed, seedless, newly introduced, positive mutants, and recalcitrant seeders.

Specific objectives

Identification of tree crops having any one of the above problems.
Formation and preparation of appropriate media for raising such trees.
Collection of appropriate ex-plants and establishment of septic cultures.
Hardening and nursery establishment.
Field trials of seedlings and studies on phenotypic characteristics of seedlings raised through different methods.

Activities undertaken

Continued evaluation and monitoring of *Grevillea robusta* and *Milicea excelsa* transferred to the field in 1990.
Preliminary investigations on raising *Cupressus genome* resistant to *Cinara Cupressi. By* the end of 1992, more than 100 seedlings were raised from 5 and 20 year old parents. Also raised were *Juniperus procera* from over 10 years old trees.

Constraints

There was inadequacy in provision of chemicals and other necessary inputs, especially from the National Aphid Project.

1.8.3 Collaboration

KEFRI and Dundee University continued their collaboration on African rhizobia Technology Research Project.

1.9 PATHOLOGY AND MYCOLOGY PROGRAMME

1.9.1 Introduction

This programme undertakes research to determine causes of tree diseases and recommends appropriate control measures.

1.9.2 Research activities

Diseases of tree seeds,
Diseases of seedlings in the nurseries,
Diseases of plantation trees, for example the Armillaria root rot,
Mycorrhiza associations,
Advisory service.

Diseases of tree seeds

Studies were undertaken to find the incidence of fungi and to identity fungi associated with seed of different tree species. The associated fungi were tested for their pathogenicity to determine their potential to inhibit germination of seed of tree species from which they had been isolated. Fungicidel control measures that inhibit microbial growth and enhance seed germination were evaluated. Fungi associated with the seeds include: *Alternaria alternate, Fusarium .solani, Aspergillus sp., Rhizoctonia solani, Rhizopus stolonifer, Musor mucedo* and *Penicillium spp.* Of these fungi, *Rhizoctonia solani, Alternaria alternate* and *Fusarium solani* were pathogenic. Fungicides with the ability to inhibit microbial growth included Benlate, Thiram, Captan and Fernasan D.

Diseases ofseedlings in nurseries

Studies were centered around foliage disease of *Caledendron capense* caused by Phomopsis. Prolonged leaf wetness was found to be a prerequisite for infection to occur. Defoliation and subsequent dieback occurred when no funggccddl application was attempted. Leaf spots were reduced after application of Benlate(a fungicide).

Armillaria root rot

Research work of this project continued during the year. A report has been compiled and sent to the EEC. The report is summarized below.

Surveys

Further surveys of Armillaria were carried out in Meru, Cheche, Sabatia and Kerita. More isolates were obtained from samples collected during the surveys. Abundant fruit bodies of A. *heimii* were found in July at Sabatia on dead C. *lusitanica* trees and G. *robusta* stumps. These species continued to be predominant in forest plantations. *A. mellea* was isolated from tea and fruit-trees (peach, plums) growing on sites previously occupied by forests. Laboratory maintenance of cultures continued.

Damage assessment

Assessment was carried out at Ragati where 2.7% infection of *Vitex keniensis* per hectare was recorded. A one hectare observation plot was also established at Chehe and assessed of infection and mortality was done.

Induction of fruit bodies in vitro

A few fruit bodies of both *A. mellea* and *A. heimmii* were obtained on half oranges and water in Kilner jars four months after inoculation. They resembled those found under field conditions. However, attempts to obtain single spore isolates were not successful. Fruit bodies were also formed on *Acacia melanoxylon* branch segments.

Pathogenicity tests

Further assessment of this experiment was carried out. It was found that more deaths had occurred of *P. patula* and G. *robusta. A* few *Eucalyptus saligna* seedlings had also died. *A. mellea* was still the most pathogenic followed by *A. heimii* isolates. *P. patula* appeared to be the most susceptible followed by *G. robusta. No* deaths had occurred on *V keniensis* and C. *lusitanica.* One group of isolates had not caused any deaths on any of the seedlings of the five species tested.

Control trials

A control trial by spot eradication of Armillaria by removal of dead tree stumps was set up at Sabatia. The first assessment was carried out after six months. Preliminary results showed that more deaths had occurred in the control treatment compared to other treatments. However, long term assessments are necessary before conclusion can be drawn from this trial.

Mycorrhiza associations

A new bilateral project on ectomycorrhizia of indigenous and exotic trees in Lowland Kenyan forests was started in January 1993. The project is being undertaken jointly by Oxford Forestry Institute (OFI), KEFRI and University of Murcia (in Spain) and financed by the EEC.

