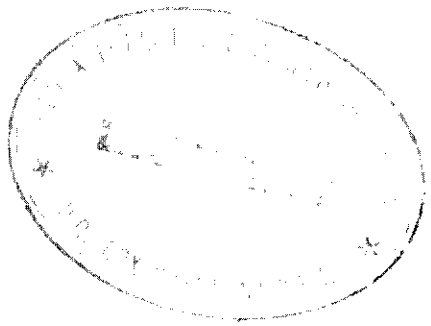
KENYA FORESTRY RESEARCH INSTITUTE
KEFRI

# ANNUAL REPORT AND RECORD OF RESEARCH

*Kenya Forestry Research Institute (Kefri) Headquarters-Muguga*

## FOR THE PERIOD

## JULY 1987 TO JUNE 1988



# RECORD OF RESEARCH

## FOR THE PERIOD

## JULY 1987 TO JUNE 1988

KENYA FORESTRY RESEARCH INSTITUTE

P.O. BOX 20412,

NAIROBI

# FOREWORD

It is often difficult to keep our target constituency for our research and training as well as the general public who provide the financial support to the Kenya Forestry Research Institute (KEFRI) informed of the Institute's programme performance and achievements through the technical papers it publishes or field days it periodically sponsors. This Second Annual Report and Record of Research has been structured to fill this important gap. In this regard, attempts have been made to cover the performance of the Institute's priority programmes by providing tentative results under specific studies over the period July 1987 through June 1988.

KEFRI was established in July 1986; and is the youngest of the national statutory scientific research institutions under the Science and Technology Act. The Institute is mandated to undertake scientific research and development in forestry (and allied natural resources) in order to provide appropriate technologies for efficient development, management and utilization of trees forests through increased sustainable availability of forest and tree products, and their associated services, for all time. Further the Institute's programme addresses issues related to the conservation of the environment, and the improvement of the welfare of the people of Kenya in relation to its forest endowment.

The Institute is administered by a Board of Management comprising seven appointed members who serve voluntarily, as well at least five members serving in their ex-officios status from the following public bodies:

The Permanent Secretary of the responsible Ministry, or his representative;

The Director of Forestry or his representative;

The Director of Agriculture, or his representative;

The Secretary of the National Council for Science and Technology;

The Permanent Secretaries of the participating Ministries, or their representative.

Attendance of the Board meetings, including visits to the various programmes of KEFRI throughout the country, have been, without exception, excellent, a clear indication of their commitment and enthusiasm in the affairs of the Institute. To them, I express my heartfelt gratitute.

During the last two years, the Board has established a firm base for the Institute's work programme, including

(a) the development of a critical mass of motivated and productive staff;

(b) the promotion of close interfacing of the Institute's R & D programmes with the forestry users and the wood industries;

(c) the assurance that the utility of the research results of the Institute have a direct bearing on Kenya's watershed management, the national energy policy, and the agroforestry practitioners etc.

A second major task of Board has been the development and rationalization of the R & D and management policies of KEFRI. In this respect, it has concluded the performance evaluation of all its staff, and established policies for periodic performance evaluation and staff development; it has completed a staff super-numerary scheme; and it has undertaken deliberate reappraisal and restructuring of the Institute's core programmes and formulated its basic budgetary plans and procedures.

The inadequacies of financial resources for programme implementation have been a matter of grave concern to the Board. It has therefore become necessary to explore alternative and supplementary sources of funding. I am confident that on-going discussions between the Board of Management, responsible Government ministries, and donor and other organizations will provide a base for a more stable funding of the basic programmes of this new rapidly developing Institute.

Prof. Thomas R. Odhiambo

Chairman, Board of Management

Kenya Forestry Research Institute (KEFRI)

# PREFACE

The Kenya Forestry Research Institute (KEFRI) was established in July 1986 as a statutory scientific research institution under the Science and Technology Act, to undertake both basic and applied forestry research.

During the year the board of management remained preoccupied with putting the final touches on establishing a firm base for the institute including programme review, staff developments, policy development and rationalization and budgetary procedures.

The programmes were integrated in five technical departments including:

(a) Forest Silviculture and Tree Improvement

(b) Forest Protection

(c) Forest Products

(d) Research Support Programme

(e) Social Forestry Training and Research Development

The programmes are represented in a network of research centres and satellite field stations.

The major capital development was completed and handed over to the GoK in May 1988, and has provided a sound institutional base for the institute's headquarters. Plans for a priority setting workshop on national forestry research were finalized. This is part of the Institute's strategy for preparing it to meet the national aspirations and expectations. The Institute is cognisant of the importance of facing forest tree crop productivity problems with facts based on results of investigation on problems of farmers or forest managers and opportunities and; concludes with solutions and development of technologies that would enable them to increase their incomes. The programme also has an important role in generating new concepts and ideas for application, facilitating technological advances and providing a reservoir of knowledge and experience on which industry can draw.

The core research programme was severely constrained by the meagre budgetary base and ceiling inherited from July 1986. the overall financial position of the Institute remains a source of anxiety and grave concern.

The major research and development focus concentrated on the areas of central importance, particularly in the development of procedures for multipurpose management of the forest resources, development of forest cultures and silvicultural choices essential for establishment of the forests, farming them on scientific lines and of utilizing them on a sustainable basis and development of reliable germplasm conservation strategies for all time. Steady progress was realized in developing multi-disciplinary research approaches with linkages with sister institutions and co-operative initiatives with the extension services. But the programmes also maintained opportunities for developing individual creativity and potential for advancing applied technology suited to achieving ground-breaking scientific discovery. New collaborative research networks, which are recognized as the main vehicle for our collaborative work were developed with the Ben Gurion University in raising of fodder plants; studies of rhizobia associated with multi-purpose legumes with the University of Dundee; lowland pine mycorhizae studies with University of Oxford; raising of *Melia volkensii* with the Rural Afforestation Extension Schemes of the Forest Department; agroforesty potentials for the landuse systems in the bimodal highlands of Eastern Africa (AFRENA) with ICRAF and KARI. Existing collaborative research projects with ACIAR; the dryland agroforestry studies with KARI, ICRAF and MIDP; the forestry training project with JICA and the forest department; and the dryland afforestation systems with the University of Helsinki were maintained. The collaborative programme with JICA on social forestry training project greatly strengthen the Institute's outreach activities, by forstering closer interaction with field officers. These initiatives hold considerable promise for the development of more productive and sustainable wood production systems for the country.

The standing monthly scientific colloquium for discussion of current research and new research proposals has provided an excellent forum and discussions are characteristically positive and constructive without inhibitions.

The Institute in collaboration with Permanent Presidential Commission for Soil Conservation and Afforestation, and the Panafrican Paper Mills, organized a rehabilitation of indigenous forest promotion effort in Kaptagat forest in June 1988 when about .5m bamboo seedlings were planted.

KEFRI maintained direct service to management and individuals through provision of technical backstopping and solution of forest management problems, whenever these arose.

Research conducted at the Institute has formal route of publication through the scientific journals. However, the Institute also makes of other means for the transfer of its findings. Activities of the Institute are featured in a quarterly newsletter, KEFRI's annual reports, monographs published from time to time, on-farm demonstrations, and members of staff are regular contributers to technical and management meetings, workshops, training seminars, and refreshers courses. Preparations are under way for holding open and field days.

To reach an even wider audience than in the past more use will be made of communication through the press and other media. Greater emphasis will be accorded to the publication of technical reports and bulletins designed to supplement the research papers that are published in scientific journals. We are confident that this will give the programme a more visible public profile. With over 20 experienced scientists knowledgeable on East African forestry and backed-up with information dating from the German library at Amani and now computerized, KEFRI offers consultancy services to all.

I would like to take to this opportunity to express here my deep appreciation for all assistance and support that we have received from so many different sources. I am confident that with their continued support the Institute will develop effective scientific and technical capacity that would address and resolve the major forest management bottlenecks and enable the forest to provide more and better products and benefits for more people for all time.

