ANNUAL REPORT
AND
RECORD OF RESEARCH

July 1998 - June 1999.

Kenya Forestry Research Institute (KEFRI)
P.O.Box 20412, Nairobi.

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MESSAGE FROM THE CHAIRMAN KEFRI BORAD

The year under review was quite challenging to the Institute. The task of restructuring research programmes was concluded. The focus is now on four core technical research programmes (Farm Forestry, Natural Forests, Forest Plantations and Dryland Forestry) and the Service Program, the latter addressing mainly information dissemination and revenue generation opportunities. The new structure has not only improved the co-ordination of research and development activities but has also contributed to better utilisation of scarce resources.

The major challenge to the Institute is inadequate funds for research. The delay in the approval of the pending Kenya Forest Policy and legislation has discouraged donors from funding forestry activities. It is my hope that the proposed policy will soon be approved by Parliament to enable the forest sector and in particular the Institute attract donor funding.

Development of KEFRI's second strategic plan for the period 1999 to 2004 was an important activity during the year. Preparation of this plan is based on the recommendations of the July 1999 Workshop on Priority Setting.

During the year, the Institute was able to update the final accounts and received commendation from the Public Investment Committee. The Staff Pension Scheme is now fully operational and the Medical Scheme was started during the year.

The Institute received assistance from various donors and I wish to extend my appreciation to all of them. I also thank members of the Board and the staff for their contribution during the year.

H.M. Ngibuini
Chairman, KEFRI Board of Management.

FOREWORD

This report covers a period during which KEFRI embarked on preparation of a five-year plan. Research and development activities were implemented through the five new research programs instead of the previous fifteen divisions. Increased emphasis was given to Farm Forestry and Natural Forests programmes.

The most notable achievement during the year was the control of cypress aphid using an introduced parasitoid, Pausia *juniperorum* (a wasp). The aphid, Cinara cupressi invaded Kenya in early 1990 and became a serious pest of the main cypress plantation species, Cupressus lusitanica. After five years of release, the wasp was eventually found to have established well in the Highlands West of the Rift Valley and was spreading to other areas. A programme to rear and release the wasp was, therefore started during the year to facilitate its spread, especially to the Highlands East of the Rift Valley.

Strengthening of the five Regional Research Centres continued as one of the Institutes strategies to focus scarce resources to a few key areas instead of spreading them thinly. Strengthening of the Information Dissemination Unit under the Service Program also commenced. Existing collaborative links with local and international organizations were maintained and new ones established.

During the period under review, considerable efforts were made to implement the recommendations of 1996197 external review. Preparation of the finance, procurement and human resources manuals were completed and approved by the Board of Management.

This Annual Report presents KEFRI's research and development activities undertaken during the year as well as achievements accomplished. Activities undertaken by the management services are also highlighted.

I am confident that the new research structure and the efforts to improve management services will enhance KEFRI's contribution to sustainable development of forest resources in the country. I wish to thank the KEFRI Board and members of staff for their contributions during the year.

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

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1.0 RESEARCH ACTIVITIES BY PROGRAMS

1.1 FARM FORESTRY RESEARCH PROGRAMME

1.1.1 Introduction

The major problems currently facing farmers in Kenya include high incidence of poverty, food insecurity, and degradation of the natural resource base among other constraints. These problems are closely linked to the high population increase over the years, which in turn has exerted a lot of pressure on the environment and arable land.

The future supply/availability of wood products is uncertain and presently headed to critical levels if appropriate measures are not taken immediately. It is predicted that products (like wood products for industrial, domestic, micro and small enterprises) will in future be obtained from trees grown on farms. The alternative that offers great potential is the intensification and diversification of farm based wood production. As part of a strategy to alleviate these problems, the Farm Forestry Research Programme is working closely with development organizations and farmers to generate technologies that promote tree production systems on farms.

There are ample signs that farmers in Kenya are up to the challenge of tree farming. Research support to develop improved species, to increase the range of priority species, to design improved management strategies that will increase overall tree productivity and associated crop components and to promote sustainable tree germplasm production and distribution systems is critical. Equally important is the need to advise farmers on appropriate harvesting techniques, value adding processing technologies and suitable marketing strategies of farm based tree products, for intensifying farm production while maintaining land productivity and to generate income from tree growing.

The focus, activities and achievements of the program are presented in the following sections.

1.1.2 Research Focus

The main focus of this Programme is to contribute to the current efforts of tree planting, conservation, and utilization activities by farmers to diversify farm products and improve living standards. In order to achieve this objective, the Farm Forestry Programme strives to strengthen the linkages amongst extension agents, researchers and farmers through development of effective extension approaches as well as production of appropriate management guidelines. The research is focused on development of fast growing species with high market demand and their management practices. The main research thrust areas during this reporting period were soil fertility improvement, fodder production, fodder utilization, wood and fruit research.

1.1.3 Research and Development Activities

A. Soil fertility improvement research using Agroforestry trees and shrubs

The objective of this study is to ensure land productivity by introducing and managing suitable woody perennials that would improve and maintain the productivity of the soil, thus improving crop production.
The main activities under this theme during the 1998/99 reporting year included:-

D Characterization and Diagnostic surveys of farmers' fields for soil fertility management practices in Western Kenya highlands

In the Western Kenya Highlands, the continuous sub-division of land, due to high population densities has resulted into uneconomical farming units that are depleted of most nutrients. A soil survey in the region revealed that 90% of farms had less than 10% ppm P, and inadequate levels of N and K. Scientists in this region have adopted the Participatory Learning and Action Research (PLAR) method to involve farmers in the integrated soil fertility management (ISFM) process through self-discovering and learning process. In this process, researchers, extensionists and farmers team up to diagnose and analyse soil fertility and management problems, which are then used to initiate alternative practices suitable for crop productivity improvement within their farming conditions.

Diagnosing and analyzing 'cause and effect' of soil fertility depletion, planning mitigating strategies, suggestion of alternative ways of soil erosion management, implementation of technologies agreed upon, and evaluation of the effectiveness of the PLAR are crucial towards ensuring that the new methods are successfully adopted by the farmers. All these activities are carried out at village level and have been very successful in involving farmers within a community.

Contour hedgerows using a combination of tree and grass species: Embu and Kibwezi

Like in many of parts of Kenya, soils in the slopes of Embu region are prone to erosion due to high rainfall, and sloping topography. The major aim of contour hedgerow research is to assess the potential of tree hedges as monocultures and/or in combination with grasses. Results from Embu indicated that dry matter production as well as the cumulative crude protein yield was higher for tree/grass combination hedge of *Cafandra calothyrsus* and *Pennisetum* purpureum as opposed to when the species were grown in pure cultures planted in rows along contours. The results further demonstrated that the tree hedges help to build up terraces and also stabilize the soil at the tip of the terraces.

Current research efforts on contour hedges have shifted towards an expanded testing and dissemination of the practice with farmers. Such work is on going in a number of districts in Mt. Kenya region and other parts of Western Highlands.

In Kibwezi, trenched contour hedges were established in the long rains in 1999 targeting soil moisture conservation and fertility in sites, which were adversely degraded because of soil erosion, excavation and soil compaction by livestock.

D Nutrient management using short fallow species

The Kenya highlands represent a large concentration of small-scale farmers whose preoccupation is mainly food crop production. The Agroforestry technologies being developed with the use of short duration fallow species are aimed at improving the productivity, profitability and sustainability of the agricultural systems in the region. The area faces declining food crop yield as a result of soil fertility decline. To assess the potential of fallow species in addressing the soil fertility problem, the following experiments were established:

(a) Nutrient sourcing and soil organic dynamics in mixed species fallows of fast-growing trees

The objectives of this experiment were:-

- To estimate N-fixation by different species using natural abundance method and tissue ureide method
- To assess the mineral changes within the soil profile for sole and mixed species
- To determine root length density and biomass under monoculture and mixed cropping system
- To assess nutrient interactions and organic residues in tree mixtures

Interim results showed that:

- Mixed fallow containing Macroptilium and *Sesbania* + Crotalaria mixture were superior to single species fallows
- Leguminous fallow species contributed substantially to the overall N balance of the system through significant inputs from biological N-fixation. Estimates of N-fixed ranged from 10% to 78%
- N derived from fixation showed that Crotalaria was the highest N fixer among the tested species
- Mixed fallows yielded higher efficiency of soil mineral N capture at both top and lower soil depths compared a control plot of maize
- Macroptilium and *Sesbania* + Crotalaria have different rooting patterns and hence source soil nutrient from different soil strata, thus if grown in a mixture are capable of maximizing below ground resource capture
- Early growth performance was better in all legume fallow system than in control or natural fallow.

Plate 1. Sesbania sesban as a short duration fallow species.

Maize grain yields of up to 5 tons ha -1 have been harvested following a 12-month S. sesban fallow in western Kenyan soils. This represents a 2.5-fold increase over the natural fallow.

(b) Species mixture for soil fertility enhancement and fodder production

The objectives of this experiment were:-

- To evaluate the residue effects of improved fallow species with litter of different nutrient release patterns in sole and mixed stands
- To determine the residue effects of fallow where the biomass is either removed as fodder or retained in the field

Data generated so far include standing biomass (above ground leafy biomass), root biomass, soil mineral nitrogen (2 metres down the soil profile) and mineral nitrogen dynamics.

Interim results indicated that:

Sesbania yielded more biomass when grown alone than in combination with *Macroptilium*
Macroptilium is more productive when combined with *Sesbania* than when planted as a monocrop
Macroptilium is a better suppressant of weeds than Sesbania

D Diversification of tree species for biomass transfer m Western Kenya

Previous work in Western Kenya showed that *Tithonia diversifolia* had a potential of improving crop yield when applied as mulch material. To compensate against over reliance on a single species, for instance, in case of disease and pest outbreak, it is imperative to screen other species that have the same utility as *Tithonia so* as to sustain the technology. In order to achieve this objective, an experiment was set up to compare several tree species/shrubs as possible mulch material and to determine their effect on crop yield. The treatments in this experiment comprised *Tithonia diversifolia, Acanthus pubesense, Veronia holstii, Buddlefia davidii,* inorganic fertilizer and animal manure. All these treatments were with and without Phosporus.

Preliminary results for one season indicated that Veronia *holsf is* a possible replacement of Tithonia diversifolia for biomass transfer as the two resulted in similar performance in maize growth and were superior to the other treatments.

D Hedgerow intercropping for soil fertility improvement

The objective of this trial was to assess the feasibility of using leaf pruning of Calliandra calothyrsus and Leucaena leucocephala as a nutrient source for crop production. This trial established in Embu in 1992, was concluded in 1999.

Results of several seasons showed that the application of Leucaena leucocephala biomass supplemented with inorganic phosphorus was a sustainable soil fertility management option. Calliandra calothyrsus was found to be very competitive with the maize crop. During the 1999 cropping year, a nitrogen dynamics study was superimposed on this hedgerow experiment with an objective of assessing the mineral N movement in the soil during the cropping season. The results indicated that the mineral N moved down the soil profile as the season progressed, accumulating in the deeper soil horizons. Treatments comprising of tree hedges accumulated less mineral N in comparison to no tree hedges indicating the important role of trees in preventing N losses through leaching.

D Calliandra calothyrsus microsymbiont research

Research on C. calothyrsus microsymbiont association is one of the strategies being developed to enhance soil fertility under agroforestry systems. The research on C. calothyrsus began in 1984 in collaboration with other partners namely; International Centre for Research in Agroforestry (ICRAF) and the Kenya Agricultural Research Institute (KARI). Calliandra calothyrsus, is now widely cultivated in the central and western highlands of Kenya. Zero-grazing dairy cattle farmers around Mt. Kenya and other parts of Kenyan highlands grow the species on their smallholdings as a high protein fodder supplement. In the western highlands, where soils are highly acidic and deficient in phosphorus and nitrogen, farmers inter-crop it with other food crops. Other agroforestry technologies in which the species is used include fodder bank, biomass transfer and short-duration improved fallow.

However, very little attention has been given to improve quality and productivity of C. calothyrsus through enhancement of its symbiotic status with Rhizobium and mycorrhiza, especially in under impoverished tropical soils. Whereas research has been undertaken to improve biological nitrogen fixation of many leguminous trees and shrubs used in agroforestry, this is the first time that special emphasis has been placed on microsymbiont research of C. calothyrsus in Kenya.

The main objectives of Calfandra microsymbiont research were to:

- Collect and preserve microsymbiont culture collection for C. calothyrsus,
- Develop effective Rhizobium and Mycorrhiza inoculants for use by small scale farmers;
- Improve the fodder quality and productivity of C. calothyrsus
- Improve soil fertility and stability, especially on the slopes in the highlands (soil conservation);
- Develop appropriate protocols for on-farm inoculum production and utilization; and
- Establish seed orchards of productive provenances of C. calothyrsus.

Results of the work so far indicate that:

- There is high diversity of indigenous microsymbionts compatible with C. calothyrsus. Rhizobial population sizes vary from site to site, and range from 2 to 4 $x\ 10^5$ cells g^{-1} of soil. The population sizes appear to be influenced by the type of vegetation/crop cover. Sites having some history of C. calothyrsus cultivation generally harboured large compatible microsymbiont population sizes.
- Indigenous Rhizobia nodulating C. calothyrsus are fast-growing types.
- There is substantial genetic variation in nodulation and nitrogen fixation potential between C. calothyrsus provenances.

B. Fodder production and utilization

Natural fodder supply in Kenya for the smallholder farmer is usually inadequate in quantity and quality especially during the dry season. Farmers have therefore adopted more intensive systems of livestock production based on locally available resources which tend to be low in protein. High protein concentrates such as bone meal are expensive for the small-scale holder farmers. In an attempt to improve livestock performance without such costly inputs, tree foliage has been proposed as an alternative.

Development of tree fodder species for smallholder dairy

Studies in Embu, on the potential of Calliandra calothyrsus as a fodder crop, indicated that tree fodder is a good alternative for the small-scale farmers. Results indicated that 3kg of fresh Calliandra (1 kg dry matter) could replace a kilo of dairy concentrate without affecting milk production. To avoid over reliance on one species, fodder research in Embu has been expanded to include other exotic and indigenous fodder species.

Research activities include determination of optimum management practices to maximize yield and utilization of dry matter, determination of the nutritive and anti-nutritive value of the species, monitoring their effect on animal production and reproduction performance as well manure quality.

Results from a study designed to determine the effect of dietary inclusion of other fodder species on milk production indicated that dairy meal and Calliandra can substitute each other, while Mulberry (Morus alba), can substitute Calliandra. Cassava leaf hay (*Manihot* glaziovii) was found to be unsuitable.

Dissemination efforts on the use of Calliandra as fodder source for dairy cows in Embu District has been going on since 1993, but targeting individual farmers. In 1996197, the focus of the dissemination efforts was shifted from individual farmers to community groups. As a result, membership of farmers groups and the number of community tree nurseries established, increased. Many farmers have adopted the fodder technology in Embu region.

On-farm research on fodder trees is also being carried out in Muguga with the support of International Atomic Energy Agency (IAEA) and FAO. The main objectives of this project are to;-

- develop a system of using fodder tree legumes as a source of supplementary livestock feed in combination with nappier grass and maize stover, and
- determine the socio-economic impact as affected by use of fodder trees to improve livestock production strategies

In 1998199 contact farmers within Muguga, Kikuyu Division established Calliandra calothyrsus and Leucaena *diversifolia* seedlings on their farms. The survival of these seedlings ranged from 60% for those planted in existing nappier plots to 90%, for those in other niches such as external and internal farm boundaries and as pure stands. A survey carried out in 1999 indicates that farmers lacked information on propagation and management techniques of the two species. This contributed to the low adoption of fodder trees.

C. Wood and fruit tree research

Wood research

The objective of this research is to increase the production of fuelwood, poles, timber and fruit, thus increasing the domestic supply and cash income of the rural households.
Research activities include species selection, trials on planting density and arrangement on farms as well as provenance evaluation. In the eastern part of the country Grevillea robusta is a very important agroforestry tree as shown by the widespread domestication on farms. Unfortunately, the genetic variation of the planted stock at the moment is of a narrow base. Work on provenance trials to broaden the genetic base showed that Guy Fawkes, Albert River and Rappville provenances performed better in comparison to the local provenances, namely Gaturi South and Rift Valley.