Preliminary survey work was started in March 1993. Several sites were selected for survey work in Kwale, Gede (Arabuko Sokoke Forest) and Jilore on *Brachystegia spiciformis, P. caribae, Afzelia cuanzensis* and *Julbernardia* sp. Surveys carried out in May yielded about 40 putative ectomycorrhiza fungi. The most abundant species were in the genera Russula. They were isolated in pure culture after collection and material preserved in liquid for DNA finger printing.

The following experiments were set up in the glass house at KEFRI which included four species i.e. *B. spiciformis, P. caribae, E. camaldulensis* and *A. cuanzensis.*

Inoculation with P. *tinctorius* spores and *Rhizopongon luteolus* (ex Gede and ex Kwale),
Synthesis of ECM with soils collected from the sites,
Synthesis of ECM using "mother" seedlings from Kwale, Jilore and Gede.
These experiments will be assessed in November.

Advisory Services

The services handled a few disease specimens from institutions engaged in forestry activities. Londiani and Turbo Pathology Units undertook diseases surveillance west of the Rift Valley. Noteworthy disease organisms included:

Diplodia pinea dieback on *Pinus patula* from Londiani and Makutano Forest Stations,
Sclerotia sclerotium on stem of *Sesbania sesban* from KAKI Agroforestry plot,
Monochaetia unicorn is/Seiridium unicorne canker on *Cupressus lusitanica* from Muguga,
Alternaria alterata from seedlings of *Pinus patula,* ex Muguga Nursery,
Pestalotiopsis guepinii from seedlings of *Juniperus procera,* ex Muguga Nursery.

1.10 ENTOMOLOGY AND ZOOLOGY PROGRAMME

1.10.1 Introduction

This programme offers advisory services to other programmes in the institute when problems are encountered with insect pests of forest trees.

1.10.2 Research activities

Cinara Cupressi (Cypress aphid)

Population dynamics monitoring of *Cinara Cupressi* was carried out in a more systematic way. Permanent Sample Plots (PSPs) were established in Kinale, Uplands and Ngong Forest Stations. These activities were carried out monthly, and will continue for the next two years. Damage assessment was also carried out in May 1992 in Nyandarua and Laikipia Districts. Other activities for the control of *Cinara cupress* included a study of it's life cycle and life span under laboratory conditions.

Heteropsylla cubana (Leucaena pysllid)

This pest was first noticed in August 1992 on on-farm agroforestry trials of *Leucaena leucocephala* in Kilifi District. Since then, further citing have been made in other parts of Kenya including Muguga and Machakos areas.

Presently, Entomology staff are involved in monitoring population dynamics of this pest. Surveys are also being carried out to assess damage. A proposal will soon be ready on ecological/biological studies, biological control, socio economic as well as extension research. This Division is collaborating with Agroforestry Division and other institutes such as National Museums of Kenya and ICRAF in writing the proposal.

Forest insect reference collection

Maintenance work on the preservation of insect specimens proceeded with emphasis on the refilling of the spirit collection specimens as well as refilling of drawers with Napthalene. The Reference Collection is being modified for preservation of duplicate specimens.

Other activities

Identification of insects

Identification services were extended to individual farmers. The programme continued to advice on remedial measures on insect pest damage.

Agricultural shows

The Division participated actively in the Kiambu Show held in March 1992 and the Nairobi International Show held in September - October 1992.

1. 11 SOCIAL FORESTRY PROGRAMME

1.11.1 Introduction

The mandate of the programme is to provide an enabling ground of experience and expertise for planning and management of short intensive social forestry courses for a broad spectrum of participants at professional, technical and grassroots levels through the training sub-programmes. The programme undertakes: organisation of external courses, seminars and workshops at national and international levels, promotion of tree planting and management through urban and amenity forestry sub-programmes.