*J.A. Odera*

*DIRECTOR – KEFRI*

## CONTENTS

## MEMBERS OF THE KEFRI BOARD OF MANAGEMENT

| | | |
|---|---|---|
| 1. | Prof. Thomas R. Odhiambo | Chairman |
| 2. | Prof. Fred Owino | Member |
| 3. | Prof. George Eshiwani | Member |
| 4. | Prof. David Ngugi | Member |
| 5. | Dr. Francis M. Muthuri | Member |
| 6. | Mr. B.R.K. Shuma | Member |
| 7. | Mr. Paul K. arap Konuche | Member |

(From left to right)

Mr. J.W. Wasike – Tourism • Dr. Francis Muthuri – Board Member • Mr. P.K. arap Konuche – Board Member • Mr. S.C. Mbinda – MENR • Hon. J.P. Korelach – Asst. Minister, MENR • Hon. J.J.M. Nyaga – Minister, MENR • Mr. E.C. arap Lang'at – Permanent Secretary, MENR • Mr. B.R.K. Shuma – Member • Dr. David Ngugi – Member Prof. F. Owino – Member • Prof. G. Eshiwani – Member • Dr. J.A. Odera – Director, KEFRI

# STAFF OF THE KENYA FORESTRY RESEARCH INSTITUTE

## DIRECTORATE

J.A. Odera Bsc, Msc, Phd — Director

R.W. Macharia
B.T.W. Nyala
S.N. Kariuki

### Research Programmes

#### General Silviculture:

| | |
|---|---|
| C.K. Kiriinya, Bsc, Msc | Research Officer |
| J.M. Kimondo, Bsc, Msc | Research Officer |
| T.O. Omenda, Bsc. (arrived July 1987) | Assistant Research Officer |
| J.K. Maingi, Bsc. " " " | Assistant Research Officer |
| J.G. Kariuki, Bsc. (arrived July 1987) | Assistant Research Officer |
| M. Gathura, Dip. For. | Forester |
| J.K. Kioko, Dip. For. | Forester |
| C.M. Muchoki, Dip. For | Forester |
| Njeru, Dip. For. | Forester |
| A.O. Ajuka, Dip. For. | Forester |
| J, C. Njuguna, Dip. For. | Forester |
| G.K. Mutua, Dip. For. | Forester |
| B.M. Kipkemboi, Dip. For. | Forester |
| D.I. Mwangi, Cert. For. | Forest Assistant |
| J.K. Kiamba, Cert. For. | Forest Assistant |
| J.M. Wambugu | Technician I |
| S. Thogo, | Laboratory Technician I |
| B.K. Wachira | Laboratory Technician III |
| S.O. Ochieng | Laboratory Technician III |
| R.I. Gibera (Ms) | Shorthand typist |
| B.N. Oenga (Ms) | Copy typist |
| A.I. Indimuli (Ms) | Copy typist |
| H. Obati | Copy typist |
| J. Abok | Clerical Officer |
| A. Bosibori (Ms) | Clercal Officer |
| L.N. Kamari | Clerical Officer |

#### Forest Genetics and Tree Improvement:

| | |
|---|---|
| S.Y.S. Kaumi, Bsc. | Principal Research Officer |
| E.M. Chagala (Ms), Bsc, Msc. | Research Officer |
| P.O. Oballa, Bsc, Msc. | Research Officer |
| E. Onzongo, Bsc (arrived Oct 1987, left April 1988) | Assistant Research Officer |
| J.F. Kamiri, C & G Lab. Tech. | Laboratory Technologist |
| M.D. Kibuku | Senior Technician |
| P.O. Wanjawa | Technician I |

| | |
|---|---|
| S. Thogo | Technician |
| J.M. Wambugu | Forest Nursery Supervisor |
| V.W. Chege (Ms) | Copy Typist |
| G.K. Mungai | |

**Forest Ecology**

| | |
|---|---|
| B.N. Kigomo, Bsc. Msc | Research Officer, Forest Ecologist |
| M.M. Wairagu, Bsc. | Assistant Research Officer |
| J.M. Were. Bsc. | Assistant Research Officer |
| J.A. Awimbo, Bsc. (Arrived Aug. 1987) | Assistant Research Officer |
| D.K. Muchiri, Dip. For | Forester |
| B. Owuor | Forester |
| W. Kipkemboi | Technologist |
| F.N. Gachathi Int. Dip. Kew | Technologist |
| L. Kihura | Senior Technician |
| S. Wakaba | Technician Trainee |
| F. Muindi | Technician Trainee |
| R. Oywer | Technician Trainee |
| E. Achola | Technician Trainee |
| D. Sachita | Nursery/ Field Worker and Enumerator |
| B. Maina | Nursery/ Field Worker and Enumerator |
| P. Muiruri | Nursery/ Field Worker and Enumerator |
| D. Gichinga | Nursery/ Field Worker and Enumerator |
| R. Ngendo | Nursery/ Field Worker and Enumerator |
| A.N. Mutiso (Mrs) | Copy Typist |

**ASALS Afforestation Systems:**

| | |
|---|---|
| P.B. Milimo, Bsc, Msc, | Research Officer |
| J.M. Mulatya, Bsc. | Research Officer |
| G.N. Muturi, Bsc. | Assistant Research Officer |
| R.K. Chirchir, Bsc. | Assistant Research Officer |
| C. Nyandiga, Bsc. | Assistant Research Officer |
| G.N. Mwaura, Dip. For | Forester |
| J. Kioko, | Forester III |
| A.O. Ajuka | Forester III |
| G. Wanyanja | Lab. Technician |
| M.M. Meso | Lab. Technician |
| A. Wekesa (Ms) | Lab. Technologist Trainee |
| J. Wandabwa | Lab. Technologist Trainee |
| E. Bukasa | Lab. Technologist Trainee |
| J. Gaya | Higher Clerical Officer |

**Tree Seed Technology and Seed Quality control:**

| | |
|---|---|
| E.M. Kariuki (Ms), Bsc. Msc | Research Officer |
| G. Rode (German) | Research Officer |
| C. Schaefer (German) | Research Officer |
| J.W. Wanyondu (Ms,) Bsc. (arrived Jan 1988) | Assistant Research Officer |
| W.N. Mucheke, Dip. For. (Arrived August 1987) | Forester |

| | |
|---|---|
| J.J.J. Munyao, Dip. For (Arrived August 1987) | Forester |
| Z.V. Siva, Dip. For. | Forester |
| D.K. M. Kahuthie, Dip. For. | Forester |
| D.M. Angaine, Dip. For. | Forester |
| K. Wachira | Lab. Technician |
| L. Wambui (Ms) | Lab. Technician |
| D.K. Musya, Dip. For. | Forester |
| A. Mbora (Ms) Dip. For. | Forester |
| A. Ng'ang'a (Ms) | Lab. Technologist III |
| J. Gichana | Lab. Technologist III |
| J. Obango | Lab. Technologist III |
| R. Njambi (Ms) | Secretary/Typist |
| A. Mutua | Clerical Officer |

**Forest Protection and Conservation**

**Forest Entomolgy and Zoology**

| | |
|---|---|
| M. Gichora (Ms), Bsc. | Assistant Research Officer |
| A.L. Owuor, Bsc. (arrived Oct. 1987) | Assistant Research Officer |
| M.K. Karanja, C & G Lab. Tech. 'O' Cert. | Senior Lab. Technologist |
| F.C. Mbugua | Senior Technician |
| J.K. Mbathi | Lab. Technician III |
| J.N. Nyamo | Lab. Technician |
| J.N. Kabute | Lab. Technician I |
| H.M. Kuria | Lab. Technician III |
| F. Mwaura | Lab. Technician III |
| E.N. Maruku (Ms) | Copy Typist |