A common niche in the Kenya highlands where upper storey trees are grown for poles and timber is the farm boundary. The main reason for this preference is the relatively small land sizes. The economic feasibility of growing the trees in the fields depends on the value of the trees and the interaction with neighbouring crops. Thus, it is imperative to improve our understanding on the mechanism of competition and complementarity in order to predict production characteristic of such a system. Work in western Kenya to determine production of crops and timber tree growing in boundary with and without Phosphorus replenishment, showed that Eucalyptus grandis grew tallest in response to P application. Markhamia lutea (the only local species tested) showed the lowest growth rate.

D Fruit Research

Survey on production and marketing of fruits in the coffee-based land-use system in Kirinyaga and Embu Districts revealed that this is an important component for family nutritional supplementation and for income generation purposes. In these districts, local mangoes are common with attendant problems of negative tree-crop interaction due to the large canopy coupled with the problem of poor marketability. Improved mango varieties have smaller canopies, mature earlier and have a better local and international market. In order to improve the productivity and quality, a trial was initiated in Embu to assess the adaptability and the performance of improved dwarf mango varieties, namely, Sensation, Van dyke, Kent, Tommy Atkins Alfonso, Apple and Haden. On-station results showed that Van dvke and Sensation varieties had the highest fruit production. Sensation variety was observed to suffer from serious attacks by fruit flies and mango seed weevil. As a result, a study was initiated to assess the feasibility of changing the existing stock. Through side veneer grafting technique, Haden and van Dyke have been top-worked with success. The performance of these varieties under different agro-ecological zones and under farmer-management is also being evaluated.

1.1.4 Technology development and transfer

Agroforestry technologies developed on-station have to reach the end users. It is thus crucial to strengthen the link between farmer's (producer's) extensionist, researchers and marketers in the whole process of technology development.

The success of any technology development and transfer depends on active participation of all stakeholders in the entire process of planning, decision-making, implementation and evaluation.

Plate 2. Farmers at Kangundo and other partners in agroforestry R & D getting together.

1.1.5 Collaborators and Partners in the Farm Forestry Programme

Farm forestry is inherently multi-disciplinary in nature. Therefore, it is inevitable that for effective technology generation and transfer of technologies, the programme operates in partnership with a wide range of research extension/development agencies including farmers and NGOs/CBOs. Currently, the programme work closely with the following organizations/projects:- International Centre for Research in Agroforestry (ICRAF), Agroforestry Research Network for Eastern and Central Africa (AFRENA-ECA), Government of Belgium executed through the Belgium Administration for Development Cooperation (BADC), European Union, GTZ, ASAL pigeon pea project of the University of Gembloux, Local universities namely University of Nairobi, Egerton University and Moi university, Kenya Agriculture Research Institute (KARI), International Atomic Energy Agency (IAEA), NGOs and CBOs working within the various regions, Forest Department (FD), Leicester UniversityUniversity of Dundee, Centre for Ecology and Hydrology (UK), CIRAD-Foret among many others.

1.1.6 Conferences and workshops attended

Conference Title	Dates and Venue	Participants
The 8th International Congress of the African Association for Biological Nitrogen Fixation	November 22-27, 1998, South Africa	David Odee
The First National Symposium organized by The Kenya Society of Microbiology	April 15-17,1999, Nairobi.	Jacinta Kimiti
10th ISCO Conference at Purdue University	May 20 - 28,1999, U.S.A.	Jane Mugwe and Paul Tuwei
The Darwin Initiative Project	February 11-1st March, Ghana	John 0. Otieno
Symposium on recalcitrant seeds	October 7-21,1998, Malaysia	William Omondi

1.2 NATURAL FORESTS RESEARCH PROGRAMME

1.2.1 Introduction

The main objective of natural forests conservation and management are to conserve soil, water, biodiversity and to exploit in a sustainable manner, the productive potential of these forests. Kenya's natural forests which cover an estimated area of 1.2 million hectares have been over exploited, degraded and are currently not managed sustainably. Limited research has been done to provide information needed to guide the conservation and management of natural forests.

Research focuses on policy issues, economic valuation and quantification of forest conservation, creating better understanding and appreciation of wood properties, monitoring regeneration and growth development of rehabilitation techniques and provision of information to enhance biodiversity conservation. To improve productivity per unit area, methods for enrichment of degraded forest stands have been tested and verified. Methods for restoration of cleared sites using indigenous tree species in mixtures have been tested and demonstrated.

Permanent sample plots in natural forest stands have been established and monitored over the years. This has provided a better understanding of the development and succession processes in several representative forests. Concerns on conservation and use of unique indigenous ecosystems mangroves, bamboo and threatened tree species have been addressed through several research protocols and tools. Impact of human activities on many forest formations and ecosystems have been studied in representative forests and sites.

Research in development efforts have also been directed to search for suitable approaches to enhance participatory management, conservative and sustainable use of representative indigenous forest mainly in partnership with forest adjacent local communities.

Results of research and development initiatives in natural forests have greatly helped in the formulation of relevant sections of the new forest policy and law. Guidelines have also been provided to enhance the sustainable management, conservation and use of the natural forests in Kenya.

In pursuit to fulfill its mission of providing information for the development and implementation of sound and just forest policy on conservation, management and utilization of natural forests, the programme will endeavor to enhance the delivery of its research results. This is the vision which we intend to achieve for a well managed natural forest resource.

1.2.2 Research Focus

The objective of Natural Forests Research programme as identified in the Strategic Plan (1999-2004) is to enhance the conservation, management and sustainable utilization of the natural forest in Kenya. Research in natural forests is therefore mainly focused on the improvement of natural forest productivity, strategies to improve policy in natural forest management, methods of forest rehabilitation and development of technologies which encourage the planting of indigenous tree species for the production of several highly valued timber and non-timber products. In order to successfully address these concerns, community and farmer friendly approaches will be used.

1.2.3 Research and Development Activities

Research and development activities which were undertaken by the programme during the report period can be divided into the following:

- Policy and legislation
- Valuation and costing
- Restoration I Rehabilitation
- Management
- Products development and Diversification of utilization.

1.2.3.1 Policy and Legislation

IFRI Research Project

The International Forestry Research and Institute (IFRI) is an international research programme whose objective is to reduce the deforestation of tropical forests.

The main focus of the programme is the analysis of both human and natural causes of deforestation and how these factors can be analysed, understood and used as means of reducing deforestation.

The programme is implemented in 21 countries across the tropical world with its headquarters in the USA.

The Kenyan programme collaborates with similar ones in Uganda and Tanzania. Using the IFRI protocols and tools work was done in the Mt. Kilimanjaro forest - Loitokitok forest station.

The major finding of this work was that due to lack of appropriate forest policy and legislation, the forests were being destroyed due to human activities such as charcoal burning, harvesting poles, pit sawing and grazing. The local communities indicated their readiness to participate in the protection of the forest if appropriate mechanisms were put in place.

Piloting of Joint/ collaborative forest management strategies

In a world where government resources are dwindling, allocation of funds for natural forest policing has been reduced to an extent that the forest departments are not able to control the utilisation of the nations forest resources.

The Forest Department has taken steps to address this issue through the establishment of two pilot areas. These are, Mt. Elgon and Arabuko Sokoke forests. In both areas Natural Forests Programme worked with the project implementation agencies to develop structures and mechanisms to institutionalize joint/ collaborative forest management in Kenya.

The major findings so far are that:

Lack of institutions for joint/collaborative forest management implementation,

Existence of shortcomings in both the policy and legislative instruments which do not support the joint/ collaborative forest management approach, and

- Lack of awareness on expectations of communities expectations in terms of responsibilities and rewards acruing from this approach to natural resource governance.

1.2.3.2 Valuation and costing

The determination of the correct value/ worth of any resource is necessary for the development of correct strategies for its management.

Natural forest resources have suffered a lot from under valuation to the extent that forests in Kenya have often been destroyed ostensibly, to create space for development.

During the report period, the programme started developing linkages with the University of Nairobi, Department of Planning and Human Settlements; Moi University's Department of Forestry and potential donors. The purpose for these initiatives are to develop both long and short term studies targeting some sample natural forests for valuation studies.

(a) Economic Analysis of Forestry Resource Values to Local Communities around Kakamega and Ntugi - Kijeje forest reserves

This was a case study of the two forest reserves in Western and Eastern Kenya. The study had three specific objectives:-

To estimate the net economic value of forest resources at the local level and demonstrate its importance to local economic needs of the people;
To illustrate that the unaccounted forest values are significant; and,
To propose policy measures that seek to account for local forest values.

The main conclusions from this study were that:

Forest resources had substantial values for local communities although presently such values remain unaccounted for;
As a tool for planning, financial analysis of forest resources may be inappropriate at the local level while economic analysis on its own is inadequate;
Local level forest utilization is perceived as an integral part of livelihood system and therefore, efforts to assess its value require an integrated approach.

(b) Natural Resources Conflicts Management: A comparative study of Uganda's fisheries and Kenya's Forestry Sectors.

This study was carried out to address the following four objectives aimed at stimulating interest in the conservation of the two natural resources:-

To determine the nature and extent of conflicts prevailing within Uganda's fisheries and Kenya's forestry sectors;
To determine and understand the proximity and ultimate causes and sources of conflicts within the two sectors;
To draw lessons on how past conflicts have been managed or resolved; and,
(iv) To draw recommendations on effective natural resource conflict resolution and management strategies.

The main observations/conclusions from this study were:

Conflicts are aggravated by both actual and perceived resource scarcity and the inevitable struggle for the various stakeholders to gain access to and control over these resources;
Resolution of conflicts over natural resources ownership, access and use require innovative management approaches which take into account appropriate economic, technological, political and social institutions that enhance the desire for the local communities to satisfy their socio-economic needs;
Such approaches need to provide a policy environment that would encourage strategic engagement of all stakeholders in the resource management regime; and,
In order to resolve natural resource conflicts between the local communities and the state, there should be a deliberate policy to enhance the capacity of the communities to effectively negotiate for his/her interests/stakes in the resource.

1.2.3.3 Restoration and Rehabilitation activities

Restoration of degraded natural forests

The Nguriunditu Valley forest restoration activities which stated in 1994, continued during the report year. Upto now, all the 200 indigenous tree species which have been planted are doing very well. Some species like *Brachylaena* hullensis and Vitex keniensis were thought to have no potential of doing well in this site have demonstrated excellent growth rates and form.

Early observations on the valley conditions have shown improved moisture retention and increased biodiversity.

Regeneration and succession studies

Work on regeneration and succession continued in three sites during the report period.

Kikuyu escarament

A natural succession study was started in Kwarigi block of Kikuyu escarpment forest in 1996. The results of the investigation indicate that the dominant species include Allophyllus *abyssinicus, Macaranga Kilimandishchorica, Neobutomia* macrocalyx and *Psychotria tractinervata.*

Grazing and tree poaching are major factors affecting regeneration and succession in the forest. It is therefore important to develop a management plan with the people so as to control these activities.

. Impact of grazing on regeneration of important indigenous trees

This study was started in 1996 and it is located in Lari forest of Kikuyu escarpment. Observations during the report period have shown that the regeneration of Olea uropea spp. africana is most affected by grazing and browsing. Other threats to this forest include production of charcoal and tree poaching.

In situ' regeneration of Ocotea usambarensis

The study explored the ability of Ocotea usambarensis roots to sprout after exposing them to sunlight. This is important because the natural regeneration rate of the species is very low necessitating the need for artificial regeneration.
Generally, exposing the roots to sunlight accelerate the rate of sprouting both by the stamps and the standing trees.

Forest regeneration

A study to investigate the regeneration of parts of Arabuko Sokoke was initiated in 1986. During the report period, condition of regenerated parts looked good but to ensure that this is sustained, management plan is required which will determine the rates of exploitation by the local communities.

1.2.3.4 Management

Two major developments were undertaken involving forest management strategies.

One strategy was to revive the development of management plans for specific forests; and involve more stakeholders in the management of sample natural forests. The work has progressed slowly. Areas where activities have been started are in Mt. Elgon, Mt. Kilimanjaro, Gwasi, Migori Riverine, Gogo, Mt. Blacket, Kedowa and Homa Hills forests. Investigations will continue for the next ten years.

1.2.3.5 Products development and diversification

D Economic analysis of the Bamboo sector

Bamboo is a multipurpose resource which is used as a source of the following

- Food (Bamboo shoots)
- construction material (bamboo poles)
- handicrafts (poles)
- ornaments (poles)
- firewood (poles).

The production and utilization of bamboo is still not well developed in Kenya. Often, the resource has been used for a wrong purpose and wastefuly.

During the report period, a project to assess the bamboo sector's contribution to the national economy with a view to diversifying its utilization was started Results from this initiative will be discussed next year; indications are that, there is a great potential for bamboo production and utilization as an alternative to the tree resources in the country.

D Domestication of High value *forest products*

A natural resource, *Mondia* Wytei has potential to alleviate poverty through its use in the health care of humans and animals. Its potential for domestication when exploited will enhance farm forestry especially in Western Kenya.

A study carried out in Western Kenya found out that:

- The plant is used both at commercial and subsistence levels
- The current exploitation rate of the plant is not sustainable
- Some people depend on the plant as a source of livelihood
- The plant has a potential to be used in both health and food industries
- Farmers have started domesticating the plant.

From the above preliminary findings, it is important to take the following actions:

- Urgent conservation measures should be initiated.
- Rural/ local communities must be involved in the conservation measures.
- Appropriate technologies for processing should be developed.
- Certification and market procedures should be developed to promote the conservation and utilization of the shrub.

D Germplasm conservation of some indigenous tree species

Conservation of plant genetic materials is an important step towards ensuring the conservation of the tree and forest resources. During the year activities were carried out to develop new projects and complete on-going projects.

(i) IPGRI/DANIDA Project on recalcitrant and intermediate seeds.

The project, initiated in 1996 was the result of a global evidence that effective conservation and large scale use of a number of socio-economically important tree species is hampered by inadequate seeds handling and storage methods.

To improve the sustainable management of forests and the conservation of Biodiversity, the project aims at:-

Developing effective techniques to handle and store a number of economically valuable tropical forest tree seeds;

- Improving the basic scientific knowledge on recalcitrant and intermediate seeds.

1.3 DRYLAND FORESTRY RESEARCH PROGRAM

1.3.1 Introduction

Kenya's drylands cover about 80% of the land area. These have been classified into four agro- ecological zones on the basis of Thorn Waite Moisture Index ratio of precipitation to potential evapo-transpiration) The four zones are: subhumid (zone iv), semi acid (zone v), acid (zone vi) and very acid (zone vii). The major challenge facing drylands is that of desertification brought about by interplay of several factors. Amongst these are

Scarce and unreliable rainfall, and for some areas poorly developed soils which contribute to low productivity.

Frequent droughts, which pose a challenge to survival in the drylands.

Population increase in the drylands. The increase is both internal and external with the former occurring within the ¡ndigenous population brought about by improved life expectancy and reduced infant mortality resulting from ¡mproved health services. External influences are the result of migration from high population density areas into the drylands.

Changing lifestyles, especially a shift towards sedentarization.

Land tenure issues which could be seen at two levels - traditional communal ownership and extensive pastoralism which is under threat from increasing population on one hand and land privatization and accompanying resource use conflicts on the other.

1.3.2 Research Focus

The objectives of Drylands Forestry Research Programme, as identified in the Strategic Plan (1999-2004), are to place the woodlands, wooded grasslands and bushlands under effective management, to develop technologies for improving the utilization of forest products, monitor trends in vegetation changes, document traditional knowledge, ¡dentify drought and pest resistant trees and generate information needed for policy formulation.