1. 11.2 Activities

Training

The programme conducted both Social Forestry and Agroforestry courses. A number of external courses were also hosted as indicated below:

Social forestry and Agroforesoy courses

Course Title (Muguga)	Attendance	Expected	%
Special Orientation	18	30	60.0
Extension Officers	98	120	82.0
District Level Agroforestry	51	60	85.0
Agroforestry Extension	19	30	63.0
Total	186	240	77.5

Course Title (Kitui)	Attendance	Ex	to	
Women's Course	26		30	90
Field Technical Assistants	50		60	85
Teachers	58		60	99
Field Seminar	228		open	
Farmers	85		90	90
Follow-up Workshop	22		30	85
Total	241		270	90

Courses hosted (Muguga)	
TREECD Training	12
Reporting & Dissemination of Research Results	13
Timber Grading	17
Exploratory Timber Grading	37
Maendeleo Liner Production	24
Effective Pesticide Use	60
Tropical Agroforestry & On-farm Trials Techniques	8
MENR Senior Staff Management	26

Course hosted (Kitui)

Organization/Course/Seminar	Frequency	Attendance
Ministry of Health	2	56
DARP - Katumani	1	-
UNICEF/WHO	1	26
World Vision	1	42
KIDP Seminars	5	121
Action Aid Kenya	2	36
AMREF Seminar (Health)	1	34
Communication Speciality	1	22
Public Works	1	15
Machakos Environmental Action	1	12
Plan Group	-	-
Total	16	364

The Plants for Life Sub-programme conducted a 5-day workshop at Loitoktok in Kajiado District. The sub-programme has also started a referral forestry herbarium of herbal medicinal shrubs and trees. Altogether, courses were conducted by different organizations in collaboration with the programme.

Social Forestry Prize Day

The Fifth National Forestry Prize Day was successfully held at ICRAF on 22nd April I993 and attended by a total of I20 Research Scientists, Subject Specialists, Extension Officers, Farmers and Distinguished Guests (Her Excellency, Mrs. G. Sato, the Ambassador of Japan to Kenya and Hon. F. Kagwirna, Assistant Minister, MRTTT). The competing districts and the winners were:

Kisumu	Mr. Ogwang' Odawo	- First
Kwale	Mr. William Mbora	- Second
Tharaka Nithi	Mr. Peter Kirinya Kiame	- Third
Turkana	Mr. Abdul Rahaman (Islamic Centre)	
Busia	Washington Wafula	

The Social Forestry Nurseries

Muguga

The Social Forestry Training Nurseries continued to establish and develop a large collection of both indigenous and exotic trees, shrubs and related plants for different values. Over I60 different species totalling I72, 377 plants were raised.

The collection continued to provide a plant genetic resource bank for training, research and ceremonial plantings. The Plants for Life Sub-programme strengthened its nursery and it raised seedlings of nutritional and/or medicinal value.

Kitui

The Kitui Centre Nursery increased it's target from I00,000 to I20,000 seedlings during the period under review. A total of 112,680 seedlings of 43 different species were raised. Most of the seedlings were distributed to farmers free of charge.

The Centre Nursery also collected 433.3 Kg of seeds of various species which were also distributed to farmers free of charge. Some seed was sent to KEFRI Seed Centre, Muguga.

Appropriate Methods of Harvesting Farm Woodlot in Kenya

Objectives:

Document the state of forest harvesting in Kenya,
Evaluate the cost and productivity associated with methods used for timber harvesting,
Develop appropriate systems and equipments for harvesting farm woodlot in Kenya,
Communicate to farm woodlot owners and industries the appropriate methods for harvesting farm woodlot.

Achievements:

An initial survey of methods used in logging in Kwale and Taita Taveta was done and a report was written. The productivity study on logging methods used by Pan Paper Mills (PPM) Logging unit was studied and a report compiled. PPM supported the officer during this study. Arrangements for the second phase of the study in PPM region are at an advanced stage. This phase will complete data collection and compile the data on cost of production.

Studies on Biomass Energy

This mainly involves comparison of charcoal recovery and quality using various carbonization methods.

Objectives: To assess the general sustainability of various kilns in terms of conversion efficiency, rate of carbonization, quality of charcoal and cost of production. Performance of the kilns was assessed. The type of

Improved Earth Kiln,
Metal kilns (drum & circular),
Casamence Kiln,
Half Orange Kiln.

Achievements:

Successfully introduced gum acacia as alternative binder to starch.
A quarter of remaining conservation done,
Survey of Nairobi completed. Literature review to determine present demand/supply situation.

Appropriate Technologies in Furniture and Joinery Industry in Kenya

Objectives: To document the state of the furniture and Joinery industry in the country to-date:

- to evaluate, develop and promote machinery layouts and maintenance practices for improved production efficiency,

The CTP site is located along Mombasa Road across an air-traffic landing corridor to Jomo Kenyatta International Airport, over a distance of 4 km. To date, a total of about 2,172 trees of 32 different species continued to be maintained by 1 I KEFRI staff after it was phased off from JICA support in Phase II of the Social Forestry training Project.