**Forest Pathology and Mycology:**

| | |
|---|---|
| E.J.M. Mwanza, B.Ed. (Science), M. For Sc. | Research Officer Forest Pathologist |
| L.M. Mwangi, Bsc, Msc. | Research Officer, |
| J. Karinga (Ms), Bsc. (arrived July 1987) | Assistant Research Officer |
| F.M. Munga, Dip. For. | Forester |
| S.K. Waithaka | Lab. Technician I |
| A. Mukwana | Lab. Technician I |
| V.J. Mburu | Lab. Technician I |
| A. Mulongo | Lab. Technician I |
| R.W. Njuguna | Lab. Technician |
| T.M. Owiyo | Lab. Technician III |
| B.O. Ng'ong'a | Lab. Technician III |
| L.A. Gibera | Lab. Technician III |
| M. Mulwa (Mrs) | Copy Typist. |

### Forest Products Research

| | |
|---|---|
| B. Chikamai, Bsc. Msc. | Research officer |
| T. Kabii, Bsc. | Assistant Research Officer |
| J. Githiomi, Bsc. | Assistant Research Officer |
| D.M. Mikili | Laboratory Technologist III |
| A.D. Musekah | Laboratory Technologist III |
| J. Katuva | Laboratory Technician III |
| M. Lukibisi | Laboratory Technician |
| R. Shanda | Laboratory Technician |
| L. Wanamo | Laboratory Technician |
| BCheruiyot | Clerical Officer |
| I.N. Kiiru | Clerical Officer |
| B. Sabaya (Ms) | Typist II |

## Social Forestry Research and Training Development

### Agroforestry Systems:

| | |
|---|---|
| D.O. Nyamai, Bsc, Msc, PhD | Research Officer, Agroforester |
| R.J. Mwendandu, Bsc. | Assistant Research Officer |
| J.H.O. Otieno, Bsc | Assistant Research Officer |
| D.N. Mugendi, Bsc. | Assistant Research Officer |
| J. Amwata, Bsc. (arrived July 1987) | Assistant Research Officer |
| F.M. Kanja, Bsc. (arrived July 1987) | Assistant Research Officer |
| Okumu | Senior Laboratory Technologist |
| C.J.M. Ochieng | Technologist II |
| W.O. Atie | Technologist Trainee |
| R.M. Mutunga (Ms) | Laboratory Technician |
| P. Juma | Laboratory Technician |
| J.A. Malanga | Laboratory Technician |
| M.K. Changwony | Laboratory Technician |
| M.N. Odongo | Research Technician |
| M. Etindi | Research Assistant/Technician |
| O. Okumu | Research Assistant/Technician |
| C. Agidho | Research Assistant/Technician |
| T. Omondi | Research Assistant/Technician |
| A. Abol | Research Assistant/Technician |
| S.R. Odemba | Research Assistant/Technician |
| N.O. Muok | Technician Trainee |
| H.K. Wandabwa | Research Technician |
| P.I. Njoroge | Clerical Officer |
| J. Ngugi | Clerical Officer |
| J. Owalo | Nursery Head man |
| A.M. Muli (Ms) | Copy Typist |
| H.O. Achieng (Ms) | Typist/Junior secretary |

### Social Forestry Training and Research

| | |
|---|---|
| K. Watanabe | Chief Adviser (JICA) SFTP |
| Y. Watanabe | Japanese Expert, SFTP |
| C.K. Kiriinya, Bsc, Msc. | Research Officer, Project Manager. |

| | |
|---|---|
| E.K. Kireger Bsc. (arrived July 1987) | Assistant Research Officer |
| T. Niino | Japanese Expert, SFTP |
| Y. Yanagihara | Japanese Expert, SFTP |
| N. Noda | Japanese Expert, SFTP |
| H. Hatori | Japanese Expert, SFTP |
| H. Yamashita | Japanese Expert, SFTP |
| S. Takabatake | Japanese Expert, SFTP |
| M. Arai | Japanese Expert, SFTP |
| O. Edazawa | Japanese Expert, SFTP |
| L.O. Sabaya, Kew Certificate | Senior Laboratory Technologist |
| M.O. Mukolwe, Dip. For | Forester |
| J.C. Njuguna | Forester |
| G.K. Kimani | Forester |
| C.N. Ong'weya | Forester |
| D.O. Otieno | Laboratory Technician |
| J.S. Mutange | Laboratory Technician |
| S.A. Othuon | Laboratory Technician Trainee |
| S. Atanas | Laboratory Technician Trainee |
| D.A. Kitur | Field Technician |
| A. Gonosa | Plant Operator |
| K.M. Mutwiwa | Clerical Officer |
| J.J. Mwendwa | Clerical Officer |
| S. Achia | Clerical Officer |
| C. Sikuku | Typist |
| J.N. Nyamai | Typist |

## Research Support Units

### Chemistry and Biotechnology

| | |
|---|---|
| J.G. Mwangi High Dip, Bsc, Msc, PhD. | Principal Research Officer |
| D.W. Odee, Bsc. | Assistant Research Officer |
| M.M. Yonga (Ms) Bsc | Assistant Research Officer |
| N.M.Wairagu | Laboratory Technologist Trainee |
| M.W. Macharia | Laboratory Technologist Trainee |
| L.M. Mwaura | Laboratory Technologist Trainee |
| E.T. Makatiani | Laboratory Technician |
| B. Khasiala | Laboratory Technician |
| E.A. Adongo | Laboratory Technician |
| N.A. Achieng | Laboratory Technician |
| W.M. Mauta | Laboratory Technician |
| S.G. Muriithi | Laboratory Technician |
| J.N. Mwororo | Laboratory Technician |
| M.M. Onyiego | Laboratory Assistant |
| D.K. Kiberenge | Laboratory Assistant |
| P.M. Ndungu | Laboratory Assistant |
| A.N. Kimani | Clerical Officer |
| J.N. Mwangi | Typist II |

**Forest Soils:**

| | |
|---|---|
| C.K. Serrem, Dip. Ed., Bsc | Assistant Research Officer |
| A.C. Yobterick (Ms) Bsc. | Assistant Research Officer |
| D.M. Kamau, Bsc. (arrived Aug. 1987) | Assistant Research Officer |
| G.K. Mbuthia | Lab. Technologist II |
| J.K. Lelon | Lab. Technologist III |
| G.N. Ngigi | Lab. Technician Trainee |
| A.F. Korir | Lab. Technician Trainee |
| Z. Ogara | Lab. Technician Trainee |
| S. Kirui | Lab. Technician Trainee |
| J.A. Sigei | Lab. Technician Trainee |
| G.J. Tomno | Copy Typist |

**Forestry socio-economics and Policy Studies:**

| | |
|---|---|
| J.K. Cheboiwo, Bsc. | Assistant Research Officer |
| H.K. Kariuki | Technologist Trainee |
| R.K. Mutwol | Technologist Trainee |

**Information and Documentation**

| | |
|---|---|
| G.H.O. Aoko C & G Cert. Print. | Technologist |
| P.H.N. Mairu | Printing Assistant |
| M.N. Kasango | Printing Assistant |
| S.N. Kamonde | Printing Assistant (Trainee) |
| C. Nyogot | Scientific Illustrator |
| W.N. Kagina | Library Assistant |
| J.K. Koech | Library Assistant |
| N.A. Achieng (Ms) | Assistant Documentalist |
| J.O. Otuoma | Printing Assistant |
| A.M. Wambui (Ms) | Library Assistant |
| H.A. Oduor | Binder |
| A.K. Wangunyu | Binder |