1.3.3 Research and Development Activities

Research during the reporting period could be classified into three categories as follows;

- Adaptive Research
- Conservation and Reforestation of the Drylands
- Management and Utilisation of Dryland Resources

1.3.3.1 Adaptive Research

D Social Forestry Extension Model (SOFEM) Project

SOFEM represents the major activity in this category. It is a five-year bilateral project between the Governments of Kenya and Japan. The project is implemented by KEFRI and FD with support from Japan International Cooperation Agency (JICA). It was launched in November 1997 and is expected to end in October 2002. The goal is to equip inhabitants of semi-arid Kenya with appropriate technologies for planting and managing trees under dryland conditions using Kitui District in Eastern Province as a pilot district.

To achieve this goal, the project has four components;

- Technology development (on station) - for experimenting and developing practical techniques of establishing farm forests at pilot level,
- Technology development (on farm) - for verifying proven technologies with farmers i.e. adaptive on-farm research,

- Farm forest establishment (extension) - for production of various guidelines based on information generated and demonstration of various packages among selected farmers, and
- Information Dissemination

Technology Development (on Station)

Two establishment and management experiments were carried out:

1. Studies on establishment involved soil moisture and evapo-transpiration. The purpose of soil moisture studies was to determine the effect of different soil moisture levels of growth of plants. A new set of equipment which automatically collects, stores and retrieves data by means of a criox logger and was installed to replace moisture point probes. Collection of data is continuing.

   The purpose of evapo-transpiration studies is to examine the effect of evapo-transpiration on water consumption and sap flow in *Senna* siamea trees. Equipment that measures tree transpiration rate by heat pulse velocity methods was installed and collection of data is continuing.

2. Studies on management focused on the effect of weeding, pruning and coppicing trials on growth and survival of *Senna* siamea. A weeding trial was established on a plot planted in 1995 and comprised clear weeding and slashing. Interim results showed that clear weeding produced better performance as indicated by survival rates and height growth compared to slashing.

D Technology Development (on-farm)

On farm experiments were established on farms of three farmers who were selected in the first year of the project. Three technologies were established on each farm;

- Water harvesting techniques - The V and W water catchment structures. Controls were prepared. Grevillea robusta was planted as a test species

  Site preparation techniques - Involved use of ox plough, hand tilling and control. Melia volkensii was planted as the test species

  Hole size testing - Using (20x20) cm, (45x45) cm and (60x60) cm holes. Melia *volkensii* was planted as the test species.

Farm Forest establishment (Extension)

A total of six farmers were selected from the former Social Forestry Training Project Phase II (SFTP II) and a profile survey conducted to collect information on size of the farms, households, activities undertaken by the farmers, farmers preferences in tree planting, among others. Various designs of farm forests were carried out on the farms in joint consultation/participation with the farmers. Items considered were planting site, establishment and management techniques, species choice and procurement of seedlings, among others. Monitoring of the established forests and collections of data is continuing.

Nomination of second group of 90 target farmers was done in June 1999 using a farm forest establishment guideline. A final selection of 31 farmers was made from the initial list.

Meanwhile, improvements on a demonstration farm forest model (Demo II) was started to promote the use of low cost and ecologically sound and sustainable farm forestry techniques for mitigating against food insecurity

Extension method and information

This component aims at developing appropriate extension methods in the ASALs based on experiences accumulated from the project and elsewhere. The main activities are:

- Clarifying information flow among implementing institutions and preparation of a guideline for information activities within SOFEM. These activities are almost complete.

- Collection and analysis of publications on social forestry extension activities aimed at extracting useful information for compilation of extension messages. The activity is in progress.

1.3.3.2 Conservation and Reforestation of the Drylands

Two projects - Embu Meru Isiolo 2 (EMI 2) and the Desert Margins Programme (DMP) were undertaken.

(a) Desert Margins Programme (DMP)

The DMP is an eco-regional programme that was implemented in 1997 in nine African countries and involves eight Consultative Group on International Agricultural Research (CGIAR) and affiliated centres, National Agriculture Research Systems (NARS) and NGOs active in the African Semi-Arid Tropics. International Crops Research Institute for Semi-Arid Tropics (ICRISAT) is the convening centre. The primary goal is to contribute to sustainable food security and poverty alleviation in the desert margins through promotion of innovative and action oriented dryland management research, which mitigates against land degradation.

Kenya's component which is also being implemented by Botswana and Burkina Faso is focussing on bench mark sites characterisation where bio-physical and socio-economic data is being gathered for the development of relevant technologies and policies for intervention. It is supported by funds from International Research Development Center of Canada (IDRC).

Two bench mark sites with contrasting bio-physical and land-use characteristics have been selected based on the presence of two main implementing institutions (KEFRI and KARI):

Lopur near Kakuma is within Tarach riverine forest in Turkana District. The area is heterogenous in canopy and fairly undisturbed. It has a settlement and both agricultural and livestock activities are evident. Close to it are Kakuma refugee camps. The site is therefore experiencing increasing population and pressure to meet increasing demands. KEFRI is coordinating studies on the site.

(ii) Kargi near Marsabit town is a man-made desert in Marsabit District. Severe deforestation and land degradation has taken place because of settlements around the market. KARI is coordinating studies on the site.

A PRA has been carried out at Lopur and a community action plan prepared based on 14 identified activities. A village environment committee, a forest nursery and support to alternative sources of livelihood through agriculture have been initiated and their performance are being monitored. An inventory of the vegetation has been carried out (during the rains) and data is being analysed. Assessment of crops and livestock is planned.

A sensitization workshop with the community on range rehabilitation techniques has been carried out at Kargi. The level of awareness is low. Eleven issues were raised by the community requiring attention.

(b) Embu Meru Isiolo 2 (EMI 2)

EMI 2 refers to an assessment of forestry trials established in Embu, Meru and Isiolo Districts by the former Embu Meru Isiolo project. These trials were established between 1983 and 1990 at 9 different sites in the dryland areas of the three districts. The overall objective of the project was to test the adaptability of the species/provenances (indigenous and exotic) on different sites in the drylands and the effect of land preparation on their performance. The project came to an end before final analysis was carried out.

The objective of EMI 2 was therefore to assess the performance of the tested species in terms of survival and growth (height and diameter) as a means of evaluating species adaptability and potential to provide desired products. The assessment was carried out in early 1999, some 9-16 years after initial establishment. The study was undertaken by KEFRI under contract from Belgium Administration for Development Corporation (BADC) through

technical supervision by District Forestry Development Programme (DFDP). Data generated will provide technical support for forestry projects working on afforestation/reforestation in the drylands of Kenya.

The assessment was planned in two phases. Phase 1 involved data collection where height and diameter were measured and described. Volumes were computed from these parameters where applicable. The present tree stock was also recorded for determination of survival. The second phase consisted of forestry management and training based on the findings of Phase 1. Management involved pruning and thinning of the trials where farmers and schools were trained on pruning and thinning techniques.

Results

It was not possible to assess adaptability of several species and provenances across sites because such an objective was not included in the initial design with respect to species representation and replication in treatments. Species screening was therefore narrowed to those having great potential in specific sites. Using a survival percentage of 40% as cut-off for adaptable species and above average growth potential, the following exotic species were identified for different dryland sites of Embu, Meru and Isiolo; Eucalyptus camaldulensis, E. microtheca, Acacia auriculiformis, A. safcina, P. dulle and Senna atomaria. Melia *volkensf* was the only indigenous species found to be widely adapted to the drylands of the three districts. However, lack of bio-physical baseline data on most of the trial sites limits adaption of present findings to other sites.

A total of five trials with good survival and growth performance have been reserved as demonstration sites on dryland forestry afforestation. They will also serve as sites for training in pruning, thinning and coppicing. Meanwhile data generated is being compiled into a technical note for use by projects working in the drylands.

1.3.3.3 Management and Utilization of Dryland Resources

Three projects were carried out under this category

(a) Community Conservation and Utilization of Dryland Resources: The case of Mukogodo forest reserve and adjacent rangelands, Laikipia District.

The overall objective is to involve local communities in the promotion of an alternative source of livelihood a conservation sustainable management and use of vegetation resources aimed at reducing over-dependence on livestock production system and consequent effect on land degradation (and hence desertification). The first step involved a review and documentation of the existing vegetation resources in relation to different uses by the community. A total of six studies were carried out with four of them involving the active participation of local pastoralist farmers. Phase 1 of the project was carried out between May 1995 and April 1999 and was a collaborative project involving Semi Arid Rural Development Programme (formerly Applied Research Unit of ASAL Laikipia), KEFRI, World View Kenya (a locally based NGO) and the local community.

Highlight of the results *of* Phase

- Mukogodo Division comprises of three main vegetation communities; a dry upland forest (Mukogodo Forest Reserve), bushland and bushed grassland. All these vegetation types are used by the community to varying extent and are also home to a variety of wildlife.

- A survey of the indigenous knowledge and participatory inventory revealed a total of 156 plant species of value to the local community. The plants were classified into seven major use groups for which outreach materials have been prepared. Three predominant uses of the vegetation include fodder (all and dry season), medicines (human and livestock) and cultural attributes (construction and religious/festive symbolism).

- Preference for some plant species for a variety of uses is exerting pressure on available resources. Also increasing population (human, livestock and wildlife) and the shift towards sedentarisation among some members of the community is contributing to resource use conflict, which is manifesting itself in land degradation.

- The opportunities identified in the development of alternative livelihoods and the urgent need to mitigate against land degradation is the focus of phase 2 "Towards Community Conservation and Sustainable Management of the Forest Reserve and Adjacent Rangelands".

(b) Indigenous knowledge system underlying the management and use of tree fodder resources in Kajiado District, Kenya

The project's overall objective is to document indigenous knowledge among the Maasai's of Kajiado District in the use and management of tree fodder resources with the aim of developing intervention strategies that are responsive to local needs. It involves carrying out baseline and household surveys as well as inventory on tree resources. The project is for two years and is a grant by Research Programme on Sustainable Use of Dryland (RPSUD). The project was started in April 1999.

Baseline and household surveys have been conducted. Preliminary results show that

- Land tenure is rapidly changing from communal to individual ownership. Average acreage per family in Mashuru Division is 274 acres.

- The economic mainstay of the Maasai's of Mashuru Division is still predominantly on livestock production. Cattle, sheep and goats are the main animals kept. Donkeys represent a small fraction and are used mainly in transporting luggage. An increasing number of households are keeping improved cattle while some are practising agriculture on a small scale.

To cope with harsh environmental conditions, they have evolved elaborate livestock management system of utilising forage. These include, among others, high mobility (supported by extensive pastoralism though this is changing with subdivision of rangelands), rotational grazing (wet and dry season) combined by setting aside of special grazing reserves (olopololis/olalas) by individual pastoralists or hill tops by communities and use of fodder trees during the dry season. The community's knowledge base on fodder is immense. About 75 species are used for fodder with specific species being used by different categories of livestock, for increasing milk production or fattening. All this information will be useful in guiding management decisions in rangeland improvement and future policy issues.

(c) The Economic value of wood carving timber in Kenya

The overall objective is to generate data that will assist in the formulation of a relevant policy in support of sustainable management and use of timber resources for the wood carving industry. The project is a joint collaboration involving UNESCO, World Wide Fund for Nature (WWF) (through the people and plants initiative) and KEFRI. It involves determining prices of selected wood carving species along market chains, quantity and volume of *Brachylaena huillensis* (Muhugu) logs in the market, formal and informal rules of access to carvable wood and taking measurements for modelling investments in *Azadirachta indica* (Neem) and *Brachylaena huillensis* (Muhugu).

Prices for wood carving species vary according to the geographical location of the market. Timber prices are comparatively highest in Nairobi and lowest along the coast irrespective of species. Ukambani and Central Kenya are intermediate. Prices are higher in Ukambani. Among the species used, *Brachylaena huillensis* (Muhugu) is the most sought accounting for 84%. Studies in other competing uses for the major species, efficiency in utilising the logs and growth of *Brachylaena huillensis* (Muhugu) and *Azadirachta indica* (Neem) are going on.

1.4 FOREST PLANTATIONS RESEARCH PROGRAMME

1.4.1 Introduction

The main objective of the Forest Plantations Programme is to meet the country's demand for industrial wood. However, there are major problems facing the development of forest plantations in Kenya and these include: Inadequate supply of high quality propagation material, low rate of replanting in harvested areas due poor application of silvicultural practices, reliance on a few exotic species which are being threatened by pests and diseases, and inefficient use of wood. These problems have to be addressed if the forest plantations programme has to fulfil its objective.

1.4.2 Research Focus

To address the above problems, future research activities will be directed at improving supply of high quality propagation material, diversification of plantations species, reducing damage due to pests and diseases, undertaking a cost benefit analysis of silvicultural operations and improving wood utilization.

1.4.3 Research And Development Activities

1.4.3.1 Plantation Development

(a) Promotion of Sustainable Forest Management (PSFM) Project

The Promotion of Sustainable Forest Management Project was started in 1994 with the following objectives:

- To strengthen the KEFRI research infrastructure
- To improve the capacity to manage research
- To develop a forest management system
- To improve the advisory services for on-farm and community forestry in Kenya.

The project was implemented by KEFRI and FD in partnership with collaborators from the informal sector through GTZ. During the period of reporting, the project operated on government funds after discontinuation of funding by the German Government.

The project operated under a multi-disciplinary structure with the following main research areas:

Plantation silviculture
Natural Forest Management
Tree Improvement
Tree Stand Assessment
Socio-economics

Several experiments were undertaken during the period of review:

D Optimum sowing density

With increase in demand for seeds for plantation establishment, tree seeds are becoming very expensive and scarce. One way of minimising cost is by using enough seed which will grow to a vigorous planting stock. This can be achieved by determining the amount of seeds to be sown per square metre. A study was started with the objective of determining the optimal sowing density of some of the plantations species: Eucalyptus spp., C. lusitanica and P. patula in high potential areas and Casuarina *equisetifolia, E.* camaldulensis and *E.* tereticomis at

the coast. The experiment started at Muguga in October 1998 and will be replicated in Nyeri, Londiani and Turbo. It will be completed in the year 2000.

D *Effects of* seedling size and pricking out time *on* survival *and* growth in the field

Potted seedlings are usually sown in seedbeds before transplanting into pots. The best seedling size for pricking out varies from species to species. Slow growing species may need more time in the seed bed than fast growing ones, therefore the time taken in the seed bed and the correct size for pricking out should be determined. The objective of the experiment was to determine the effects of pricking time and size on survival and growth of the seedlings. The experiment was established in Muguga, Gede and Londiani in 1998.

Results showed that at Muguga for *E.* saligna, E. *grandis* and *E.* regnans, pricking out should be done when seedlings attain one to two pairs of leaves (3 - 7 weeks). At Gede *E.* camaldulensis should be pricked out with one to three pairs of leaves (3 - 5 weeks), and Casuarina with two to three pairs (2 - 4 weeks). At Londiani pricking out for C. lusitanica and P. patula should be done between 3 - 5 weeks after germination.

D *Effects of seedling size* in the nursery on the growth *of* trees

Seedlings should be planted when they are ready but not when they are too young due to their tenderness or when overgrown as they may not withstanding shock. The objective of the experiment was to determine the age/size of seedlings in the nursery before transplanting to the field. The experiment was started in May 1996 at Muguga. The species used were *E.* saligna, *E.* grandis, E regnans and Acacia *melanoxylon.* The interim results showed that *E.* salgna should be transplanted when they have stayed in the nursery for 5 months, *E. grandis* for 6 months, *E. regnans* for 7 months and Acacia melanoxylon for 5 months. Presently in the highlands, seedlings stay in the nursery for over 9 months before transplanting. This period can be reduced to 6 months, hence save the cost of labour by 3 months. At Gede, it was found that both C. *equisetifolia* and *E.* camaldulensis should be planted after 5 months in the nursery instead of 7 months. The experiment was replicated at Londiani, Muguga, Turbo and Nyeri using different species.

Although the duration of the experiment was supposed to be 3 years, the trial in Nyeri did not do well because of drought, therefore no planting was done. At Londiani, the experiment was burnt down and at Gede, it was destroyed by wild animals. The trial will be repeated in these three sites, while at Turbo, seeds have been sown and seedlings will be ready for next planting season.