Karai was a National Tree Planting site in 1987, whose active maintenance continue to be carried out by two KEFRI staff. It is anticipated that the trees growing in both sites will continue to provide a gradual but continuous positive change in the quality of these difficult environments.

11.3 Collaboration

Collaboration continued with both governmental and non-governmental organizations as well as individuals especially in the area of implementation of the training activities and ethnobotanical surveys and ex-suit conservation of plants of medicinal and nutritional values.

1.12 FOREST PRODUCTS PROGRAMME

1.12.1 Introduction

The programme's research activities aim at optimum and efficient utilization of forest products.

1.12.2 Research Activities

Research Project Proposals within Forest Products for the report year included:

Timber structure and characteristics

Objectives:

Identify key Kenyan grown timber based on anatomical structure.
Develop efficient methods for preparing permanent slides for developing a photomicrography atlas for tree species in Kenya.
Determine durability, conversion and seasoning behaviour of Kenyan grown species.

Achievement: *A* total of 130 species have been collected.

1. 13 FOREST MENSURATION AND INVENTORY PROGRAMME

1.13.1 Introduction

Forest Mensuration and Inventory Programme is charged with the responsibility of undertaking and guiding research in development of methodologies for enhancement of improved forest resource assessment and monitoring of tree species performance, for example, indigenous forests, plantations, farm forests and forest arboretums.

1.13.2 Research activities

A series of Permanent Sample Plots that were established in Nakuru and Kericho districts with the support of funds provided by FAO Forestry Inventory Project.

Twenty three plots which were established in 1991/92 for monitoring the effect of cypress aphid infestation on growth of cypress plantations were assessed. Additional two plots were also established in Chehe Forest Stations. Geographical distribution of these plots is as presented in Table 1.

The forester continued assisting the Silviculture division in naming, locating and measuring trees in the arboretum at KEFRI Headquarters.

The head of the programme continued to teach Forest Mensuration in the Department of Forestry, Moi University in Eldoret for two days in a week during the period August - December 1992 and May - June 1993.

1.13.3 Courses, Training and Workshops

The head of the programme attended:

Geographical Information Systems/data Base Management Workshop sponsored by Kenya Forestry Master Plan Project at Nakuru in February 1993.
Monthly National GIS/Data Base Task Force Meetings sponsored by Kenya Forestry Master Plan Project and collaborating institutions.

1.13.4 Visits

Various officers and especially those from Forest Department visited KEFRI concerned with Cypress Aphid Project.

1.13.5 Collaboration

Collaboration with the Government Departments, Non-Governmental Organizations and the public remained cordial throughout the year.

to study the wood species, adhesive and finish, which are almost suitable for furniture production,
to develop adequate cost evaluation pricing and marketing systems,
to disseminate generated information to the industry.

Achievements:

Trials on the suitability of soft-woods (Cypress and Pine) for furniture making and the manufacturing procedures have been going on and an interim report on the results has already been forwarded for recommendations.

Production and Utilisation of Non-wood Forest Products

Objectives

to screen and identify tree/shrub species for production of essential oils
to carry out a resource availability for production of essential oils,
to collect samples from identified tree species for chemical characterization and quality analysis,
develop a simple distilling unit to process essential oils.

Achievements

This is a new sub-programme and limited research had been undertaken during the reporting period.

Other- activities:

The non-research activities of Forest Products Research Programme comprise saw-milling, carpentry and joinery, timber seasoning and treatment. Consultative services are rendered to the public.

In the year under review, despite the availability of machinery and qualified personnel, the programme has been affected by shortage of saw logs and other raw materials for the workshop.

Through these non-research activities, the programme has shown progress n the following areas:

Furniture and design,
Preparation of timber fancy items which include laminated wood items,
Wood preservation,
Timber grading,
Timber recovery to the tune of 51 % through improved technology in saw milling.