**Executive and Adminstration**

| | |
|---|---|
| S.N. Kariuki | Executive Officer I |
| A.O. Otieno | Assistant Executive Officer |
| R.W. Macharia (Ms) | Personnel Officer I |
| S.M. Mwakisha | Personnel Assistant |
| H.G. Maina | Senior Clerical Officer |
| J.M. Karanja | Higher Clerical Officer |
| E. Anyango | Clerical Officer |
| D. Ongeri | Clerical Officer |
| D. Muthoka | Clerical Officer |
| E. Mungai (Ms) | Clerical Officer |
| J. Mutua | Clerical Officer |

| | |
|---|---|
| S. Kigomo (Ms) | Clerical Officer |
| M. Njoki | Clerical Officer |
| F. Kandaya | Clerical Officer |
| M. Waitherero | Clerical Officer |
| M. Chumburi (Ms) | Clerical Officer |
| S.K. Kirimi | Clerical Officer |
| J. Mwaura (Ms) | Clerical Officer |
| J. Mbogo | Clerical Officer |
| A.O. Bosibori (Ms) | Clerical Officer |
| E.M. Mbugua | Clerical Officer |
| M. Maina (Mrs) | Personal Secretary |
| L. Ndurya (Ms) | Secretary |
| G. Owino (Ms) | Copy Typist |
| E. Mbatia (Ms) | Copy Typist |

**Accounts**

| | |
|---|---|
| B.T.W. Nyala | Senior Accountant |
| J. Makimii | Accounts Assistant |
| Z. Rao (Ms) | Accounts Assistant |
| H. Egese | Accounts Assistant |
| J.S. Musah | Senior Clerical Officer |
| J. Chege | Higher Clerical Officer |
| S. Oduor | Higher Clerical Officer |
| C. Wachira (Ms) | Clerical Officer |
| F. Ochungu | Clerical Officer |
| C. Hiram (Ms) | Clerical Officer |
| P. Sang | Clerical Officer |
| J. Kirai | Clerical Officer |
| S. Ogao | Clerical Officer |
| P. Wachira | Clerical Officer |
| R. Okello (Ms) | Clerical Officer |
| R. Mukami (Ms) | Clerical Officer |
| M. Mulei | Clerical Officer |
| Njuguna (Mrs) | Shorthand Typist |
| R. Gathuru (Ms) | Copy Typist |
| F. Omollo (Ms) | Copy Typist |

**Maintenance and Workshop**

| | |
|---|---|
| G.K. Kariuki | Senior Artisan/Estate Foreman |
| J. Gwedi | Artisan |
| J. Otieno | Artisan |
| G. Kiarie | Artisan |
| G.W. Rongo | Artisan |
| A. Karani | Artisan |
| W. Onditi | Artisan |
| S. Oketch | Artisan |
| G.O. Nyaguti | Electrician |
| W.O. Mate | Electrician |

| | |
|---|---|
| W.O. Magare | Mason and Joinery |
| W. Kiptui | Mason and Joinery |
| K. Njelewa | Mason and Joinery |
| L. Chemwalo | Mason and Joinery |
| G.M. Kamau | Clerical Officer |
| E.O. Owino | Clerical Officer |

**Stores and Suplies**

| | |
|---|---|
| G. Onyango | Supplies Officer |
| R.K. Kariuki | Supplies Assistant |
| E.M. Akali | Supplies Assistant |
| M. Muloki | Storeman I |
| H.N. Muthoni | Storeman II |
| B. Ngugi | Stores Issuer |
| B.M. Osero | Stores Issuer |
| P. Kotacha | Stores Issuer |
| P.K. Soli (Ms) | Clerical Officer |

# GENERAL REVIEW

The Kenya Forestry Research Institute (KEFRI), one of the statutory scientific research institutions under the Science and Technology Act (cap 250) proceeds to its third year since its instituing. KEFRI's main objective is to promote and undertake research and development on all aspects of forestry. The existing heavy demand for scientific information and technological packages for solving forest management problems has led Kefri to a research agenda tuned to lead to scientific discovery and technological innovation. Operative under now expand five technical research programmes Kefri has been able to make progress in scientific discovery in some aspects of forestry.

KEFRI as an institute plays in addition to its research role an advisory one of resolving forestry related anomalies. KEFRI also actively participatesin the A. S. K. Nairobi International Show.

**Staff:** Details of staff are given at the beginning of the report. The senior position improved with the recruitment of 5 new graduates with a Bsc. Forestry degree from Moi University and 6 graduates with a Bsc. in Basic science from Nairobi University.

The following scientists returned from Canada after completing their Msc. degree studies: - Mr. J.M. Kimondo, Mr. L.M. Mwangi. Mr. Nyamai returned from U.K after PhD studies in Agroforestry.

**Training**

The staff training programme was maintained to the extent possible under the organisation process.

In the Forest Genetics sub-programme Miss E.M. Chagalla proceeded to a PhD course in Canada under CIDA sponsorship at the University of Toronto. Ms E.M. Kariuki went to Australia for an on the job training. Two officers of the Seed Centre inthe collection and extraction unit went to Germany in October 1987 for further training. M.M. Wairagu went to Canada for an Msc Course.

A number of technical staff are attending courses at the Kenya Polytechnic.

**Collaboration with other organizations.**

Collaboration with both national and international organizations continued. The Institute worked closely with the Kenya Forest Department and Non-governmental organizations providing free consultancy services.

The ASAL subprogramme collaborates with ACIAR, NORAD, FINNIDA, FAO and EMI projects in establishment of various field experiments. The Tree Seed Centre in collaboration with GTZ put up a conference room, two offices and computer room. Agroforestry subprogramme collaborates with CARE, AFRENA and ICRAF in various stations. The Social Forestry subprogramme in collaboration with JICA continued. The Project concentrated on nursery and plantation establishment activities and prepared for training activities scheduled for later 1988. The Forest Soils subprogramme collaborated with CARE/KEFRI agroforestry project, KUINET-KEFRI/DDC/International Fellowship Clergy Project in analysis of soil and evaluation of agroforestry systems.

**Travel outside Kenya**

Mrs. E. Murugi, Mr. G. Rode and Mr. P. Oballa attended a seminar in Zimbabwe on proceedings of the International Symposium of 'Forest seed problems in Africa'.

Mr. Oballa, Miss M. Gichora also attended a 3 week course on 'Forestry Research Methods' in Arusha Tanzania. Mrs. E.M. Murugi went to Denmark on a familiarisation tour of the Danida Forest Seed Centre.

Mr. P.B. Milimo took a study tour of ACIAR and Agroforestry Projects in Zimbabwe, Zambia and Malawi. Mr. G.M. Muturi attended a short course on 'Experimentation techniques on fodder production with saline water' in Israel. Dr. Nyamai attended a course in plant Tissue culture in U.K. Miss A.C. Yobterick attended a 5 months' course on forest soils in Japan. Mr. J. Cheboiwo attended an IUFRO course on Statistical Methods for Forest Research in Austria. He also took a familiarization tour of Germany's Forestry.

**Local Activities**

In July 1987, Mr. E. Mwanza attended a course at the University of Nairobi's Geeaga Institute on "Electron microscopy and purification of viruses" organised by KARI, Rothamsted Experimental Station and the University of Sussex in co-operation with the British Council/ODA.

The ASAL Subprogramme hosted a Forestry Seminar in Embu from 22nd to 24th February 1988.

J. Were attended a seminar on Agroforestry networks for the East African Highlands in Nairobi. Mr. J. Were and Miss J. Awimbo attended a course on 'Use of Remote sensing and G.I.S. for resource management' in Eastern Africa' in Nairobi.

N. Gachathi gave a lecture in a seminar on Tree indentification and timing of seed colletion at KEFRI Seed Centre.

Miss J. Awimbo participated while Mr. J. Were gave a paper 'Ecological significance, utilization and conservation of bamboos in Kenya' at a National expedition on Natural resources and habitats. Mr. A.L. Owuor attended the second East African Training Course on Insect Identification and Biosystematic services for Agriculture, in Nairobi in April 1988.

Dr. D. Nyamai attended an AFRENA workshop organized in Nairobi to discuss experiments laid out and to plan for additional ones in May to June 1988.

Dr. J.G. Mwangi attended a National Development workshop held at KIA in July 1987.

**Papers and Publications**

Dr. J.G. Mwangi submitted a paper 'Soil and Wood block Moisture Interactions upon decay' to the International Journal of Woodscience.