D *Effect of* site preparation *and tending on* growth *and* survival *of planted* seedlings

The specific objectives of the experiment were to determine the effect of site preparation and subsequent tending on tree establishment and survival and to determine the costs and benefits involved in various plantation establishment techniques. A completely randomised split plot design was used with two levels. The first level was site preparation methods and the second level was the tending methods. The trial was replicated in Gede, Turbo, Londiani, Muguga and Nyeri Research Centres and the tree species used were C. lusitanica, P. patula, C. equisetifolia and *E. grandis.*

Initial results for Cupressus lusitanica in Muguga (Uplands) at two years of age indicated that mean height growth for total cultivation was 3.7m and DBH was 4.1cm, compared to the control which had means of 2.6m and 2.3cm respectively.

These trials are expected to conclude in the year 2000.

Woodlot Development

The trial was designed to involve farmers in the establishment of on-farm woodlots with the objective of making them self-reliant in major tree products and the surplus for generating income. The second objective was to involve farmers in establishing spacing trials with a bid to finding the most appropriate spacings for different species for the woodlots.

Farmers were recruited on their willingness to plant trees, and readiness to provide land and labour. KEFRI and FD contributed technical know-how and seedlings for the trial. GTZ contributed in terms of capacity building for both farmers and GoK staff.

The trial was established in Muguga, Nyeri, Londiani, Turbo and Gede in 1998. Further planting and recruitment of farmers (total 12 per Centre) was carried out in 1999. The main tree species established were Grevillea robusta, Eucalyptus grandis, E. safgna and Casuarina equisetifolia.

A monitoring and review exercise carried out in August 1999 in Londiani, Turbo, and Nyeri trial site indicated that further plantings and recruitment of farmers was done in all the three Centres.Turbo had thirteen, Nyeri ten and Londiani nine farmers actively managing their woodlot. The level of farmers' participation in decision making in the management of the trees was found to be very high. In Turbo, for instance, some farmers had judiciously embarked on pruning of young Eucalyptus to allow for inter-cropping with annual crops.

The monitoring and evaluation exercise is planned for Gede and Muguga early 2000. Thereafter, monitoring and evaluation will be carried out annually for two years. It is also planned that on availability of funds, open days and field days will be organised in all these Centres to facilitate adoption of the technology by more farmers.

D Polycias kikuyuensis and Polyscias fulva provenance delineation.

The aim of the study is to establish the distribution and the specific locations of the two provenances in the country. The two species are among of the fastest growing indigenous tree species and can therefore be of high economic and environmental importance. Their potentials have not been fully exploited.

Spot check surveys were done in and around Mt.Kenya, Aberdares and Marmanet forests. Results showed that P. kikuyuensis occurs naturally in all the areas surveyed, while P. fulva was only observed in plantations. Where plantations exist, these two species were observed to be growing together but P. fulva was dominant.

Further spot check surveys will be undertaken in Rift Valley and Western regions in February 2000. Phenology studies will continue at Uplands and Kinale forests. Based on spot check surveys, provenance boundaries will be drawn and seeds collected for provenance trials.

D Rooting of Ocotea usambarensis stem cuttings

0cotea usambarensis is classified as endangered due to high exploitation pressure and difficulties in natural regeneration. In order to save the species from extinction, studies on rooting of stem cuttings were initiated. Different rooting media were used and put in a non-mist propagator chamber. Preliminary results showed that a combination of IBA and red soil gave the highest rooting success of 27.5%, while other combinations (vermiculite, sand, vermiculite and sand) registered rooting success of between 6.5 and 13% (Table 1).

Table 1. Number of rooted, dead and unrooted Ocotea *usambarensis* cuttings after 50 weeks

Rooting Media	Red soil	Vermiculite	Sand	Vermiculite & Sand
Initial No. of cuttings	40	40	40	40
Rooted cuttings	11	6	6	3
Dead cuttings	29	34	34	37
Unrooted cuttings	0	0	0	0

D *Regeneration of Ocotea usambarensis through roots: The effects of exposing roots to different duration of sunlight.*

Roots of *Ocotea usambarensis* have been reported to grow to new shoots which often grow into mature trees. This process is not well understood, neither have the possible factors influencing its success studied. This study was on the effect of sunlight on the sprouting ability of the 0. *usambarensis* roots and the subsequent survival. The study was conducted in Uplands forest, Kwaregi block for 16 months.

Table 2. Variation in number of *O.usambarensis* root sprouts with different treatments

	Treatment		
Block	Roots exposed and covered immediately	Roots exposed for 16 days and then covered	Roots remain exposed throughout
Stump 1	0	1	7
Stump 2	1	3	4
Stump 3	3	0	0
Standing tree 4	0	0	1
Standing tree 5	5	3	3
Standing tree 6	0	0	0

Results showed no significant difference between treatments at F 0.5 level. However, the roots which were exposed and left throughout the experimental period produced more nodules which formed. The roots covered immediately and those left exposed for 16 days gave the same response (Table 2). The survival of the sprouts greatly varied from stump to stump probably due to different genetic make up. Most sprouts died after a prolonged drought.

D *Impact of grazing and browsing on regeneration of important indigenous species*

The objective of the experiment was to determine the effects of livestock grazing on regeneration, tree diversity and density. Transects were established and will later be used as permanent sample plots. Monitoring and data collection is still continuing.

D Environmental requirements for successful regeneration *of* some important indigenous tree species

Nursery experiments involving Polycias fulva and Warbugia ugandensis were set up under artificial shading to produce three levels of irradiance. The actual irradiance, Photosynthetically Active Radiation (PAR) was obtained using Infra-Red Analyser (IRGA) and cross-checked with a radiator sensor. The parameters assessed in-situ were expansion, increase in leaf numbers, height and carbon assimilation. The nursery experiments were completed and data analysis and write up are going on.

(b) Industrialised Countries - Developing Countries Cooperation (INCO-DC) Project

This is a regional project funded by the government of Finland. It was started in 1998 and is undertaken by Kenya, Tanzania, Uganda and Zambia. The project has three parts:

- Management of natural regeneration
- Nursery
- Development of models for agroforestry tree species.

D Management *of* Natural Regeneration

In the period under review, a natural regeneration management trial was initiated for P. patula in April 1999 at Lorenge forest within Londiani area, using the prescriptions provided by Marti Varmola of MELTA, Finland. The area was previously under a P. patula plantation, which was clearfelled in 1995 at age 29 years. At the time of clear felling, the stand had a density of 980 stems per hectare.

The mean stocking density of the regenerates was 80,638 seedlings/ha, while the mean height was 1.4 m with a range of 0.98 - 1.82m. These attributes of regeneration were suitable for the management trial. One replicate was established and the first set of thinnings was carried out in April 1999, leaving stocking densities of 800, 1600 and 3200 stems per hectare. Additional replicates will be established in 1999/2000 period.

Nursery

The main task was developing a database on priority species for each country involved in the project according to an agreed format. Sclerocarya birrea, Tamarindus indica, Melia volkensii and Vitex keniensis were proposed for the Kenyan partner. However, phenology and seedling production of V. keniensis cannot be compiled since there are no relevant reports on the subjects. Table 3 summarizes the information to date for all the species apportioned to Kenya.

So far, distribution maps are available for S. birrea and *M.* volkensii. Development of maps for other species is anticipated to be completed before July 2000 to enable use in the development of Expert System Model for species selection and site matching.

Table 3: General Information obtained for the Five Species

Subject	Species				
	A. digitata	S. birrea	T. indica	*M.* volkensh	V. keniensis
General Information		r			
Uses					
Phenology					
Seedling production	\/0	V	'0		X

D Effect of Grevillea robusta on Yield of Maize in Central Highlands of Kenya

Grevillea robusta is a very popular tree species among the farmers of Central Highlands of Kenya where it is grown as a multipurpose tree in small scale mixed farms. The tree is intercropped with maize without significantly reducing the yield of maize. Nevertheless, casual observations in farms densely planted with G. robusta indicate otherwise. A study was carried out during two maize harvesting seasons in February and August 1999. Data was collected for use to model the effects of G. robusta on yields of maize in Central Highlands of Kenya. The objectives of the study were to construct distance dependent models to describe the influence of G. robusta on yield of maize; describe the influence of G. robusta trees to each other; and to optimize management of an intercropped agroforestry system of G. robusta and maize.

Maize yield data (x and y coordinates, biomass, seed source and fertilizer application status) were collected from 2500 mini plots of 1 m x 1 m in 16 G. robustalmaize fields. Tree data (x and y coordinates, DBH and age) were obtained in 18 such fields for about 1000 trees; height, crown diameter and management status stating whether the tree was lopped, for about 100 trees. Data analysis is ongoing.

(c) ***Prunus africana*** project

The project was initiated in collaboration with ICRAF, FD and Kenya Wildlife Services.A National Working Group was formed to set up Kenya's priorities on research and development on Prunus africana The species is a high value medicinal plant and its existence is threatened under excessive exploitation. Although P. africana is still widely distributed, there is need to evaluate the status in its range of occurrence.

During the year under review, a study was started on recruitment of Prunus africana. Results showed that germination is prolific under the canopy and in tea-coffee plantations, but recruitment after germination is the biggest problem and requires manipulations.

Planting in a pure or mixed stand has been successful, but seed production in pure stands has not been very good . Vegetative propagation has been successful but there are limitations with the tissue culture method. Studies have also shown that seeds of P. africana are not fully recalcitrant and when collected just at maturation can be stored for 1 year with little loss of viability. Seed years are followed by low production periods. Studies on disease pathogens of seedlings at nursery stage will be done in future.

The priority areas of research have been identified as follows:

- Evaluation of existing plantations for their security and general performance on growth and health conditions,
- Provenance trials along with the studies on phytochemical and genetic variation
- Determination of current distribution/abundance,
- Marketing of Prunus products,
- Determination of the demand for seeds/seedlings and
- Determining alternative ways of processing to add value to the products.

(d) Comparison of germination rates and desiccation sensitivity of Neem ***(Azadirachta indica)*** seeds from two provenances

The development stage at which seeds attain optimum physiological maturity is very crucial in determining vigour, storability and genetic integrity. The determination of this stage therefore assures that seeds are collected before they are infested by pests, dispersed by birds and deteriorated due to weathering. The determination of developmental and storage behaviour based on provenances would mean that separate methods of seed handling and storage be developed.

Fruits from two Kenyan provenances of A. *indica;* Kilifi (coastal) and Marigat (inland) were collected from the crowns of solitary trees during the peak production period when 50% of the fruits on most of trees had turned yellow. The fruits were divided into two categories; green and yellow to signify two maturity classes. Only fruits that had achieved maximum sizes in both provenances were categorised. The fruits were depulped separately, left for 2 hours at ambient conditions (25 t 2◊C) to allow drainage of excess water after which the moisture content was determined.

Germination tests were determined by removing the endocarps from 100 seeds from each category, and incubated on blotter paper in petri dishes at 28 t 2◊C in a germination cabinet. Germinated seeds were recorded daily based on emergence and elongation of the radicle to at least 1cm length. Vigour index for each category of seeds based on the germination was determined using the formula:

$$\frac{\text{Total number of viable seeds}}{\text{Number of days to achieve maximum viability}}$$

The remaining seeds from each batch were desiccated by placing them in glass jars containing silica gel at ambient temperatures for four days. Moisture content and germination tests were then conducted as for the fresh seeds. The results were as shown in Table 4.

Table 4. Mean weight (gm) of seeds at different maturity stages from two provenances

Seed part	Maturity stage	Kilifi	Marigat
Axis	green yellow	1.1 10.1 1.4 t 0.4	1.3 t0.2 1.7 t 1.5
Cotyledon	green yellow	237 t 11 206 t 18	152 t 13 152 t 15
Ratio: Coty/axis	Green yellow	215 147	129 127

From Table 4, it was concluded that axes of yellow fruits from both provenances were heavier than those from green fruits and those of seeds from Marigat provenance were heavier than those from Kilifi regardless of maturity stage (Table 4). However, seeds from Kilifi provenance were heavier than those from Marigat (Table 4).

Table 5. Moisture content (%) of fresh and desiccated seeds from two provenances

	Kilifi		Marigat	
Maturity stage	Green	Yellow	Green	Yellow
Fresh	48	50	52	55
Desiccated	5	6	6	7

Table 6. Cumulative germination of fresh and desiccated seeds from two provenances

Days	Kilifi				Marigat			
	Fresh		Desiccated		Fresh		Desiccated	
	green	yellow	green	yellow	green	yellow	Green	yellow
1	0	0	0	0	0	0	0	0
2	8	44	0	0	35	59	0	0
3	67	64	0	0	56	80	0	0
4	99	84	0	39	100	100	0	31
5	100	88	49	57	100	100	0	33
6	100	88	82	82	100	100	6	35
7	100	88	85	83	100	100	12	35
8	100	88	92	84	100	100	20	36
9	100	88	92	84	100	100	24	37
10	100	88	92	84	100	100	33	37
11	100	88	92	84	100	100	44	37
12	100	88	92	84	100	100	44	37
Index	20cd	17.6c	11.5b	10.5b	25d	25d	4a	4.1a

*Values followed by the same letters in the bottom row are not ***significantly different, Duncan*** Multiple Range Test.

The results on moisture content and germination rates (Tables 5 and 6) show that

(i) Fresh seeds had consistently higher germination rates than desiccated seeds irrespective of provenance

(ii) There was no significant difference in germination rates between seeds from both yellow and green fresh fruits of both provenances

(iii) The germination rate of desiccated seeds (from both green and yellow fruits) of Kilifi was higher than those of Marigat and whereas there were major differences in germination rates between seeds of both green and yellow fruits from the Kilifi provenance, such differences were not recorded from seeds from Marigat.

(e) Phenological studies

Various phenological studies have been undertaken on Tiichilia emetica and the following results have been obtained:

Flowering pattern: February - March:

Flowers; March - May:

Seed development; June - July:

Seed maturity; August:

Flowers; August - November:

Seed development; December - January:

Table 7: Weight of fruit- seed parts and respective moisture content based on 50 fruit units of Trichilia emetica.

Component	Moisture content
Whole fruit	65.5
Whole seed	56.4
Pulp	76.2
Testa	75.9
Storage tissue	72.3

Germination trial results for Trichifa emetica using Vermiculite in Petawawa boxes, with a temperature regime of 25-30°C, light regime of 10hrs light/14hrs darkness in a germination cabinet (plant growth cabinet) revealed that initial germination commenced about 22 hours after seed collection without seed pre-treatment and initial germination was 21 % when seed had a moisture content of 56.4% after 94 days.

Table 8 shows the effect of desiccation on germination rate. From literature review, low germination results coupled with long germination period are uncharacteristic for Trichilia emetica. This could be due to several reasons: firstly, seed was procured before it was fully mature, and/or, the treatment with captan could have inhibited germination. The seeds were also not given any pre-treatment, indicating that the species requires some form of pre-sowing treatment.

Table 8. Effect of desiccation on germination rate

Moisture content (%)	Germination percentage
56.4	21
44.3	1
32.5	1
23.6	1
15.3	1
11.6	0
7.1	0

(f) Seed Source Selection, Establishment and Management

During the year under review, a multi-disciplinary team of scientists was constituted to select new seed sources of Pinus patula and Cupressus lusitanica from the existing forest plantation within Londiani and Muguga regions. A total of 16 new seed stands were selected in both regions, nine of Cupressus lusitanica and seven of Pinus patula. In Londiani area, P. patula seed stands were selected from Nabkoi 6(B), Buret I(P), Buret, 2(V), Narasha 7(J) and Lalaikmen 3(D), while those for C. lusitanica were from Masaita 7(F), Maji Mazuri 2(D), Kampi Kongoni 4(A), Lalaikmean 1(D), North Molo 5(D), North Molo 4(A) and Surget 10(N). In Muguga area, P. patula was from Kiburu 9(D), and Kamae 7(H) and C. lusitanica was from Kiamweri 4(K) and Kerita 3(A).

By the end of the year under review, thinning operations had already started in Londiani and Muguga region on the newly selected seed stands as per the recommended prescriptions.