Table 1. Location of plots for monitoring Cypress Aphid

FOREST STATION	COMPART NO.	SPECIES	YEAR	DATE
Ol bollassat	7R, 12.5 ha	C.lusitanica	1981	4/7/92
Geta	10A, 19.7 ha	"	1983	6/7/92
S. Marmanet	8S (Proposed)	"	1985	1/7/92
N. Kinangop	7J, 9.4 ha	"	1975	7/792
S. Kinangop	10E, 11.5 ha	"	1972	8/7/92
"	9N, 17.0 ha	"	1984	30/6/92
S. Marmanet	3C, 29.9ha	"	1972	1/7/92
"	6J, 22.2 ha	"	1973	7/7/92
N. Kinangop	6M, 20.5 ha	"	1979	2/7/92
Gitundaga	5A, 15.0 ha	"	1988	2/7/92
"	19K, 7.7ha	"	1971	2/7/92
Ol Arabel	1H, 13.4 ha	"	1983	3/7/93
"	1B, 27.4 ha	"	1978	3/7/92
Migori	1A, 13.52 ha	"	1982	13/3/92
Ontulili	3N, 33.0 ha	"	1986	17/2/92
Njuldini	1C, 3.2 ha	"	1986	24/2/92
Mucheene	IQ, 15.8 ha	"	1978	21/2/92
Gathiuru	2F, 23.5 ha	"	1985	20/2/92
Ontulili	2C, 10.5 ha	"	1988	19/2/92
"	5A, 30.2 ha	"	1976	19/2/92
Naro Moru	3E, 27.6 ha	"	1975	22/2/92
Gathiuru	8G, 15.0 ha	"	1984	20/2/92
Mucheene	4A, 19.8 ha	"	1981	21/2/92
Chehe	3B, 21.4 ha	"	1983	5/3/93
Chehe	3G, 3.5 ha	"	1986	11/1/94

1.14 SOCIO-ECONOMICS AND POLICY STUDIES PROGRAMME

1.14.1 Introduction

The Socio-economics and Policy Studies division was established to enhance interactive research. The purpose of the programme is to carry out basic forestry research survey with identified forestry extension areas. It aims at offering solutions to socio-cultural, socio-economic and policy issues affecting forestry development both in the private, community and public forestry sectors.

The division undertakes the following research activities.

Documentation of existing knowledge in forestry management and development,
Promotion of forestry as a source of generating income to small scale farmers,
Undertaking marketing research analysis on all forestry products,
Monitoring and evaluation of forestry training requirements in social forestry and agroforestry.

1.14.2 Research Activities

The division has undertaken research in the following areas:

Hunting in the Arabuko Sokoke Forest Reserve.
Use of the forestry products by households living adjacent to.
- Mt. Kenya Forest Reserve
- Shimba Hills Forest Reserve
- Aberdare Forest Reserve
- Kiang'ombe Forest

Field investigation of certain aspects of forest utilization in the Shimba Hills National Reserve and the Maluganyi and Mkongani Forest Reserves.
Technology (agroforestry and social forestry) monitory and evaluation.

Hunting in the Arabuko Sokoke Forest Reserye.

The objective of the study was to establish a hunting activity profile and to obtain a clear indication of the extent of both in-forest and on-farm hunting in terms of numbers of households involved and the circumstances under which such activity is carried out.

The use of the forestry products by households living adjacent to:

Mt. Kenya Forest Reserve
Aberdare Forest Reserve
Shimba Hills Forest Reserve
Kiang'ombe Forest

These surveys were undertaken to assess/document the current and historical importance of the forest areas to adjacent households and to investigate their perceptions of current management and use.

Field investigations of certain aspects offorest utilization in the Shimba Kills National Reserve and the Muluganvi and Mkongani Forest Reserves.

The survey concentrated on specific subjects e.g. the use of Kaya Forests, in an attempt to add information to that collected in previous surveys.

Technology monitoring and evaluation works undertaken to develop methods for monitoring and evaluating agroforestry/social forestry activities in Maseno, Machakos and Kitui areas.

2.0 THE YEARS PUBLICATIONS

Publications by ***KEFRI*** Staff in the Years 1992/93

I Journal Articles

Mwendandu, R. J., Otsamo, A and Otsamo, R. (1993). Effect of irrigation on soil nutrient status on a 14 - month - old *Prosopis julifora and Eucalyptus microtheca* plantation in Bura Irrigation Scheme, Eastern Kenya. - E. Africa for J. (special issue) 58: 101 - 105.

II Technical Papers presented at National and International Workshop/Conferences

Kamau , D. M. (1992). *Phosphorus* and *Potassium sorption* characteristics and other relation to seedlings growth in a kaolimite soil. A paper presented at the 12th Soil Science Society for E. Africa, 30.11.92-4.12.92 Nakuru, Kenya.

Kaudia A. A. (1992). Extension Strategies for Tree Species Introduction: Lessons from *Grevillea robusta* Adoption in Less Developed Countries. In: *Proceedings of an International Workshop on Grevillea robusta in Agroforestrv and Forestry*. ICRAF, Nairobi.