Mr. C.K. Serrem and Ms. A.C Yobterick published research reports 'First Season Results'

Mr. C.K. Serrem, Mr. D.M. Kamau and Mr. J.H.O. Otieno published research report "Preliminary results - Biomass Growth rate and woodlots data analysis for a 4 species in 5 sites.

Mr. C.K. Serrem, F.K. Arap Sang and D.A. Hoestra published research report No. 6 entitled "Mineralization aspects and growth yield".

## Visitors

The Vice President of the Republic of Kenya, Honourable Dr. J.N Karanja accompanied by several Ministers, Assistant Ministers, chairman of NCC. (Nairobi City Council), Japanese representatives from JICA, Kenya and Embassy of Japan, several Members of parliament and other distinguished guests was the guest of honour at the Institute on the ocassion of The 1988 National Tree Planting Day, 22nd April 1988.

3 teams of Japan Government officials including JOFCA on different ocassions visited the Institute to observe the Social Forestry Training facilities and on technical staff cooperation activities. The Vice President JICA Mr. H. Sano visited the Institute in March 1988 prior to the handing over of the Social Forestry Project facilities to the Government of Kenya.

The Minister for Research Science and Technology Hon. G.M. Ndotto accompanied by the Assistant Minister Hon. S. Lugonzo officiated on the ocassion of the handing over of the Social Forestry Project facilities by the Government of Japan to the Government of Kenya on 31st May 1988.

Other important visitors on different ocassions include Ministers for Research, Science and Technology and Environment and Natural Resources, members of PCSCA, representatives of SIDA, FAO, DANIDA, ICRAF, UNDP, KWDP, EMI, OXI and universities both local and overseas, for various research collaborative programmes.

## KENYA FORESTRY RESEARCH INSTITUTE
## BALANCE SHEET AT 30 JUNE 1988

| | 1988 | 1987 |
|---|---|---|
| | KShs. | KShs. |
| FIXED ASSETS | 223,967,783 | 20,885,246 |
| CAPITAL WORK IN PROGRESS | 1,862,033 | – |
| CURRENT ASSETS | | |
| Debtors | 248,274 | 21,125 |
| Stocks | 2,978,924 | 1,197,766 |
| Cash at Bank and on hand | 9,699,783 | 1,974,829 |
| | 12,926,981 | 3,193.720 |
| CURRENT LIABILITIES | | |
| Creditors | 298,397 | 719,130 |
| NET CURRENT ASSETS | 12,628,584 | 2,474,590 |
| | 238,458,400 | 23,359,836 |
| FINANCED BY: | | |
| GOVERNMENT GRANTS FOR DEVELOPMENT | 14,197,808 | 2,750,693 |
| GOVERNMENT GRANTS FOR CAPITAL ASSETS | 233,855,842 | 24 259,313 |
| EXTERNAL GRANTS FOR RESEARCH | 867,027 | 438,450 |
| EXCESS OF OPERATING DEFICIT OVER RECURRENT GOVERNMENT GRANTS CARRIED FORWARD | (10,462,277 | (4,088,620) |
| | 238,458,400 | 23,359,836 |

*The difference is due to the acquisition of the assets through grant in aid handed over by the Government of Japan to the Government of Kenya and the depreciation provision thereon.

## SUMMARY OF RESEARCH ACTIVITIES

KEFRI'S research activities now constitute 5 programmes each of which is subdivided into sub-programmes

**1. Forest Silvicuture and Tree Improvement:**

a) *General Silviculture:* expanded the international as well as indigenous species and provenance trials by introduction of new species on various sites, to further provide information on parameters of silvical importance as well as for conservation. Other studies that were also given emphasis are establishment techniques and documentation of timber trees of Kenya. The plantation management studies continued.

b) *Forest Genetics and Tree Improvement:* Genetic improvement of *Eucalyptus saligna, pinus radiata* and *Populus denhardtiorum* was highlighted, it was initiated and is in progress. Work on establishment of clonal seed orchards and tree banks was intensified while the nursery continued to raise seedlings of a few ornamental species; species, provenance and progeny trials were assessed and maintained.

c) *Forest Ecology:* Growth, phenological and ecological studies on *Brachyleana hutchinsii* and *B. huillensis* were given high priority. Other studies included propagation and establishment of bamboo for its multiple utilization. A consultancy review of the project prompts the introduction of exotic bamboos. Conservation work on Arabuko Sokoke forest was initiated.

d) *Asals Afforestation Systems:* Maintenance of browse trials and regeneration of riverine trees, handed over from the Forest Department and NORAD in Lodwar, were given more emphasis in an effort to solve marginal lands forestation problems.

Establishment of Species, provenance, irrigation and weeding trials for the same made a good start.

e) *Tree Seed Technology and Seed Quality Control:* The new Seed Centre is responsible for research on extraction, storage and germination of all species handled in order to optimise the procurement of the species. With its various collection centres it carries out activities that include: establishment of seed stands and provenance trials, seed tree selection, seed stand selection, seed collection from all over the republic, seed extraction, germination tests at various conditions, viability tests, purity tests, weight moisture content determination and phenology studies.

**2. Forest Protection and Conservation:**

a) *Forest Entomology and Zoology:* The determination of most appropriate means of control of pests of economic importance is the mainstay of the subprogramme. Chemical and biologial control methods are based on studies - chemical efficacy and pest predator relationship for termites and pine woolly aphid respectively. Monitoring of millipede population is in an effort towards their control. The insect reference collection continued to grow.

b) *Forest Pathology and Mycology:* Research in mycorrhiza, actinomycetes - Casuarina Nitrogen Fixation, plantation diseases e.g. cypress canker Armillaria Root disease still continue. The joint projects with Tree-Breeding and Tree Seed Centre subprogrammes on breeding *P. radiata* for resistance to Dothisroma blight and identification of pathological causes of losses of viability in stored seed respectively are also still in progress. The experiment on timber decay was concluded.

**3. Forest Products Research**

Project F[3] on photomicrography's phase 1 was concluded and the programme proceeded to phase 2. In project LD[3] determination of the physical properties of tested logs still continued while work on fancy items production was initiated, it has favourable financial gains. The introduced charcoal conversion menthods are being studied for their suitability and efficiency.

**4. Social Forestry Training and Research Development:**

**a)** *Agroforestry Systems:* An intensive research programme in agroforestry's need is realized. The KEFRI-AFRENA project was implemented. On-station experiments/demonstration plots at Muguga, Dryland agroforestry research experiments on-station in Katumani and;

on-farm at Kakuyuni were initiated. The CARE — KEFRI agroforestry research trials in Siaya were assessed.

b) *Social Forestry Research and Training:* This sub-programme aims at developing a package for tree planting by farmers on their own land. The thrust is focused on semi-arid land the most vulnerable and the one called for immediate action with national applicability in consideration. Establishment of nurseries at both Muguga and Kitui has been the main activity.

**5. Research Support Unit**

a) *Chemistry and Biotechnology Research:* In an effort to improve and increase forestry resources, the subprogramme undertook studies on rhizobial biotechnology, timber preservatives, biodegradation and biodeterioration of timber, natural durability of timber, shooting and rooting of *Melia volkensii* and low cost method of treating timber. The culture collection attained 40 and quantifying their nitrogen fixing potentials in scheduled.

b) *Forest soils:* Soil chemical analysis under different agroforestry tree species and crops in relation to their growth is the main activity. Soil samples were collected in the field and phisical and chemical analysis carried out in the laboratory.

c) *Forest Socio-economics:* The subprogramme concentrated on surveys aimed at determining research needs, socio-economics of projects and management and marketing of *Acacia mearnsii.* It liases with other sub-programmes in all aspects of economical management research.

# SILVICULTURE AND TREE IMPROVEMENT PROGRAMME
# GENERAL SILVICULTURE

C.K. Kiriinya, J.M. Kimondo, T.O. Omenda, J.K. Maingi, J.G. Kariuki, M. Gathura, J.K. Kioko, C.M. Muchoki, Njeru

The year marked a transition stage for the subprogramme due to the reorganization of the programme of Environment and Silviculture into several subprogrammes in the previous year. Most of the activities of the former programme are now being handled under specific programmes/ sub-programmes: Despite these reorganizations the subprogramme achieved substantial progress in implementation and evaluation of research programmes in high and medium potential zones of Kenya.