New seed stands or seed orchards were not planted during the year.

(g) Seed Quality Testing

Routine seed quality testing continued to be undertaken. The tests include (glasshouse and nursery) quick moisture content testing, purity analysis, weight determination and germination/viability tests. A total of 130 seedlots were tested during the year.

It is planned that new seed stands of plantations species will be selected to enable the Seed Centre to meet the demand for seeds by FD in addition to the establishment of new seed orchards of pine, cypress and eucalypts.

1.4.3.2 INTEGRATED PEST MANAGEMENT

(a) Cypress aphid (Cinara cupressi)

Monitoring Cypress Aphid and its Parasitoid

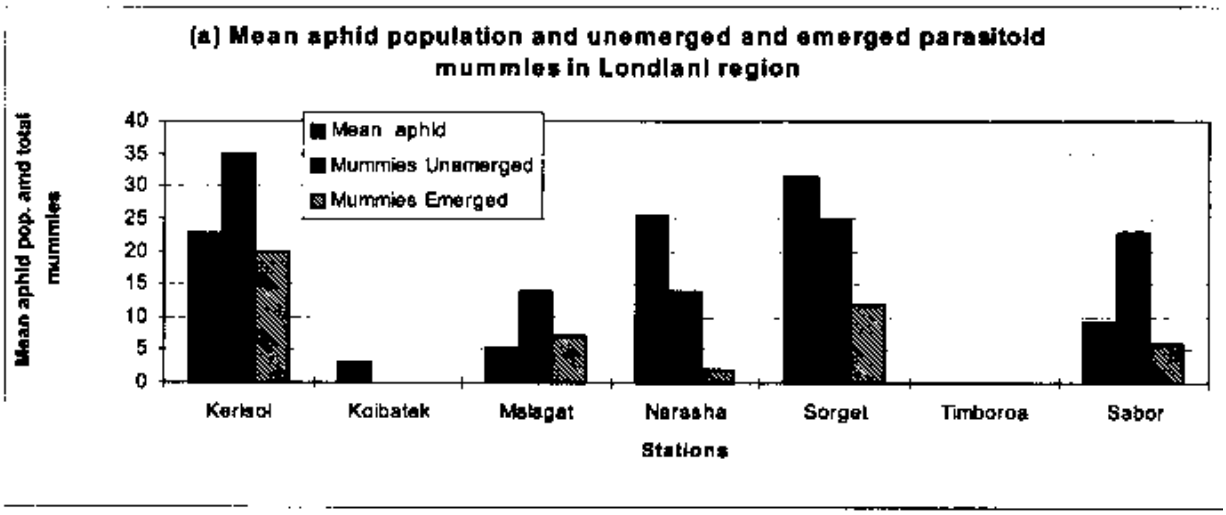
During the period under review, one of the major achievements was the pleasant discovery in mid January 1999 in Londiani area of established exotic cypress aphid parasitoid Pauesia juniperorum which had been released around Kiambu in 1994 to 1996. The parasitoid was discovered around Londiani in cypress plantations. Sample specimens were sent to France and the species confirmed as P. juniperorum which was the identity of the species released during the initial stages of the regional project.

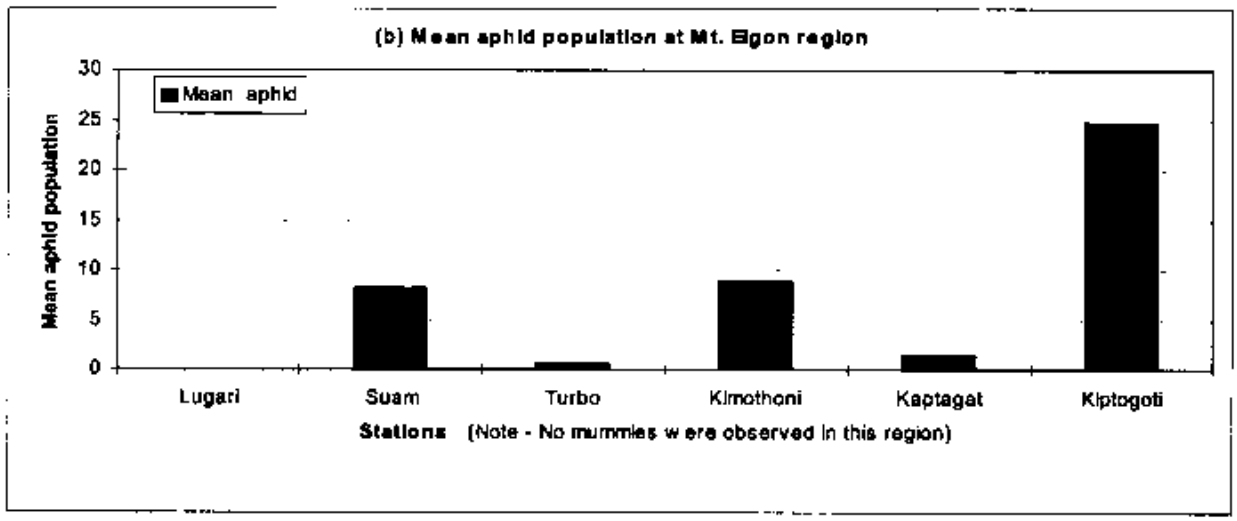
Establishment of the parasitoid may have been due to cooler conditions and the large hectarage in the Rift Valley of the host tree - cypress. This favours survival of a moderate to high aphid population throughout the year and could have resulted in the establishment of this parasitoid after it had been blown by wind to this area.

This discovery necessitated the need to cant' out a survey in major host growing regions of the country in February and March 1999, which included the following activities:

1. Collection of field sample specimens to confirm the parasitoid identity,
2. Identity Determination of the extent of spread and abundance of the parasitoid,
3. Establishment of Permanent Sample Plots (PSP's) for further monitoring of cypress aphid and the parasitoid impact,
4. Assessment of the situation of the cypress aphid population and host damage and
5. Assessment of the possibility of material collected from the field for mass rearing of the parasitoid and release to hasten its spread in the country.

Monitoring for the abundance and spread was carried out using similar sampling method developed during the completed Regional Project published in CABI-ARC Technical Bulletin No.2 - Sampling Cypress Aphid. From the survey data the parasitoid was only found in Londiani/Turbo region and not in Mt. Kenya and Mt. Elgon region [Figures 1(a), (b)and (c)].





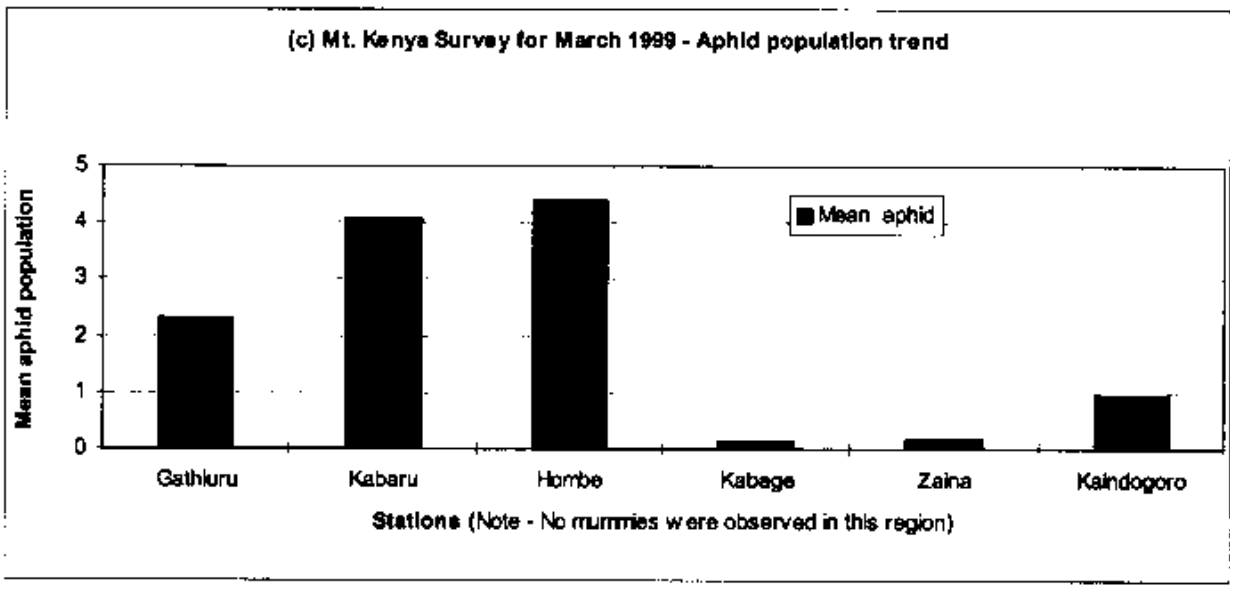


Figure 1 (a), (b) and (c): Shows the mean aphid population and the total number of unemerged and emerged parasitoid mummies after a survey in February and March 1999 in the above mentioned areas.

From the data analysis, the major conclusion is that the parasitoid population is increasing. In all the stations where the parasitoid was found, the number of unmerged mummies was always higher than emerged mummies. This is a sign of an expanding parasitoid population. Most of the trees were in damage category 1 and 2 showing a low aphid damage level in these areas (Figure 2(a), (b) and (c).

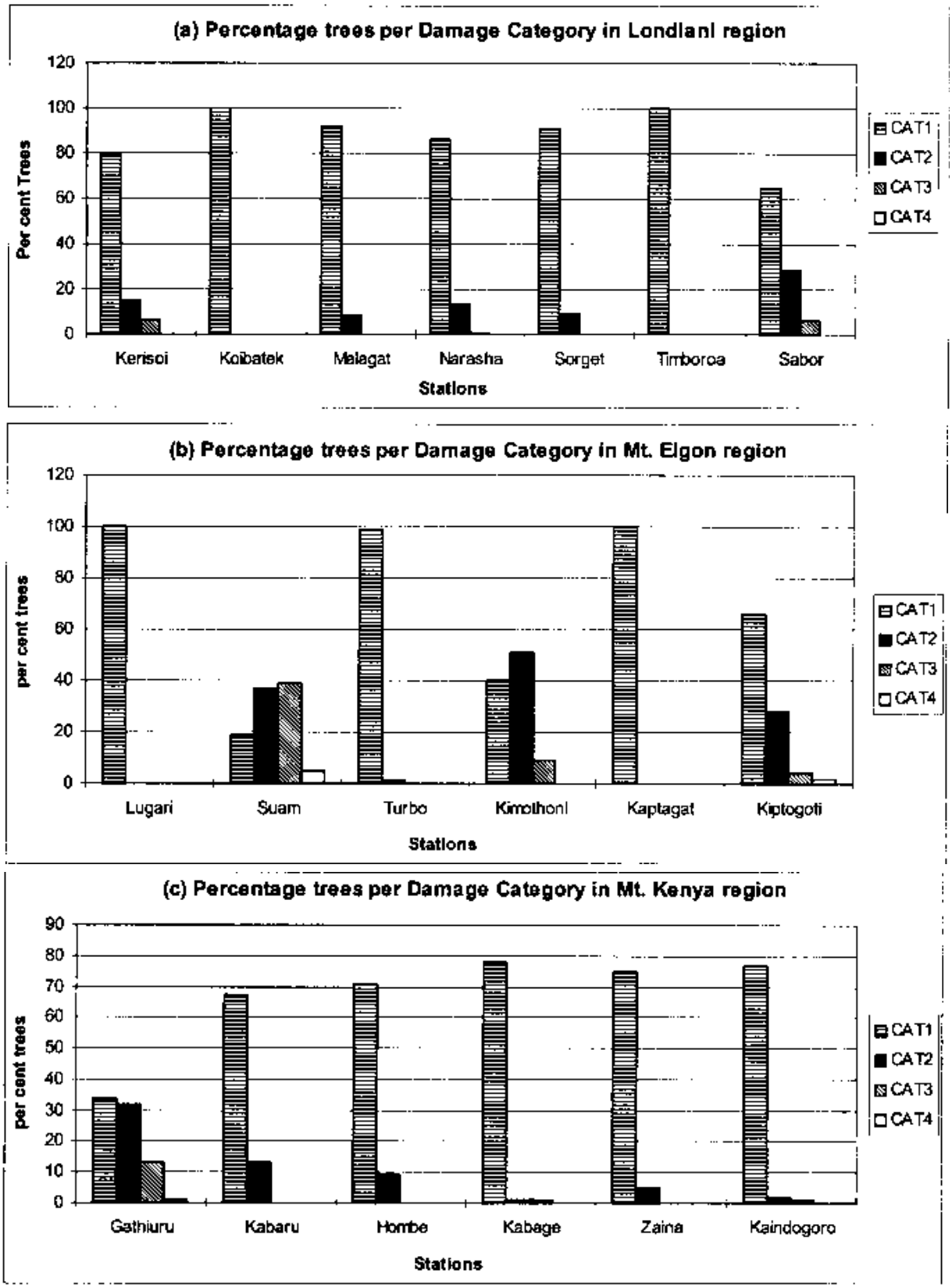
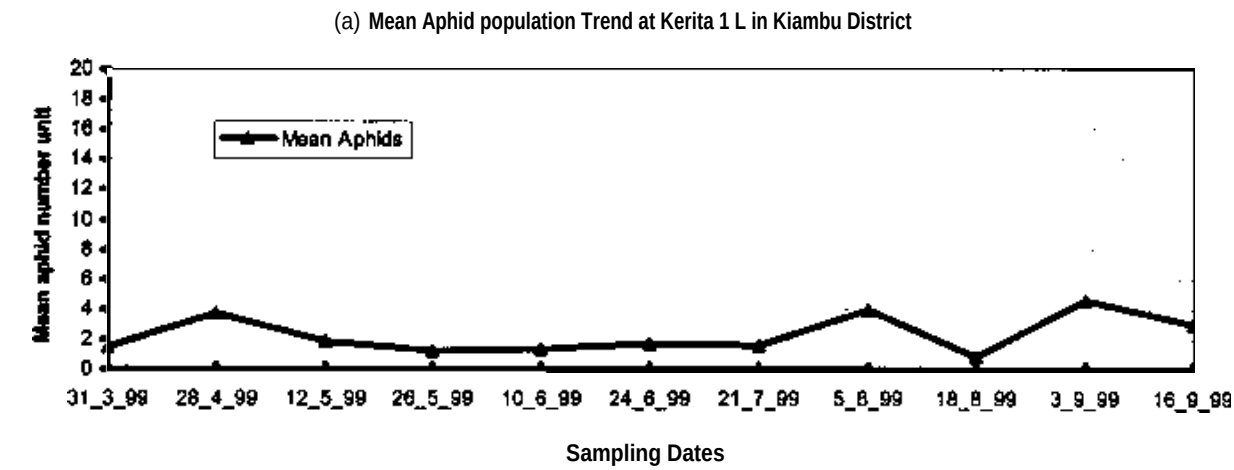


Figure 2 (a), (b) and (c) : Shows the percentage trees per damage category 1-4 in each of the survey regions.

Permanent Sample Plots (PSP's)

After the survey, it was found necessary to establish permanent sample plots (PSPs) in major host tree growing areas (Kiambu - Muguga, Kinale, Kerita; Nyandarua - Kiamweri, Nyeri - Gathiuru; and Londiani in North Molo and Makutano) . The primary objective of the PSP's was to monitor aphid and parasitoid spread and abundance. These PSP's will also provide data and measure the impact of the parasitoid on the aphid in the future. Figure 3 (a) and (b) shows the mean population trend of two selected PSP's.