Kaudia, A. A (1993). Social Forestry: A Case for Research Focus in Semi-Arid Areas. Paper Presented at the Graduate Research Seminar. School of Development Studies, University of East Anglia. pp 10.

Kaudia A. A. (1993). The Role of Women in Forestry Development: Mechanisms for Reconciliation of Land-Use Pressures. Paper Presented at the 14th Commonwealth Forestry Conference 3th-19 September 1993. Kuala Lumpa, Malaysia.

Kaudia, A. A., Mukolwe, M.O., Nyandiga C., Mwamburi, A., and Muniafu, N. (1994) Curriculum for extensive short courses in Agroforestry applications. In: Kenya, Japan Social Forestry Training Project Report.

Milimo, B. M. (1993). Chemical composition of *Melia volkensii* Gurke: an unrealised browse potential for semi-arid Agroforestry systems. (unpublished).

Mukolwe, M.O. (1993) Research-Extension-Farmer Linkages. A paper presented to the participants at the Extension Communications course held at Mt Owood Lodge, Embu. 21 Nov- 3rd Dee, 1993.

Mukolwe, M.O., Abista, M. and Baru, J. (1991). Background study on community forestry curriculum development in Kenya. In: Forestry Training Programme/FINNIDA 1992. Regional workshop report.

Mukolwe, M. O. (1993). On- farm Nurseries, establishment and management techniques. A paper presented at the Participatory forestry extension methods course at KEFRI, Muguga. 12-19 sept 93.

Mukolwe, M. O. (1993). A Report on Training of Trainers (TOT) Course in Extension, organized by FTP of Finland. Mutare, Zimbabwe. 4`h October - 12th November, 1993.

Mukolwe, M.O. (1993). Case Study on the Shamba System of Plantation Establishment, Kenya. In: Regional Workshop on Teacher Training and Teaching Material Development (COFOCUR) FTP/FINNIDA, 24|h May - 4'h June, Nairobi, Kenya. pp 26-27.

Mulatya, J. M. (1992). The use of biotechnology in utilization of indigenous trees and local knowledge on improving crop and livestock production in dryland areas - a paper presented at workshop on biotechnology at abardare Safari Club Hotel.

Nyamai, D.O. (1992). Introduction to Agroforestry technologies. Paper presented to Nigerian participants of the training course in Tropical Agroforestry and on- farm trials techniques organised by Technical and Study Tours Ltd. and KEFRI, 12th July - 21 st August 1992, KEFRI, NAIROBI, KENYA.

Nyamai, D.O. (1993). Agroforestry concepts and practices. Paper prepared for participants of agroforestry training for district level extension personnel from MENR, MOA and other departments, and NGOS at KEFRI Hqs 7th June 1993.

III OTHER PUBLICATIONS

-------- Kaudia A. A. (1992). Curriculum for In-Service training in Agroforestry for Forestry and Agricultural Officers. Muturi S.N. (Ed.). MENR/KEFRI/MOA., Nairobi, Kenya.

Kaudia, A. A. (1992). Agroforestry extension methods and farmer adoption strategies. An annotated bibliography. Unpublished draft, ICRAF/KEFRI, Nairobi, Kenya.

Mukolwe, M.O., Mbote, F., Baru, J. and Kipkore, W.K. (1993). The COFOCUR curriculum (Kenya). In: FTP/FINNIDA workshop reports.

Mulatya, J. M. (1992). Dryland afforestation manual for Kitui pilot forest project (field operations) unpublished draft.

Odhiambo, J. M. et al. (1984-1993). Tropical forestry reports No. 8: Forestry Research in Bura, Kenya. Final report of the research component in the Bura fuelwood project.

IV UNPUBLISHED THESIS

Yobterik, A.C. (1993). Nitrogen mineralization of agroforestry forestry tree mulches incorporated in dry land and temperate soils. Msc thesis, university of Toronto, Canada.