The subprogramme involved itself in research in high and medium potential zones of Kenya in the following areas:-
(a) Species and Provenance Research.
(b) Site Adaptability.
(c) Management Techniques.
(d) Establishment Research.
(e) Arboreta.

**(a) Species and Provenance Research**

Programme implementation continued throughout the year.
New experiments were set up, others assessed and maintained. Indigenous tree species trials were also introduced.
**GEDE:** Only one experiment was established, under ACIAR (Australian Centre for International Agricultural Research). This is a Eucalyptus Acacia species trial comprising of the following: 2 *A acciuliformis*, 3 *Acacia mangium*, 1 *A. crassicarpa* and 1 *A. flarescens* provenances; 4 provenances each of *Eucalyptus grandis; E. saligna* and *E. tereticornis* and *E. urophyla* provenance.

**TURBO:** The following experiments were established in the field.
1. ACIAR project 8320: was set up as a joint Australian-Kenyan Eucalypts/Acacia trial. New species plus new provenances of already introduced species are on trial. Some species are being tried for the first time in Kenya. These are *Eucalyptus pellita, E. aevopinea E. andrewsii,, E. pyrocarpa* and *E. oreandea*. The objective of the trial is to determine through a series of trials which Australian species in genera Eucalypts and Acacia are best suited for fuelwood/roundwood production.
2. *Pinus patula*/Pinus patula sub *sp. tecunumanii* trial at Turbo: This is a DANIDA (DANNISH International Development Agency) project. The trial's main objective is tree improvement and gene conservation.
*Calliandra calophylous* and *Gliricidia sepium* plots were established at Kakamega, measuring 3 ha each to serve as seedlots.
A gene conservation stand, set up at Nzoia near Turbo.
Indigenous species trial being undertaken in the station.
**LONDIANI:** Three experiments were set up.
1. EP 163 A base plantation of improved *Eucalyptus grandis* at Molo and Elburgon.
2. EP 164 - Progeny trial of *E. urophyla* at Elburgon.
3 pine species at Elburgon and a gene bank stand at Molo.
The following are the brief progress reports of experiments that were assessed during the year:
**RE 417/81** - Hardwood species trial. Established in 1981 at Gede with the aim of comparing survival, growth performance between different hardwood species. The trial is composed of 5 hardwood species. Analysis of variance at age 6 years shows very significant differences in growth performance between the species. *Gmelina arborea, Terminalia brownii* and *Tamarindus indica* are the most promising species. *G. arborea* has the best height and DBH growth. Performance of the species will be closely monitored for at least 10 years.

**RE/78** - Euclyputus species and provenances trials set up in 1978 at Gede. It consists of 6 treatments (provenances) in 3 replications. The object is to observe differences in growth and establishment of 6 species of Eucalypts on the same site. Data has been collected and analysed in 1984 (4 years) and 1987 (9 years).

Analysis of variance showed that there is a significant difference in performance among the six species, at P= 0.05 level. *Eucalyptus hybrid* (001) from Ghana shows the best performance in survival, height and DBH growth (Mean) DBH =39 cm, Mean Ht = 20m, survival = 85 per cent). Other species with encouraging performance are *E. alba* (400 - 001 EAAFRO arboretum), and *E. terminalia* (S11700) from Northern Bauke Australia. All have over 50 per

cent survival.
*E. sideroxylon, E. saligna* (Muguga) and E. *E. melliodora* shows very poor performance (3 per cent) survival.

SP 194 - This trial was set up with the aim of comparing growth between *Podocarpus milanjianus and P. gracillior* at Kaptagat. It was assessed for DBH and Height. Results are being handled by Inventory Section.

SP 184 - Assessment of growth of *Juniperus procera* and Timboroa. It was assessed for height, dbh and maintained.

**EP 150 A:** This *liquidamber styraciflua* trial set up in 1986, was assessed for height and survival. This is an international trial and first trial of the species in Kenya. The species does well in growth on a site previously under natural forest at Kakamega. 10 Provenances are on trial and there are no major differences in performance between them. The trees are expected to perform better after weeding. The trial is replicated on another site at Lugari.

**RE 391/80:** This is an international provenance trial of *Eucalyptus grandis* established at Londiani. It was assessed for height and DBH. Data is being analysed and results are expected soon.

**RE 218.62:** This *Pinus* sp trial planted in 1962, was assessed last in 1987 at age 26. Various Pinus species and provenances exhibit extreme differences in performance. Most of the pines show heavy branching and poor form. However, *Pinus maximinoi (Pseudostrobus)* provenance from Sierra Juarezoxaca exhibits the best growth.

**RE 299/69:** *Tectona grandis* provenance trial at Buda planted in 1969. The objective of the trial was to compare growth performance between 6 provenances (Tanzanian land races) of *Tectona grandis*.

The trial planted at 2 x 2 m spacing has two replications. Analysis of data at age 18 years shows that there is no significant difference in performance between the provenances. However, two provenances Ex-Kihumwi and Ex-Mutibwa land races had best overall performance in that order in terms of DBH and height growth.

**RE: 1986 PLANTING:** *Eucalyptus urophyla* provenance trial.
Planted in 1986 with the objective to compare survival, growth performance, stem form and branching habit of 6 provenances of *E. urophyla*. The trial was set up at Gede at a spacing of 3.0x3.0m. 5 provenances are from Indonesia. The trial was assessed and first year results show that there is no significant difference in performance between the provenances in terms of survival and DGL (Diameter at Ground Level). However the provenances are significantly different ($P = 0.05$) for height. Mountain provenances (Mt. Boleng and Mt. Elgon) Indonesia show very promising growth. Mean height at age 1 was 2.25m.

**RE: 1985 PLANTING** Mixed species trial with *Albizia falcataria, A. lebbeck, Gmelina arborea* and *Terminalia ivorensis* from Setropaland, Ethiopia, Costa-Rica and Oshogbo - Nigeria respectively. The trial was established in 1985 with an objective of studying growth and establishment of the species at Gede.
The trial, randomised in two blocks at a spacing of 2.5 x 2.5m was assessed for height DBH and survival, height and DBH performance between the species. *Albizia lebbeck* 74/04-1 from Ethiopia shows the best all round performance in height, DBH, growth and survival (with 3.94 m Ht. 3.07 cm dbh and 94 per cent survival (mean). *Terminalia ivorensis* performed very poorly with respect to all parameters assessed.

**RE 46/81 GEDE:** Eucalyptus species/ provenance trial with 5 *E. camaldulensis, 3 E. tereticornis* and *2E. urophyla* provenances to compare establishment and growth of the 3 species analysed provenances. At age 6, data have been analysed and *E. urophyla* shows the fastest growth. The provenance from Indonesia in particular is outstanding.

**(b) Site Adaptability**
A comprehensive programme to compare growth of species under different site conditions continued throughout the year. A mixed species trial at Siaya was set up to determine the adaptability of several species.

RE 366(Eucalyptus and Pine Species trial on Shallow soils:)
Planted in 1974, was assessed for height, diameter at BH, form and survival. All pines except *P. radiata* have completely failed. *E. grandis* again emerges as the best followed by *E. saligna E. camaldulensis* is doing well but has poor stem form.

**RE 310 - Sites 2, 3 and 7:** *Pinus* species trial at different sites (7), planted 1971. 3 sites were assessed during the year under review, and results have not been analysed. The sites have different soil conditions.

**RE 373, 371:** *(Eucalyptus* species trial on different soils.
(TURBO) conditions was assessed and maintained.

**(c) Management Techniques** This was largely confined to the field. Trials largely involved espacement, thinning and prunning trials.