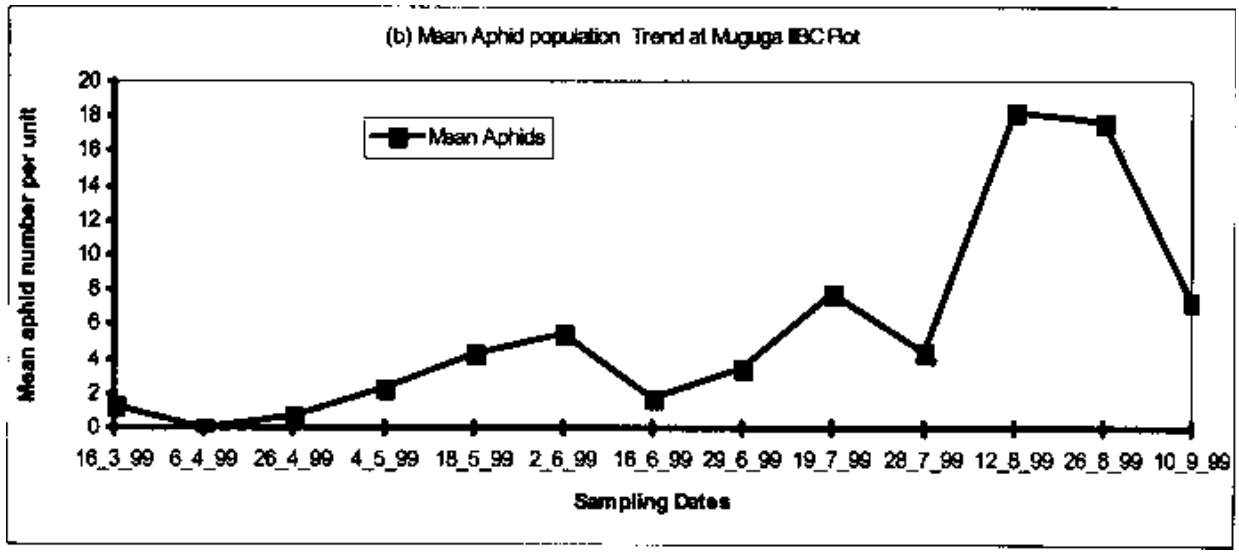


Figure 3 (a) and (b): The mean aphid population trend in two selected PSP's in Kiambu District.

Mass-rearing of Pauesia *juniperorum*

After the discovery of P. *juniperorum* in Londiani region, mass rearing of P. *juniperorum* was started. The rearing was started in February 1999 and was carried out using the locally adapted strain of P. *juniperoum*. Initially, P. *juniperorum* collected from Londiani region was used to start mass-rearing both at Londiani and Muguga insectaries. Later, more locally adapted parasitoid was collected from other regions like Mt. Kenya and used for rearing at Muguga insectary. The main aim of mass rearing was to hasten spread of the parasitoid in all major host tree-growing areas. This will be achieved through releases in certain strategic areas.

(b) Mycorrhiza project

The mycorrhiza research work in Arabuko Sokoke Forest reserve continued during the reporting period. The objective of the study was to collect ectomycorrhiza fungi associated with the selected tree species and carry out synthesis studies in the glasshouse and laboratory.

Three sites were visited in Arabuko Sokoke forest and 2 sites near Gede station. In Kararasha, 12 species of mycorrhizal fungi were collected in the genera *Cantharellus, Russula,* Lactarius, Boletus and Amanita. Similar genera were collected from the Gede site as these sites are dominated by Brachystegia spiciformis and Julbemadia magnistipulata. The dominant species collected in both sites were Amanita *rubescens* and Cantharellus symoensii but *Cantharellus congolensis* was only found in Kararasha. Pisolithus spp. were collected from under both Afzelia *quanzensis and* Eucalyptus camaldulensis trees/plantations. A total of 22 specimens were collected from all sites. Most of the species were isolated into pure culture on modified Melin Norkrans medium in glass tubes. Sporocarps were also dried at Gede using a drier for herbarium curation. Plants inoculated with mycorrhiza are still being maintained in the glasshouse to determine persistence of mycorrhiza types. In vitro synthesis experiments were carried out in the laboratory with some of the mycorrhiza fungi with E *Camaldulensis.*

(c) Black Blister disease of Casuarina

Following reports of attacks on Casuarina by black blister disease, further investigations were carried out in May 1999 at the Coast. Plantations and farms were visited in Malindi and Kilifi. The disease was found at Bofa Beach Camp and a farmer's plantation at Kibarani in Kilifi. It was also found in the international provenance trial of Casuarina and an FD plantation in Gede.

In the provenance trial, the most affected provenances were Ela Beach (PNG), Efate Vanua Levn (Pacific) and Wangetti Beach (Queensland). The disease seems more widespread in both Kilifi and Malindi Districts. It is found in both plantations and farmers' plots. Trees die in patches of plantations although individual infected trees can also be found. Disease symptoms occurred on trees under the bark and also on excavated roots. Drought seemed to be one of the predisposing factors to infection. The mode of spread is suspected to be either aerial or via root contact. The fungus Trichosporium vesiculosum Butler has been isolated from diseased material but does not seem to sporulate. Research is ongoing.

(d) KEFRI/Pan Paper *Mill Pinus* radiata Research Project

The *Pinus* radiata improvement research is a collaborative effort between KEFRI and Panafrican Paper Mills (PPM) aimed at breeding and developing varieties of the species that are resistant to *Dothistroma pint,* a fungi causing needle blight.

During the period under review, the two institutions signed an agreement for the third phase of the project. Within the phase the following activities will be carried out:

(i) Collection of seed and scions from identified resistant/plus trees for progeny trials and grafting

(ii) Mass production of already promising resistant varieties through vegetative means.

(iii) Establishment of pilot plantations, seed orchards, tree banks and progeny trials.

(iv) Assessment of existing experiments for both growth and disease resistance.

(v) Collection and compilation of data on yield of P.radiata by use of permanent and temporary sample plots established within the pilot plantations and existing plantations.

(vi) Genetic improvement through controlled pollination for clonal propagation.

(vii) Research on different planting/tending methods.

1.4.3.3 PLANTATION SPECIES DIVERSIFICATION

(a) Species and provenance trial of Cypress

The main objective of the experiment was to compare commercial Cupressus lusitanica in Kenya with four selected cultivated provenances, Cupressus benthamii and C. lindleyi. The four provenances selected in Kenya were from Sokoro 2D seed stand, selected plus trees west and east of Rift and one provenance each from New Zealand and Costa Rica. The Mexican stock consisted of Mexican C. benthamii and Mexican C. lindleyi.

The experiment was planted in 1968 at Muguga, Ontulili, Uganda and Tanzania. Results after 33 years of growth of the Muguga replicate (Table 6) indicate that, provenances raised from selected plus trees from both east and west of the Rift Valley performed better in diameter growth. There was no major difference in height growth and stem form. The trial shows the importance of selection for specific traits that are highly heritable.

Table 9: Performance of Cupressus species at age 31 years for height, DBH and stem form

SEED SOURCE/ Seedlot No.	Mean Height (m)	Mean DBH (cm)	Mean stem form (Scale 1 to 5)
C. lusitanica SOKORO (1319)	18.7	36.5	2.3
C. lusitanica East Rift (1333)	18.7	39.8	2.3
C. lusitanica West Rift (1334)	19.3	39.7	2.0
C. usitanica Costa Rica (1335)	18.5	35.9	3.0
C. benthamii Ex. Mexico (1336)	18.0	32.3	2.3
C. lindleyi Ex. Mexico (1337)	18.6	35.5	2.0
C. lindleyi Ex. Mexico (1338)	18.0	34.1	2.3
C. lusitanica ex New Zealand (1339)	18.0	34.6	2.6
Mean	18.5	35.9	2.3

(b) Species-cum-provenance trial of Eucalyptus teredcornis and E. *camaldulensis*

The experiment was planted in 1981 in a randomised block design with four replicates. The treatments consisted of 16 provenances:10 *E.* tereticomis and 6 *E.* camaldulensis (Table 10) with 5 x 5 trees in each plot spaced at 2.5 m. Assessment was only conducted for 9 inner trees.

The objectives of the experiment were to:

- compare survival growth and stem form of the two species on that site;
- identify the best performing provenance

Table 10: Provenances planted and their origin

Kenya introduction number	CSIRO seedlot number	Provenance location
E. tereticomis		
1. 2786	12189	Southwest of Mt. Garnet Northern Queensland
2. 2787	12377	Northwest of Mareeba Northern Queensland
3. 2788	12376	South of Helenvale Northern Queensland
4. 2789	10851 +10837	North of Woolgoolga Northern New South Wales
5. 2790	12502	North of Taroom Southern Queensland
6. 2791	11239	South of Casino Northern New South Wales
7. 2792	11034	West of Mackay Northern Queensland
8. 2795	12882	South Gipps-land - Victoria
9. 2797	10816 +10775	Schacdts Creek Southern Queensland
E. ***camaidutensis***		
10. 2798	10781	Imbil Southern Queensland
11. 2780	12139	Petford, Queensland
12. 2781	12187	Irvine Bank Queensland
13. 2782	105714	Halls Creek West Australia
14. 2783	10182	Murchison River W. Australia
15. 2784	12437	Durhum River W. Australia
16. 2785	Turbo R.E 326 BIN 412-010	Turbo

The growth pattern indicated that the two species performed well in height growth up to age 8 years. Thereafter, the growth slowed down. At age 13 years, growth in height completely reduced, while growth in diameter was progressive with a steady increment up to age 17 years.

(c) Species trials of P. patula subsp. tecunumanii and P. maximinoi

After a long experience with P. patula as one of the major plantation species in Kenya, several shortcomings with the species such as pest problems, utilization and ecological limitations have been noted, suggesting the need for alternative pines. Among species suggested for trials for the same ecological zones are Pinus patula subsp. tecunumanii and P. maximinoi.

Since 1980s the two species have been deliberately introduced for trial against the P. patula. Observations show that P. patula subspecies tecunumanii has strait form with good branching habits and can tolerate low rainfall than P. patula.

Some germplasm of P.maximinoi and P. patula spp. tecunumanii were procured from Oxford University (Table 11). Additional seeds of P. patula subsp. tecunumanii were collected from Selboume in Turbo as landraces. All the seeds were sown in August 1998 in preparation for field planting in 1999. However, P. maximinoi showed extremely poor growth rate in the nursery. This observation was attributed to poor potting medium. When fertilizer (urea) was added to the media 30% of the raised seedlings dried. The remaining seedlings have been retained for planting a gene conservation stand of the two species in the year 2000.

Table 11: P. maximinoi seedlots procured

Ref. No.	Provenance	Seed ID	NO. surviving 10/11/99	% of the total germination
1	Loma de Ochoa	2/74	18	86
2	Jinotega	7/76	48	73
3	Dantali	37/78	12	71
4	Minas de Oro	11/81	26	79
5	San Juan Sacatepequez	42/71	Non	---
6	Guinope	10/81	Non	---
7	Dantali	8/76	5	71
8	La Fortuna	20/75	Non	---
9	San Rafael	28/71	7	70
10	Xuan Tho	9/74	34	65
11	Comalapa	31/70	167	65
12	Jinotega	27/77	6	40
13	Dulce Nombre	30/77	Non	---
14	Dipilto	4/76	14	70
15	Sn Fernando			93

1.4.3.4 STRUCTURAL TIMBER TESTING

(a) Effective use of Plantation Grown Timber project

The overall objective of this project was to establish the strength of Kenya C. lusitanica and Pinus species to be used for deriving permissible design stresses and for drafting a Kenya standard code of practice for structural timber.

Laboratory structural size testing of samples continued throughout the year. Over 90% of the bending samples have been tested. Samples sent to British Building Research Establishment (UK) for tension testing were brought back together with test results. The test could not be undertaken in Karura Engineering Laboratory due to the short span available in the Universal Strength Testing Machine. The machining and testing of compression samples will be undertaken within the course of the year.
Selection of test specimens from sawmills in all plantation areas has been completed. The flatwise and edgewise bending strength tests on structural sizes 3x2, 42 and 6x2 have been completed. Preliminary analysis on Modulus of Elasticity (MOE) and Modulus of Rupture (MOR) has been done.

(b) An appraisal of sawmill industries in Kenya

The overall objective of this project was to appraise the sawmill industry and the specific objectives were:

- To establish the number of sawmill licensees and existing sawmills/pitsawyers licensed by the Forestry Department for the period 1994-1997

- To determine the criteria used to issue licenses at regional and national level

- Improve the sawmills and pitsawyers.
- Review the training programme on skill improvement courses in sawmilling at Forest Industrial Training Centre (FITC) in Nakuru.

For existing sawmills and pitsawyers it was necessary to establish the following:

(i) Installed capacity and potential achievable capacity;

(ii) The source of raw material and average annual log intake and hence actual consumption;

(iii) Method of sawing and recovery data;

(iv) Type of equipment used for logging, sawmilling and saw doctoring;

(v) Level of skilled manpower

(vi) Constraints encountered.

The following has been achieved: The number of sawmilling and pitsawing licenses during the period between 1994 to 1996 and the actual number of operating licensees was established

It was not possible to determine the actual existing sawmills/pitsawyers. The information available was that of the actual number of operating licensees during that period, and this figure was different from the number of licenses issued during that period. The reasons for this discrepancy was investigated. The criteria used to issue licenses for operating in the forest was established; it is the same at all levels.

1.4.4 Other Forest Development Activities

1.4.4.1 Participation In Conferences And Workshops

Conference Title	**Dates and Venue**	**Participants**
KARI 2nd Biennial Crop Protection Conference	16 - 17 September 1998, NARL, Nairobi	K.E. Mutitu, J. Ogembo and M. Gichora
Leadership Skills	19th - 20th August, 1998- Machakos.	Mercy Gichora
2nd International Conference on Mycorrhiza	5th to 10th July, 1998, Sweden	L. Mwangi

1.4.4.2 Training

1. S.O. Aduol continued with his training as Laboratory Technician certificate course at the Kenya Polytechnic.

2. D.O. Otieno enrolled for a one year fulltime course in Information Systems Management Diploma course from 1st March, 1999 at the Kenya Polytechnic.

1.4.5 COLLABORATORS

During the period of review, the program collaborated with, CAB International, Africa Regional Centre, ICRAF, FD, NMK, KARI, KWS and farmers.

2.0 SERVICE PROGRAMME

2.1 Introduction

The programme was created in 1998 by expanding activities of the former Information Dissemination program and consolidating service-oriented activities into one programme. It is comprised of Information Documentation and Dissemination, Public Relations, Social Forestry Training Centre, Forest Products Processing and Marketing, Muguga Plantations, Kenya Forestry Seed Centre, Consultancy Services and Research Liaison.

2.1.1 Information Documentation And Dissemination

The section documents, translates and communicates scientific information that can be used by all beneficiaries of forestry research. It is sub-divided into the following sections:

- Ilustration Drawing and Graphics Design Section
- Printing
- Library
- Public Relations
- Drawing and Illustration

(a) Illustration Drawing and Graphic Design Section

This is a small unit where graphics and other artworks are generated and prepared for incorporation into documents. During the review period, four posters, two signposts, five maps, one logo and two illustrations were prepared.

(b) Printing Section

This section edits documents and preprints stationery. All preprinted stationery needs of the Institute were printed and met during the review period. Lamination services were also provided.

(c) Library Services

There is a library at the headquarters to serve scientific staff. There are also smaller libraries in Gede, Kitui, Maseno, Karura and Muguga Regional Centres. At the headquarters, the library was reorganised and this made access of publications easier.

(d) Public Relations

This section deals with publicity issues and assists the Institute in interacting with the public. The following activities were undertaken during the review period:

(i) Press relations with the media,
(ii) Networking by maintaining inter-organisational contacts,
(iii) Briefing and informing visitors about the Institute
(iv) Preparing and providing of audio-visual services,
(v) Video production and photography, and
(vi) Preparation of publicity posters and brochures.

Achievements of Information Dissemination and Documentation Unit

(i) Formatted and redesigned Supplies data forms and vouchers,

(ii) Prepared and edited publications such as KEFRI/FD Newsletter, SOFEM Newsletter and Annual Reports,

(iii) Assisted to design the KEPHIS logo,

(iv) Actively participated in the KEFRI Y2K Task Force, and

(v) Reorganised the library and made it easier to access publications.