3.0 FINANCIAL REPORT

1992/93 Balance Sheet			**1993**	**1992**
	Note	**Kshs**	**Kshs.**	**Kshs.**
Fixed Assets	2	-	275,998,565.00	214,108,704.00
Capital Work in Progress		-		25,676,549.00
			275,998,565.00	239,785,253.00
Current Assets				
Stocks	6	3,013,850		3, 826, 714.00
Debtors	7	3,495,297		4,561,485.00
Cash at Bank	3	5.769.647		2,265,759.00
		12278.794		10.654.258.00
Current Liabilities				
Creditors	8	8,774,484		11,398,627.00
Pension	-	9,278.919		7.611.781.00
		18,053-403		19.010.408.00
Net Current Assets/			(5,774.609.00)	(8,356,150.00)
Liabilities			270,223,956.00	231,429,103.00
Financed By:				
Unspent Development Grants			22,236.00	
Govt/External Grants			265,651,288.00	258,699,741.00
External Grants for Research	5		9,140,374.00	7,502,012.00
Assets Revaluation Account			38,300,000.00	-
Excess Operating Deficit Over Government Grants			42,889,942.00	34-772-649.00
Total			**270,223, 9 56.00**	**231,429,103.00**

Ecology and Natural Forests Management

Dr. Bernard Kigomo	P.R.O. (Head of Division)
Mr. James Were	R.O.
Ms. Juliet W. Wanyondu	R.O.
Mr. Simon N. Wairungu	R.O.
Mr. David K. Lang'at	R.O.
Mr. Gordon Sigu	R.O.
Mr. G. Giathi	R.O.

Forest Products

Dr. Ben Chikamai	S.R.O. (On study leave)
Dr. Lawrence Manguro	SKO (Ag. Head of Division)
Mr. Joseph Githiomi	R.O.
Mr. J. Onchieku	R.O.
Ms. Nellie Ndegwa	R.O.
Mr. Ezekiel Kutte	R.O. (On study leave)
Ms. Sheila Mude	R.O.
Mr. Joram Kagombe	R.O.

Forest Pathology and Mycology

Mr. Elly Mwanza	S.R.O. (Head of Division)
Mr. Linus Mwangi	S.R.O.
Mrs. Jane Njuguna	R.O.
Mr. Kamau Mburu	R.O. (On study leave)

Forest Entomology

Ms. Mercy Gichora	R.O. (Head of Division)
Mr. Eston Mutitu	R.O. (Seconded to IIBC)

Plantation Silviculture

Mr. James Kimondo	- R.O. (Head of Division)
Mr. Symonds Orondo	- R.O. (Officer-in-charge, Londiani Station)
Mr. Balozi Bekuta	- R.O.
Mr. Michael Njenga	- R.O. (Officer-in-charge, Gede Station)

Tree Seed Centre

Mr. William Omondi	- S.R.O. (Head of Division)
Mr. Bernard Kamondo	- R.O.
Mr. Joseph Kioko	- R.O. (On study leave)
Mr. Joseph Ahenda	- R.O.

Social Forestry

Mrs.Alice Kaudia	S.R.O. (On study leave)
Mr. Mbae N. Muchiri	S.R.0

4.0 STAFF LIST

List of Scientists and Other Senior Members of Staff

Dr. J.A. Odera	Director

Agroforestry

Dr. Daniel 0. Nyamai	S.R.O. (Head of Division)
Mr. Francis M. Kanja	R.O. (On study leave)
Mr. Edward Mengich	R.O.
Ms. Josephine Wanjiku	R.O.(On study leave)
Mr. Ezekiel O. Ochieng	R.O.
Ms. Agnes Yobterik	R.O.
Mr. Harry Ofeno	R.O. (Center Director, Maseno - On study leave)
Mr. J. Kamiri	R.O. Maseno Centre
Mr. Collins 0. Obonyo	R.O. "
Mr. Stanley Gathumbi	R.O. (CARE-Kenya Project)
Mr. P. Tuwei	R.O.
Mr. Ahmed M. Mohammed	A.R.O. (On study leave)

Biometrics and Laboratory Services

Mr. H. Wakhungu	SRO
Mr. R. Okumu	Chief Laboratory Technologist

Biotechnology

Dr. David Odee	S.R.O. - Head of Division
Mr. Bernard Muok	R.0. (On study leave)
Ms. Jacinta Kimiti	R.O.
Mr. Joseph Machua	R.O.
Ms. Margaret Yonga	R.O. (On study leave)
Mr. Geoffery Muluvi	R.O. (On study leave)
Mr. Paul Magondu	R.O. (On study leave)

Drylands Silviculture

Mr. Richard Mwendandu	S.R.O. (Head of Division)
Mr. J. Amwatta	R.O. (Officer-in-charge, Turkana Station)
Mr. Tom Omenda	R.0
Ms. Dorothy Ochieng	R.O.
Mr. John Maingi	R.O. (On -PhD. study)
Mr. Simon K. Choge	R.O.
Mr. James Maua	R.O. (Officer-in-charge, Bura-Tana Station)
Mr. Kidundo Maushe	R.O. (on study leave)
Mr. Bernard Owour	A.R.O.
Ms. Florah Mwawughanga	R.O. "