**Re 381** *Albizia procera* espacement trial at Gede was assessed and maintained.
KW 1961 - Teak espacement trial at Gede was assessed and maintained.

**(d) Establishment Research** - Ground preparation and crop cultural techniques to maximise growth were also given emphasis. Studies included direct planting at Molo.

**(e) Arboreta** - The existing arboretum plots at Muguga, Turbo, Gede, Elburgon and Uplands were maintained.
The subprogramme undertook a survey and documentation of important timber trees of Kenya, their growth characteristics, requirement and general distribution. A survey of sacred trees for several ethnic groups was also undertaken later in the year. During the year, the subprogramme took part in a joint KEFRI-JOFCA tree growth measurements for tree species commonly grown in a cross section of regions in Kenya. These were: Kinale - for high potential zones; Embu for Medium semi-arid regions, in Eastern and Hola and Ramogi for arid zones. During the exercise, sample plots for monitoring tree growth were established in the field for the following tree species: *Cupressus lisutanica, Pinus patula, Parkinsonia aculeata* and *Cassia siamea.*

A proposal for study of tree water relations for *Eucalyptus camaldulensis* under controlled conditions, earmarked to take off late in the year but was never implemented as green houses under construction were not ready. Other necessary equipment was also not available in time.

**ADVISORY:**
A few visits were made during the year to Western, Rift Valley and Mt. Kenya regions on advisory services to Forest Stations. This included inspection of plantations for write-off.

## FOREST GENETICS AND TREE IMPROVEMENT

S.Y.S. Kaumi, E.M. Chagala, P.O. Oballa, P.O. Wanjawa, S. Thogo, J.M. Wambugu, Onzongo, J.F. Kamiri, M.D. Kibuku, Kigwa, M. Gathura, W. Abila.

### Species, Provenance and Progeny Trials

S.Y.S. Kaumi, P.O. Wanjawa, J.F. Kamiri, S. Thogo, M. Gathura.

The table below shows the experimental plots assessed during the year.

| Species | E.P.No. | Title | Location | Planting Year |
|---|---|---|---|---|
| Cupressus lusitanica | 86 | Progeny trial Controlled pollination | Muguga & Elburgon | 1973 |
| Pinus toedae | 101 | Provenance trial | Muguga | 1971 |
| Pinus patula | 104 | Provenance trial | Muguga | 1971 |
| Pinus patula | 109 | Open pollinated Progeny trial | Muguga Estate | 1971 |
| Cupressus lusitanica | 112 | Provenance trial | Muguga | 1972 |
| Cupressus lusitanica | 119 | Provenance trial | Muguga | 1973 |
| Pinus radiata | 145 | Progeny trial | Timboroa Uplands | 1985 |
| Pinus patula Subs. tecumanii | 146 | Provenance trial | Turbo | 1985 |
| Pinus maximinoi | 148 | Provenance trial | Muguga & Turbo | 1985 |

**EXP. 86**

This is a *Cupressus lusitanica* progeny trial controlled pollination established at Muguga Estate and Elburgon in 1973. The experiment consisted of 20 treatments replicated 4 times in 12 tree-plots. When assessed at the age of 12.8 and 14.2 years for both Elburgon and Muguga replicates respectively, the results were as shown below:-

**Muguga**
Canker Scores 1.98
Diameter (cm) 22.73
Height (m) 15.44
Stem Scores 2.63

**Elburgon**
Canker Scores 2.0
Diameter (cm) 24.4
Height (m) 15.3
Stem Scores 2.1

Although the assessment for both replicates was done at different periods, the progenies at Elburgon were performing much better than those at Muguga.

**E.P. 101**

This is a *Pinus taedae* trial planted on the Muguga Estate in 1971. It consists of three South African bred seedlots collected from select clones of Loblolly pollinated with selected pollen from another plus tree, and one batch from coastal Georgia U.S.A. The plot has been thinned once only to $^1/_2$ original stocking because it is patchy. When assessed at 16.2 years, results were as follows:

| | (h(m) | d(cm) | h/t | $\bar{d}$/t |
|---|---|---|---|---|
| S.A. batch 1643 | 17.7 | 21.41 | 1.1 | 1.32 |
| " " 1644 | 17.0 | 20.45 | 1.0 | 1.26 |
| " " 1646 | 15.6 | 19.59 | 0.9 | 1.21 |
| Georgia " 1647 | 11.6 | 13.82 | 0.7 | 0.85 |
| Overall mean | 15.5 | 18.82 | 0.9 | 1.16 |
| L.S.D. P = 0.05 | 1.4 | 3.34 | | |

**EXP. 104**

This is a *Pinus patula* provenance trial planted in 1971 at Muguga Estate. The objective of the experiment was to introduce Mexican (native genotypes of *Pinus patula* to East Africa and thereafter raise timber crops of this species from seedlings derived from native Mexican sources and from cultivated seed sources by the normal methods used in Kenya highlands.

Assessment after 14.9 years shows the following results:-

| Batch No. | h(m) | d(cm) | Mean Stem form (1-5) |
|---|---|---|---|
| 1565 | 18.63 | 25.15 | 43.75 |
| 1566 | 17.35 | 24.49 | 42.25 |
| 1758 | 20.75 | 26.86 | 33.50 |
| 1759 | 21.40 | 25.32 | 34.50 |
| 1793 | 18.60 | 26.89 | 39.75 |
| 1835 | 19.18 | 25.34 | 38.75 |
| 1836 | 20.00 | 25.05 | 41.00 |
| 1837 | 20.20 | 23.30 | 34.00 |
| 1838 | 19.73 | 25.43 | 35.75 |
| 1839 | 18.63 | 25.48 | 35.25 |
| 1840 | 19.48 | 25.93 | 37.50 |
| Mean Overall | 19.45 | 25.39 | 37.82 |

Based on the above results and other observations made in the field, the species is found to be doing well in terms of growth vigor.

**E.P. 109** This is an open-pollinated progeny trial of *Pinus patula* started in June 1971. It consists of one seedlot obtained from Tanzania and sixteen batches from Kenya. The plot has been thinned twice leaving 6-7 trees per plot. Some clones have been bearing cones for the last 7 years. Assessment after 16.3 years gave the results as follows:-

| Progeny | | $\bar{d}$(cm) | $\bar{h}$(m) | Mean Stem form |
|---|---|---|---|---|
| Tanzania batch | T71 | 24.37 | 18.28 | 2.37 |
| | T72 | 23.64 | 15.78 | 2.61 |
| | T73 | 26.15 | 18.78 | 2.59 |
| | TN | 24.49 | 17.24 | 2.81 |
| | K15 | 25.80 | 17.48 | 2.61 |
| | K31 | 24.08 | 17.81 | 2.79 |
| | K207 | 24.79 | 17.56 | 2.48 |
| | K208 | 25.15 | 18.69 | 2.50 |
| | K215 | 24.85 | 18.13 | 2.69 |
| | K230 | 25.42 | 18.27 | 2.71 |
| | K241 | 25.43 | 17.42 | 2.88 |
| | K245 | 25.34 | 18.87 | 2.45 |
| | K246 | 25.44 | 18.83 | 2.49 |
| | K248 | 25.40 | 18.41 | 2.39 |
| | K249 | 26.29 | 18.87 | 2.49 |
| | K250 | 24.64 | 17.84 | 2.51 |
| | K251 | 25.83 | 19.69 | 2.44 |
| | K256 | 24.54 | 18.07 | 2.43 |
| | K257 | 24.59 | 18.72 | 2.36 |
| | K261 | 23.63 | 17.75 | 2.81 |
| Overall Mean<br>L.S.D. P=0.05 | | 24.99 | 18.12 | 25.53 |

**E.P. 112**
This *Cupressus lusitanica* trial was planted on the Muguga Estate in 1972. The trial compares as a provenance trial, the growth of seedling progeny of *C. lusitanica* seed orchards with best available seed, when grown for timber production.