2.1.2 Tree Seed Production

Since August 1998 the activities of the Seed Centre were split into two parts. One part dealing with seed production and supply under the Service Programme and the other part dealing with seed research under Forest Plantation Programme. This report only deals with the seed production and supply part of the Seed Centre whose main activities include, collection and distribution of high quality tree seeds, identification, selection and establishment of appropriate seed sources, management and protection of seed sources in co-operation with the Forest Department, training in tree seed technology, and seed quality testing

The Seed Centre conducts the activities as a service to generate revenue. The Seed Center collected 1,553 kg of seed of 30 different species. During the year under review a total of 894.9 kg of seeds were supplied to various clients: Forest Department -167.5kgs, Sales - 541.4kgs and Research -186kgs.

A multi-disciplinary team of scientists was constituted to select new seed sources of Pinus patula and Cupressus lustanica from the existing forest plantation within Londiani and Muguga regions. A total of 16 new seed stands were selected in both regions, 9 of Cupressus lusitanica and 7 of Pinus patula as shown in Tables 11 and 12.

Table 11: Newly selected seed stands

LONDIANI REGION

Station	Compt. no	Species	Year established	Area (Ha)	Prescription
Nabkoi	Nabkoi 6(B)	Pinus patula	1983	43.1	thin by 50%
Nabkoi	Buret 1(D)	Pinus patula	1981	31.2	thin by 40%
Nabkoi	Buret 2(V)	Pinus patula	1983	12.4	thin by 40%
Narasha	Narasha 7(J)	Pinus patula	1983	32.3	remove regeneration of other species & thin by 40%
Makutano	Lalaikwen 3(D)	Pinus patula	1981	18.1	none
Masaita	Masaita 7(F)	Cupressus lustanica	1980	6.4	remove weak and dying trees
Maji Mazuri	MME 2(D)	Cupressus lusitanica	1975	10.8	remove dead and dying trees
Makutano	Kampi Kongoni 4(A)	Cupressus lusitanica	1986	12.9	thin by 40%
Makutano	Lalaikwen 1(D)	Cupressus lusitanica	1985	56.8	thin by 40-50%
Molo	N Molo 5(D)	Cupressus lusitanica	1983	12.5	thin by 40%
Molo	N Molo 4(A)	Cupressus lusitanica	1978	20.5	none
Sorget	Sorget 10(N)	Cupressus lusitanica	1985	20.0	thin by 50%

Table 12: Newly selected seed stand

MUGUGA REGION

Station	Compt. no	Species	Age	Size	Prescription
South Kinangop	Kiburu 9(D)	*Pinus patula*	1992	40.0	thin by 15%
Kamae	Kamae 7(H)	*Pinus pafula*	1986	18.8	thin by 30%
South Kinangop	Kimweri 4(K)	Cupressus *lusitanica*	1990	5.0	thin by 50%
Kerita	Kerita 3(A)	Cupressus *lusitanica*	1987	17.5	thin by 40
Kerita	Kerita 3(A)	Cupressus *lusitanica*	1987	17.5	thin by 40

By the end of the year under review thinning operations had already started in Londiani and Muguga region on the newly selected seedstands as per the recommended prescriptions (Table 1 and 2).

There were no new seedstands or seed orchards established/planted during the year.

Routine seed quality testing continued to be undertaken in the laboratory, glasshouse and the nursery. Tests done were moisture content determination, purity analysis, weight determination and germination/viability testing. A total of 130 seedlots were tested during the year.

No training was conducted on tree seed technology at the Seed Centre. However, two farmers' groups in Laikipia. were trained. The course was sponsored by the Applied Research Unit and Arid and Semi-arid Lands project based in Nanyuki, Laikipia.

2.1.3 Forest Products Processing And Marketing

The Workshop is based at Karura Research Station. It has facilities for commercial production of wood products. Logging was done from one pine and one cypress plot from KEFRI's forest plantations in Muguga.
Commercial production of furniture, laminated wood products, charcoal and other user defined wood products were also carried out.

During the review period the following was achieved:

- The quality and number of furniture and fancy items produced increased;
- The timber-seasoning kiln was rehabilitated and marketed to various construction firms by mail;
- Drying and planing timber services were improved;
- The lubrication of the sawmilling machine was made more cost effective by using diesel oil instead of paraffin; and
- A large showroom was constructed for displaying products from the workshop.

2.1.4 Wood And Seedling Production (Muguga)

The Forest Estates Management Section provides support to Plantation and Natural Forests Research Programmes but its main objective is to generate income from sale of poles, firewood, trees, and other forest products. During the period under review seedlings were raised for research purposes. A few overgrown *Eucalyptus saligna* and *Dovyalis caffra* seedlings were planted within KEFRI. There were no seedlings raised for sale.

During the reporting period, singling and slashing of the two plantation was undertaken. A total of 28.6 Ha. was treated as is shown in Table 13.

Table 13

Sub-compartment	Area (Ha)
2(P) 2(S) 2(L) 2(N) Veterinary 6	3.72 2.00 11.00 1.00 10.91
Total	28.63

The section is keen on generating income and establishing a sustainable supply of forest products. The resources needed are not adequate. There is need to have an extra vehicle for patrolling forest plantations.

2.1.5 Social Forestry Training Centre

The Social Forestry Training Centre is responsible for technology dissemination through training. The Centre plans, organizes, implements, evaluates social forestry training courses and produces training materials. The Centre also:

- contracts training services so as to generate revenue;
- provides an avenue for networking through development of programs aimed at enhancing KEFRI's ability to participate nationally and internationally in forestry research and development and
- offers human recourse development service to KEFRI through provision of cost effective in-house training packages and related advisory services.

During the year under review the centre hosted 6 courses and 2 workshops. Other smaller functions held included meetings of KEFRI's collaborators and related agencies.

The Fourth Regional course for promotion of social forestry in Africa was held between 5 th October and 6th November 1998. Twenty-two participants drawn from 10 countries in East, Central and Southern Africa participated in the course. For the first time there were self sponsored candidates in the course indicating that the course is gaining popularity in the region.

The training program draws 30% of its resource persons from Government institutions such as Forestry Department, Ministry of Agriculture and Rural Development, Ministry of Culture and Social Services, Kenya Woodfuel and Agroforestry Programe and Kenyatta University.

During the reiew period the centre poublished:

- Proceedings of the 4th Regional Course for the Promotion of Social Forestry in Africa; and
- Brochure detailing facilities and services offered.

Dickson Makanji continued with studies for Msc in Japan while Mr. Michael Mukolwe continued studying for an Msc. in South Africa.

2.1.6 Consultancy Services And Research Liasion

The Kenya Forestry Research Institute and the Forest Department Management and Liaison Office aims at strengthening the coordination of Management and Research activities between KEFRI and FD. This is achieved through joint Technical and Policy Liaison Committees meetings between KEFRI/FD and other co-opted members from other forestry related Institutions/organisations.

The following activities were undertaked during the review period:

- Two Policy Liaison Committee (PLC) and three Technical Liaison Committee (TLC) meetings were held;
- Four meetings on Promotion of Sustainable Forest Management were held;
- A sub-committee of the TLC held four meetings on endangered tree species;
- A Cabinet paper addressing the timber trade, sustainable utilization of forest resources and conservation of indigenous forests was prepared; and
- The Memorandum of Understanding between KEFRI and FD was reviewed and signed by the heads of both Institutions.

Discussion on the follwingissues were initiated and are yet to be finalised by various committees and sub-committees under KEFRI/ FD collaboration:

- Protection and conservation of rare and endangered tree species of Kenya;
- The joint management of Natural Resources between the County Council and Local government;
- Preparation of guidelines on Natural Forest Management;
- Management of Prosopis *juliflora* in and and semi-arid areas;
- Raising Kei-apple seedlings through seed and stem cutting;
- Propagation techniques of Melia volkensii; and
- Alternative species for live hedges.

Consultancy Services

- The two previous proposals on contracted research and consultancy were reviewed. A total of sixteen contracted research areas were identified and harmonised according to KEFRI's six Working groups.
- KEFRI undertook a consultancy with the Development Cooperation Department of the Embassy of Belgium on the Analysis of Tree Species introduction trials of the former Embu-Meru-Isiolo Project.
- A corporate curriculum vitae was drafted and reviewed intemally

3.0 MANAGEMENT SERVICES

3.1 Human Resource Division

The Human Resource Division is a service division under the Finance and Administration Department of the Institute.

The Division comprises of the following sections: Personnel Registry, Appointment, Salaries, Training and Pension. It is involved with the following activities: recruitment of staff, deployment, training and development, staff promotion, payment of salaries and wages, staff appraisal, maintenance of personnel records, discipline, transfers, welfare of staff and pension processing.

The main objective is to maintain the physical well being of employees so that they can give maximum contribution to achieve efficiency. During the year, the division has managed to:

(i) develop a personnel policy manual;
(ii) fit within the new structure of KEFRI;
(iii) pay Salaries and wages through out the year in review;
(iv) co-ordinate and Process Promotions for Scientific, Technical and Administrative staff;
(v) train members of staff at various levels; and
(vi) maintain records and address various personnel problems.

3.2 Finance

Being responsible for the financial management and control of the Institute's resources, the Finance Division forms an integral part in the management structure of any organisation.

The functions in the Finance Division can be broadly divided into two. The first is accounting which includes the application of sound principles, systems and techniques, recording of financial transactions, management of accounting information and providing timely financial and management reports for decision making, planning and control. The second function is financial duties such as financial planning, budgetary control, costs analysis, Investments and appraisals and cash management.

The Division has six sections dealing with payment, examination, expenditure, project accounts, cash and general ledger. During the year achievements were as follows:

The achievements so far attained in the Finance Division include

- financial transactions processed efficiently;
- on the job training; and
- updated annual financial report for the Year 1998/99.

Good performance by this division has made KEFRI to be rated the best among Government Institutes and other parastatals in terms of Final Accounts presentation.

The Finance Division intends to computerize its Division very soon to improve on efficiency and effectiveness in processing financial transaction and information. It also intends to train its staff and instill more professionalism in the Division so that it can serve the Institute better.

3.3 Supplies Division

Supplies Division is one of the support service divisions in the Institute and is as old as KEFRI itself.

The Division is divided into sections namely: Stock Control, Procurement/Purchasing, Warehouse/Stores, Fixed Assets, Stock Verification and Inspection Unit and Secretarial/Messenger Services.

During the review period the division achieved the following:

(i) streamlined purchase of materials from a wide range of suppliers to control payment of exorbitant bills;
(ii) complete elimination of briefcase merchants who supply sub-standard materials;
(iii) undertook efficient documentation of activities hence eliminating delays; and
(iv) disposed of old fixed assets to generate revenue for the Institute.

The Division plans to computerize the entire purchasing and warehousing operations for ease of retrieval of information relating to stocks.

3.4 Administration Division

The Administration Division is under Finance and Administration Department. The Division is responsible for overseeing the smooth day to day running of the Institute and thus contributes directly and indirectly to the research activities of KEFRI. It has the following sections: Transport, Estate management, Staff Pension, Management and Clinical Services. During the review period the following was accomplished:

(i) KEFRI Staff Pension Scheme was launched with a value of over Kshs170 million;

(ii) buildings at Headquarters were connected to generator power at a minimal cost of Kshs35,000;

(iii) successfully trained a good number of staff; and

(iv) KEFRI registered as a member of the Automobile Association of Kenya and therefore our vehicles can access professional emergency services.

The future plans include:

- computerizing the divisions' records particularly in the Registry and Transport, and the water billing system;
- retaining a workforce that can be productive at a minimal cost;
- fully operationalising the Institute's Clinic to offer efficient clinical services to the institute's employees and their immediate families; and
- Developing a training and staff development package for the workforce, of all cadres including secretaries, clerks, security guards and drivers through seminars, workshops and professional training geared towards career advancement based on good competence and performance.

4.0 POST-GRADUATE TRAINING

NAME	DEGREE	FIELD OF STUDY
Jackson Mulatya	Ph.D	Agroforestry
Joram Mbinga	MSc.	Silviculture
Robert Nyambati	MSc.	Soil Science
Doris Mutta	Ph.D	Ethnobotany
Balozi B. Kiron o	Ph. D	Silviculture
Dickson Makanji	MSc.	Socio-economics
Emily Obonyo	MSc.	Sociology
Hezron Mogaka	Ph.D	Forest Valuation
Stanley Gathumbi	Ph.D	Agroforestry
Dorothy Ochien	MSc.	Extension
M. T. E. Mbuvi	MSc.	Socio-economics
Beatrice Wanyonyi	MSc.	Silviculture
James 0. Mincha	MSc.	Wood Utilisation
Paul W. Magondu	MSc.	Forest Genetics
John K. Maingi	Ph.D	Forest Ecology
Joram Ka ombe	MSc.	Socio-economics
Michael Mukolwe	MSc.	Social Forest
Geofrey Muluvi	Ph.D	Molecular Genetics

5.0 PUBLICATIONS, CONFERENCE PAPERS AND TECHNICAL REPORTS

Chikamai B. N. and Mbiru S. S. (1999). Assessment of Gum Arabic and Gum Resins Resources in Mukogodo Division, Laikipia District. In: Vegetation and Opportunities for the development of Alternative Livelihoods in the Drylands: The case of the Mukogodo Forest Reserve and Adjacent Rangelands, Laikipia District, Kenya. Foundation Press Limited, 1999, Nairobi, Kenya.

Chikamai B. N., Ngethe R. K. and Mbiru S. S. (Eds). Vegetation and Opportunities for the development of Alternative Livelihoods in the Drylands: The case of the Mukogodo Forest Reserve and Adjacent Rangelands, Laikipia District, Kenya. Foundation Press Limited, 1999, Nairobi, Kenya.

Gichora M., Ogembo J., Day R. and Gethi M. (1998). Factors influencing populations of leucaena psyllid Heteropsylla *cubana* Crawford (Homoptera; psyllidae) and introduced exotic parasitoids establishment in Kenya. Proceedings of the 2nd KARI Crop Protection Conference held on 16 -17 September 1998, Nairobi, Kenya,
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Ivory M.H., Mwangi L.M., Mburu, B.K. and Honrubia M. (1998). Synthesis of ectomycorrhiza on indigenous and exotic tree species using basidiospores and mycelial cultures. Proceedings of the 2nd International Conference on Mycorrhiza, held on 5th to 10th July 1998, Uppsala, Sweden.

Karanja, N.K., Mwendwa, K.A. and Zapata, F. (1999). Growth response in Grevillea robusta, A. *Cunn.* seedlings to phosphorus fertilization in acid soils from Kenya. Biotechnol. Agron. Soc. Environ.1999 3(1), 57-64

Kariuki, J. G. and T.O. Omenda. (1998). Potential impacts of Climate Change on forests in Kenya. US Country Studies Programme and Ministry of Research, Technical Training and Technology.

Kigomo B. N. (1998). The Status of Forest Genetic Resources and Plan of Action for Dry Zone areas of Kenya. Paper presented at "Sub-Saharan regional workshop on Forest Genetic Resources". 22-24 September 1998, Ouagadougou, Burkina Faso.

Kigomo, B. N. (1999). Considerations and procedure for priority setting in a National Forest Genetic resources conservation and management program" National Strategic workshop on Forest Genetic Resources Conservation'. Addis Ababa, Ethiopia, 21-23. June, 1999.

Mwendwa, K.A., Eason, W., Karanja, N., Rutunga, V., Roberts J., Zapata F. and Nyamai D.O. (1998). Estimation of N2-fixation in phosphorous fertilized *Leucaena* leucocephala and Gffcidia sepium seedlings using Senna siamea and Eucalyptus *grandis* as reference trees. Prooceedings of Eighth Congress of the African Association for Biological Nitrogen Fixation: Biological Nitrogen Fixation in Africa: Linding Process to Progress. University of Cape Town South Africa 23-27th November, 1998.

Muchiri M. N. and T. 0. Omenda. (1998). The role of silvipastoral systems in the management of industrial forest plantations in Kenya. In Proceedings: Modelling the Growth of Tree plantation and Agroforestry Systems in South and East Africa. The University of Joensuu, Faculty of Forestry Technical Note No.80.