Tree Improvement

Dr. Ebby M. Chagala	- P.R.O. (Head of Division)
Dr. Phanuel Oballa	- S.R.O.
Mr. John F. Obiri	- R.O.
Mr. J. M. Mbinda	- R.O. (attached to *Pinus radiata* project at Kaptagat)

Senior Administration and Finance Staff

Ms Ruth Macharia	-	Senior Administrative Officer
Mr. John M. Gisemba	-	Administrative Officer I
Mrs. Rispha Wainaina	-	Senior Planning Officer
Mr. Robinson O. Omoro	-	Ag. Chief Accountant
Mr. Shem Ogao	-	Accountant I
Mr. Jonathan Ochieng	-	Supplies Officer
Mrs. Mercy Maina	-	Senior Personal Secretary

Tree Seed Centre

Mr. William Omondi	- S.R.O. (Head of Division)
Mr. Bernard Kamondo	- R.O.
Mr. Joseph Kioko	- R.O. (On study leave)
Mr. Joseph Ahenda	- R.O.

Social Forestry

Mrs.Alice Kaudia	S.R.O. (On study leave)
Mr. Mbae N. Muchiri	S.R.0
Mr. Michael Mukolwe	R.O.
Mr. Akula Mwamburi	A.R.O.
Ms. Doris Mutta	A.R.O.
Mr. Tito Mbuvi	R.O.
Mr. Paul Barasa	1.0

Kitui Regional Center

Mr Joshua K. Cheboiwo	R.O. (Project Manager - Kitui)
Mr. Jackson Mulatya	R.O.
Mr. Gabriel Muturi	R.O.
Mr. Robert 0. Nyambati	R.O.
Mr. Nixon M. Muniafu	R.O.
Mr. Reuben Chirchir	R.O. (On unpaid leave)
Ms. Evelyne C. Kiptot	R.O. (On study leave)
Mr. Jesse K. Lugadiru	A.R.O.

Socio-Economics

Mr. Paul Ongugo	S.R.O. - Head of Division
Mr. Hezron. Mogaka	R.O.
Mr. George Ondoro	M.O.
Mr. A. Luvanda	R.O.
Mr. Charles Koech	A.R.O.

Forest Soils

Mr. Serem	R.O. (Head of Division)
Mr. David Kamau	R.O.
Mr. Kaleb Mwendwa	R.O. (On study leave)
Mr. Joseph Lelon	R.O.

LIST OF ABBREVIATIONS /ACRONYMS

ACIAR	Australian Center for International Agriculture Research
AFNETA	Alley Farming Network for Tropical Africa
AMREF	African Medical Research Foundation
ASALs	Arid and Semi-Arid Lands
CTP	Commemorative Tree Planting
DANIDA	Danish International Development Agency
DARP	Dryland Agroforestry Research Project
EEC	European Economic Community
EMI	Embu Meru Isiolo
FAO	Food and Agriculture Organization of the United Nations
FD	Forest Department
FINNIDA	Finnish International Development Agency
FTP	Forest Trees and Plants
GIS	Geographic Information systems
IAEA	International Atomic Energy Agency
ICIPE	International Centre for Insect Physiology and Ecology
ICRAF	International Center for Research in Agroforestry
IDA	International Develoment Association
IDRC	International Development Research Centre
IDRC	International Development Research Center
IIBC	International Institute of Biological Control
IITA	International Institute of Tropical Agriculture
JICA	Japan International Co-operation Agency
KARI	Kenya Agricultural Research Institute
KFMP	Kenya Forestry Master Plan
KIDP	Kenya Institute Development Programme
KIFCON	Kenya Indigenous Forest Conservation
MENR	Ministry of Environment and Natural Resources

MPTs	Multi-purpose Trees
MRTTT	Ministry of Research, Technical Training and Technology
NFT	Nitrogen Fixing Tree Association
NMK	National Museums of Kenya
NORAD	Norway Development Association
ODA	British Overseas Development
OFI	Oxford Forestry Institute
PPM	Panafrican Paper Mill
PSPs	Permanent Sample Plots
SIDA	Swedish International Development Agency
UNHCR	United Nation High Commission for Refugees
WWF	World Wide Fund