Mugah J. 0., B. N. Chikamai, S. S. Mbiru and E. Casadei (Eds). Proceedings of a Regional Conference for Africa on the Conservation, Management and Utilisation of Plant Gums, Resins and Essential Oils. 6th -10th October, 1997, Nairobi, Kenya. Jointly organised by KEFRI, FAO and the Kenya Forestry Department.

Muluvi GM 1998 Molecular ecology and population genetics of two multipurpose tropical trees, *Moringa* oleifera Lam. and M. stenopetala (Bak.f) cuf. PhD Thesis, University of Dundee.

Muluvi G'. M., Sprent J. I., Soranzo N., Provan J., Odee D., Folkard G., McNicol J. W. and Powell W. 1999 AFLP analysis of genetic variation in M. oleifera Lam. Molecular ecology, 8(3): 463-470.

Mutitu K.E., (1999). Position paper on Cypress aphid and its parasitoid in Kenya. KEFRI Technical Report. 6pp.

Niang, A., de Wolf, J., Mwendwa K. A., Hansen, T., Nyasimi, M., Defour, T., Ongaro, V., Obaga, S. and Rotich D. (1998). Soil fertility replenishment and recapitalization in Western Kenya: Methodologies, approaches and challenges: Pilot Project Report No. 7 October 1998. Regional Agroforestry Research Centre, Maseno. KEFRI/ICRAF/KARI.

Nycguru N. N. and Omenda T. 0. 1998. The role of silvipastoral systems in the management of industrial forest plantations in Kenya. In Proceedings: Modelling the Growth of Tree plantation and Agroforestry Systems in South and East Africa. The University of Joensuu, Faculty of Forestry Technical Note No. 80.

Odee D.1998. Forest Biotechnology research in drylands of Kenya: Development of Moringa species. */n* J. Odera (ed.), Dryland Biodoversity, Biannual Newsletter of the Research Programme on Sustainable Use of Dryland Biodiversity (RPSUD) 2:7-8.

Odee, D.W., Estitubi, M., Machua, J., Njoroge, J.M., Ochieng, J., Mwendwa, K.A., Gathumbi, S., Omondi, W. and Niang, A. (1998). On-Farm Evaluation of Indigenous Rhizobia Associated with Leguminous Trees and Shrubs for Improved Fallow Systems in the Biological Nitrogen Fixation in Africa; Lonking Process to Progress. University of Cape Town South Africa. 23-27 November, 1998.

Odee D. W., Gichora M. and Mutitu K.E. (1998). Management strategy for pests of *Moringa* species in Kenya: Proceedings of the 2nd KARI Crop Protection Conference held on 16-17 September 1998. Nairobi, Kenya, pp 44-53.

Omenda, T.O. (1999). Potential Implications of Climate change for terrestrial ecosystems in Kenya. Dresden University of Technology. A thesis towards PGDip in Environmental Management.

Omenda, T.O., Kariuki J.G., and Mbuthi P.N. (Eds) (1998). A compendium of Vulnerability and Adaptation to Potential Impacts of Climate Change in Kenya. Kenya Country Studies on Climate. Ministry of Research, Science and Technology, Nairobi, Kenya.

Omenda, T. 0., Kimondo J. and Muchiri M.N. (1998). Establishment of natural regeneration management trial of Cupressus lusitanica and Pinus patula in Londiani - Kenya. In Proceedings: Modelling the Growth of Tree plantation and Agroforestry Systems in South and East Africa. The University of Jensuu.

6.0 MEMBERS OF THE KEFRI BOARD OF MANAGEMENT

Mr. Humphrey Ngibuini	Chairman
Dr. David Kamweti	Member
Prof. Michael Koech	Member
Dr. Jama Bashir	Member
Prof. Fred Owino	Member
Prof. B. N. Mitaru	Member
Dr. (Mrs.) Theresa Aloo	Member
The Permanent Secretary, Ministry of Finance	Member
The Permanent Secretary, Ministry of Environment & Natural Resources	Member
Inspector of State Corporations	Member

7.0 SCIENTISTS AND SENIOR STAFF MEMBERS

DIRECTOR AND DEPUTY DIRECTORS

Director	Paul K. Konuche
Deputy Director (Research & Development)	Bernard Kigomo
Deputy Director (Finance & Administration)	Patrick N. Omesa

NATIONAL PROGRAMME COORDINATORS 1 ASSISTANT DIRECTORS

Farm Forestry	Daniel Nyamai
Forest Plantations	Ebby Chagalla
Natural Forest	Paul Ongugo
Dryland Forest	Ben Chikamai
Service Programme	Alice A. Kaudia

REGIONAL CENTRE DIRECTORS

Muguga Regional Centre	Elly Mwanza
Kitui Regional Centre	James Kimondo
Londiani Regional Centre	Juliet Wanyondu (Acting)
Maseno Regional Centre	Collins Obonyo (Acting)
Gede Regional Centre	Caleb Mwendwa (Acting)
Karura Regional Centre	Joseph Githiomi (Acting)

TEAM LEADERS

Natural Ecosystems	Tom Omenda (Acting)
Tree Stand Management	Phanuel Oballa
Intergrated Pest Management	Linus Mwangi
Timber and Non-timber Products	Nelly Ndegwa (Acting)
Socio-economics & Policy	Evelyn Kiptot (Acting)
Agroforestry	David Odee

HEADS OF CENTRES/SECTIONS - SERVICE PROGRAMME

Seed Centre	Peter Angaine
Forest Estate	William Mucheke
Training Manager (Muguga)	Michael Mukolwe
Karura Workshop	Kamau Thuo
Training Manager (Kitui)	Bernard Muok
Information Dissemination & Documentation	Paul Barasa

HEADS OF SUB-CENTRE

Ramogi	Daniel Odhiambo
Kuja River	Antipas Orwe
Kakamega	Johnstone Ngazi
Bura-tana	Charles Ongweya
Kibwezi	Malim Mohammed
Turkana	John Oyugi
Marigat	Philip Changwony
Embu	Jane Mugwe
Turbo	Phanuel Wesonga (Acting)
Kaptagat	Thomas Kundos

LABORATORIES, GREEN HOUSES & NURSERIES

Ecology & Dryland	Joash Gichana
Forest Genetics	Peter Wanjawa
Pathology & Entomology	Luke Gibera
Timber Engineering	Dominic Mikile
Non-timber products	Mose Kature
Soils, Agroforestry & Biotechnology	James Gitu
Tree Seed Centre	Agnes Ng'anga
Tree Seed Centre Maintenance	Alloys Opiyo
Nderi Research Nursery	Joseph Kioko
Muguga Arborateum	Samuel Thogo
Demonstration/Amenity Nurseries	Clement Muchoki

FINANCE & ADMINISTRATION DIVISIONS

Human Resource	Ruth Macharia
Accounts & Finance	Charles Mungai
Supplies	Michael Karumba
Internal Audit	Ibrahim Momanyi
Administration	John Gisemba

SCIENTISTS

Gede	Tito Mbuvi
Karura	George Muthike
	James Onchieku
	Meshack Muga
	Micheal Njenga
Kitui	Josephine Kamene
	Robert Nyambati
Londiani	Joram Mbinga
Maseno	Joseph Machua
	Kaleb Mwendwa
	Stanely Gathumbi
Muguga	Albert Luvanda
	Charles Kiriinya
	Charles Koech
	Gitahi Giathi
	George Ondoro
	Gordon Sigu
	Jacinta Kimiti
	James Maua
	Jane Njuguna
	Jane Mugwe
	Jared Amwatta
	Jason Kariuki
	John Kiambaa
	Joram Kagombe
	Joseph Ahenda
	Joseph Lelon
	Josephine Wanjiku
	Kavaka Mukonyi
	Linus Mwangi

	Mbae Muchiri
	Mercy Gichora
	Paul Tuwei
	Phanuel Oballa
	Sheila Mbiru
	Simon Choge
	Tom Omenda
	William Omondi
Service Program	Paul Barasa
	Pauline Bwire
Training	Jesse Lugadiru
	Bernard Owour
	Akula Mwamburi

8.0 ADDRESSES OF REGIONAL CENTRES AND SUB-CENTRES

8.1 REGIONAL CENTRES

Muguga Forestry Research Centre,
P. 0. Box 20412,
NAIROBI.
E-mail : kefri@arcc.or.ke

Londiani Forest Research Centre,
P. 0. Box 382,
LONDIANI.
E-mail: kefri_in@africaonline.co.ke

Gede Forestry Research Centre,
P. 0. Box 201,
MALINDI.
E-mail : sokoke@africaonline.co.ke

Maseno Forestry Research Centre,
P. 0. Box 25199,
KISUMU.
E-mail : afresmaseno@africaonline.or.ke

Kitui Forestry Research Centre,
P. 0. Box 892,
KITUI.
E-mail : miyagi@africaonline..or.ke

Karura Forest Products Research Centre,
P. 0. Box 30241,
NAIROBI.
E-mail: kefri@africaonline.co.ke

8.2 SUB-STATIONS

Officer-in-Charge,
Kakamega Seed Centre,
P. 0. Box 462,
KAKAMEGA.

Officer-in-Charge,
Kitale Seed Centre,
P. 0. Box 99,
KITALE.

Officer-in-Charge,
Nyeri Seed Centre,
P. 0. Box 12069,
NYERI.

Officer-in-Charge,
Ramogi Forest Research,
P. 0. Box 184,
USENGE.

Officer-in-Charge,
Turbo Forest Research,
P. 0. Box 5,
TURBO.

Officer-in-Charge,
Turkana Forest Research,
P. 0. Box 468,
LODWAR.

Officer-in-Charge,
Baringo Forest Research,
P. 0. Box 57,
MARIGAT.

Officer-in-Charge,
Bura Forest Research,
P. 0. Box 102,
BURA-TANA
VIA GARISSA

Officer-in-Charge,
Kuja-River,
P. 0. Box 223,
SARE-AWENDO.

Officer-in-Charge,
Kaptagat Forest Research,
P. 0. Box 4028,
ELDORET.

Project Manager,
Kibwezi Forest Research,
P. 0. Box 892,
KIBWEZI.

Officer-in-Charge,
KARI-KEFRI-ICRAF,
P. 0. Box 27,
EMBU.

9.0 FINANCIAL REPORT

BALANCE SHEET AS AT 30TH JUNE, 1999

	Notes	1999 KSHS.	1998 KSHS.
Fixed Assets	2(a)	1,047,517,742	989,335,552
Current Assets:			
Stock	3	14,753,147	11,244,364
Debtors	6	3,842,698	1,227,641
Cash at Bank	4	18,824,303	6,875,242
		37,420,148	19,347,247
Current Liabilities:			
Creditors	5	2,409,810	5,834,024
		6,532,537	12,392,790
		8,942,347	18,226,814
Net Current Assets		28,477,801	1,120,433
		1,075,995,543	990,455,985
Net Assets			
Financed By:			
Government Grant for Capital Assets	14	1,165,364,920	1,211,244,403
External Grant for Research	7	10,461,118	5,072,006
Asset Revaluation Account		131,442,930	36,062,154
Accumulated Deficit:		(231,273,425)	(261,922,578)
		1,075,995,543	990,455,985

Signed:

Chairman ..... Date ....

Director ..... Date ..... I... ..I..Zo o c)

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDING 30TH JUNE, 1999

INCOME	Notes	1999 KSHS.	1998 KSHS.
Recurrent Government Grant		244,464,441	220,280,994
Development Government Grant		500,000	-
External Grant for Research		19,169,712	8,638,865
Sale of Forestry Produce		4,410,544	2,309,983
Other Income		325,574	5,790,216
Commission Income		111,118	44,384
Bus Charges (Income)		451,494	537,846
Nominal Rent		295,171	217,168
Surcharges		216,697	146,208
Hire of KEFRI Facilities		3,188,908	3,803,187
Gain on Sale of Motor Vehicles & Stores		3,029,914	592,806
TOTAL INCOME		278,163,573	242,361,657
EXPENDITURE			
Salaries and Wages		134,077,271	125,038,528
Gratuities & Pension Contribution		21,695,611	19,824,523
Other Personal Allowances		4,695,593	1,837,643
House Allowances		24,376,026	24,499,806
Motor Running Expenses		11,373,708	9,890,547
Travelling & Accommodation Expenses		8,290,572	6,973,991
External Travelling		2,425,251	1,689,683
Telephone, Telex and Postage	8	2,502,270	1,907,294
Office Entertainment		67,527	34,650
Printing, Publishing & Stationery	9	2,878,200	1,563,134
Staff Uniform		232,355	287,007
Library Expenses		71,590	83,720
Electricity, Water & Conservancy	10	3,423,52	3,221,896
Medical Allowance (Non-Accountable)		12,185,977	12,368,055
Staff Medical Allowances		9,149	51,127
Repairs & Maintenance	11	4,952,791	3,254,152
Bank Charges		311,658	231,766
Purchase of Supplies for Production		3,097,755	4,493,494
Cost of Conference & Meetings		1,236,630	563,150
Miscellaneous & Other Charges		254,849	355,590
Audit Fees		200,000	150,000
Consultancy Fees		786,609	546,903
Advertising & Publicity		223,770	111,719
Training Expenses Food & Ration	12	3,539,704	5,339,193
Honoraria & Commission		191,851	477,037
Insurance of Property		1,769,829	1,777,551
Leave & Passage Expenses		3,331,655	2,256,181
Contribution to Statutory Organizations		95,919	62,743
Compensation and Ex-Gratia		1,117,896	684,462
Investigation, Planning & Design		100,055	-
Computer Expenses		526,064	673,166
Appropriation in Aid		520,000	-
Life Insurance Premium		4,364,479	3,488,188
TOTAL EXPENDITURE		254,905,926	233,736,899
SURPLUS BEFORE DEPRECIATION AND DEFERRED INCOME		23,257,647	8,624,758

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 30TH JUNE 1999

	Notes	1999 KSHS	1998 KSHS
Surplus Before Depreciation & Deferred Income		21,257,847	8,624,758
Less: Depreciation	2a	(46,706,981)	(55,003,058)
			(46,377,300)
Add: Deferred Income:	2b	46,706,120	-
		19,256,786	(46,377,300)
Add: Closing Stock of seeds, Seedlings-Forest Plantations		11,349,441	7,917,603
Less: Opening Stock Seeds & Seedlings		(7,917,803)	7,760,339
Surplus (Deficit) For the Year		22,688,824	(46,220,036)
Operating Deficit b/f		(261,922,578)	(220,281,874)
Prior Period Adjustment	13	7,980,529	4,579,332
Accumulated Deficit c/f		(231,273,425)	(261,922,578)

CASH FLOW STATEMET FOR THE YEAR ENDED 30TH JUNE, 1999

CASH FLOW FROM OPERTING ACTIVITIES	1999 KSHS.	1998 KSHS.
Surplus For the Year		22,688,624
Adjustments For		
Depreciation		48,708,981
Deferred Income		(46,708,120)
Gain on Sale of Motor Vehicles & Stores		(3,029,914)
Operating Surplus For the Year		21,659,571
Adjustment For Prior Period Items	7,980,529	
Depreciation on Sold Motor Vehicle & Stores	[illegible]	
Capital Asset Grant Reduction on Sold M/Vehicles	[illegible]	
Cash related Prior year adjustment		420,237
Net Surplus		22,079,808
WORKING CAPITAL CHANGES:		
Decrease (Increase) in Stock	[illegible]	
Decrease (Increase) in Debtors	(2,615,057)	
Increase (Decrease) in Creditors	(3,424,214)	
Increase (Decrease) in Pension Fund Arrears	(5,869,253)	
		(15,408,307)
CASH FLOW FROM INVESTING ACTIVITIES		
Sale of Motor Vehicles and stores Items	3,029,914	
Research grants received	24,556,824	
Purchase of Assets	(3,141,466)	
Research grants spent	(19,169,712)	
		5,277,560
NET INCREASE (DECREASE) IN CASH		11,949,061
CASH BALANCE AS AT 1/7/1998		6,875,242
CASH BALANCE AS AT 30/6/1999		18,824,303