The trial consists of 4 batches:-
1582 seed collected from Rongai (Tanzania) Seed stand
2211 Muguga estate clonal seed orchard, Central rows collection
2212 Muguga estate C.S.O. General collection
2213 Lushoto (Tanzania) seed orchard.

Assessed at t = 15.5 years results were as shown:-

| | h(m) | d(cm) | h/t | d/t | Stem form | Canker damage |
|---|---|---|---|---|---|---|
| Batch 1582 | 16.0 | 25.0 | 1.0. | 1.61 | 2.63 | 2.08 |
| Batch 2211 | 17.3 | 25.3 | 1.1 | 1.63 | 2.39 | 1.96 |
| Batch 2212 | 17.4 | 26.1 | 1.1 | 1.68 | 2.17 | 1.84 |
| Batch 2213 | 16.5 | 24.8 | 1.0 | 1.60 | 2.31 | 1.90 |
| Overall means | 16.8 | 25.3 | 1.05 | 1.63 | 2.38 | 1.95 |
| L.S.D. P=0.05 | N.S. | N.S. | N.S. | N.S. | 0.23 | N.S. |

**E.P. 119** This is a *Cupressus lusitanica* progeny trial planted at Muguga in 1973. It consists of six batches of seeds obtained from orchards mainly at Muguga and Sokoro. The object of the experiment is to compare the growth of seedling progenies of Cypress derived from the various sources. Assessment of stem form, canker score, height and diameter after 14.6 years are as follows:-

| Batch | Mean Stem form | mean Canker Score | Mean Height(m) | Mean Diameter |
|---|---|---|---|---|
| 1571 Mexico | 2.73 | 1.76 | 13.02 | 22.34 |
| 2212 Orchard EAAFRO | 2.66 | 1.72 | 14.52 | 22.94 |
| 2242 Sokoro | 2.93 | 1.83 | 14.47 | 23.96 |
| 2337 Bred Seed | 2.55 | 1.79 | 14.16 | 23.94 |
| 2338 Portugues | 3.09 | 1.88 | 13.51 | 23.45 |
| 2339 Borehole S. Orchard | 2.59 | 1.85 | 15.30 | 29.05 |
| Overall Mean | 2.76 | 1.81 | 14.16 | 23.45 |
| L.S.D. P=0.05 | 0.34 | | 0.66 | |

Analysis of the above results shows that the Mexican seed Source got the highest tree vigour in terms of height and diameter growth although its mean stem form was relatively lower.

**E.P. 145**

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

The experiment consists of sixty wind pollinated seedlots received from New Zealand and one seedlot from Kenya. Assessment after 2.1 years showed the average height to be 2.35m and 2.71m for both Timboroa and Uplands respectively. Observations made at Uplands replicate showed severe Dothistroma attack and Wooly Aphid infestation on some plants.

**E.P. 146** This is a *Pinus patula Subsp. tecunumanii, Pinus patula* and *Pinus oocarpa* family within provenance trial planted in 1985 at Nzoia forest reserve. The objective of the experiment is to compare variation firstly between provenances, and then variation between species.

*Pinus patula Subsp. tecunumanii* seed lots were obtained from Honduras and Nicaragua and those of *Pinus oocarpa* were received from Nicaragua, Honduras and Guatemala while those of *Pinus patula* (true) were obtained from Zimbabwe. Assessment after 3 years shows the following results:

| Species | Seed Batch | h(m) | Overall Mean | L.S.D. P=0.05 |
|---|---|---|---|---|
| Pinus patula Subsp. tecunumanii | 5/82 | 3.5 | 3.83 | |
| | 6/82 | 3.79 | | |
| | 7/82 | 3.89 | | |
| | 8/82/8 | 3.87 | | |
| | 25/81 | 4.05 | | |
| Pinus oocarpa | 7/71 | 3.21 | 2.87 | |
| | 10/73 | 2.90 | | |
| | 5/74 | 2.49 | | |
| Pinus patula (true) | 30/79 | 4.11 | 4.11 | |
| | 31/79 | 4.07 | | |
| | 32/79 | 3.86 | | |
| | 33/79 | 4.16 | | |
| | 34/79 | 4.33 | | |
| | 25/79 | 4.11 | | |
| | 36/79 | 4.16 | | |

Above results shows that *Pinus patula* (true) is performing much better than the other families in terms of height growth.

**E.P. 148**

This is an international provenance trial of *Pinus maximinoi* planted in 1985 at Muguga Estate and Turbo. It consists of fourteen seed batches obtained from Nicaragua, Guatemala, and Honduras.

The objective of the provenance trial is to compare rate of growth and stem form of the various provenances. Results of assessment after three years are as follows:-

**TURBO**

| Provenance | h(m) | Mean Survival % |
|---|---|---|
| Nicaragua | 3.45 | 69.20 |
| Honduras | 2.95 | 61.25 |
| Guatemala | 3.39 | 53.00 |
| Overall Mean | 3.26 | 61.15 |

**MUGUGA**

| Provenance | h(m) | Mean Survival % |
|---|---|---|
| Nicaragua | 2.33 | 55.5 |
| Honduras | 2.17 | 63.43 |
| Guatemala | 2.30 | 88.00 |
| Overall Mean | 2.27 | 68.98 |

Above results show that the average percentage survival at Muguga is higher than Turbo while the latter have the higher average growth rate.

**E.P. 150**

This is *Liquidambar styraciflua* provenance trial planted on two sites Lugari, near Turbo, and Kakamega Forest in May 1986. *L. styraciflua* occurs naturally in Southern U.S.A., in Mexico and Central America. Height assessment at 1 year and 10 months at Lugari and Kakamega respectively show overall mean height 34cm and 55cm. Kakamega forest with its higher rainfall and better soil is producing faster growth and better survival 99 % overall against Lugari's 34%

**E.P. 152**

Planted at Turbo in may 1986, this trial consists of 19 seed batches collected from *Eucalyptus grandis* plus trees in Zimbabwe and one local batch collected from Turbo. Assessment at t = 1.6 years shows overall survival at 86%. Height growth is very good averaging 5.9m (M.A.I. 3.7m) and ranging 3.9 - 7.8m (M.A.I. 2.4 - 4.9m)

**E.P. 159**

This trial consists of 5 provenances of *Eucalyptus grandis*, 5 of *E. saligna* and 4 of *E. urophylla* planted on the Muguga estate in April 1987. It was assessed two months after planting for heights. Averages at this age shows *E. grandis* slightly taller than the other two species.

**E.P. 162**

In 1986 seed of different species was received from the Danish Forestry Seed Centre to carry out further species/provenance trials. This trial

results from this seed, and consists of provenance of *Pinus patula, P. patula Subsp. tecunumanii* and *P. oocarpa.* It was planted on three sites turbo (Nzoia) 1830m a.s.l., Muguga 2050m, and Elburgon at about 2300m. in May 1987. Due to severe drought in the Molo/Elburgon areas from June 1987, most of the planted seedlings died at Elburgon.

The plots at Nzoia (Turbo) and Muguga Estate were both assessed $1^{1}/_{2}$ months after planting. on both sites *P. patula Subsp. tecunumanii* was taller than the other two species.

Following interministerial transfer of forest lands in Kinale area, in 1987 tree breeding experimental plots tabled below were prematurely terminated:-

| Name of Experiment | E.P. No. Location | Year of Planting |
|---|---|---|
| Pinus patula progeny trial | E.P. 123 Kinale 6(B) | 1975 |
| Pinus patula progeny trial | E.P. 140 Kinale 5(N) | 1982 |
| Cupressus lusitanica progeny trial | E.P. 141 Kinale 4(F) | 1983 |
| Pinus patula progeny trial | E.P. 143 Kinale | 1984 |
| Cupressus lusitanica Seed Orchard | Kinale | 1982 |

The experiments will be re-established in Matching sites in 1989.

**E.P. 166**

P.O. Oballa, C.M. Muchoki.

This experiment aims at genetic improvement of *Eucalyputs grandis* through establishment of a bigger base pupulation for future selection. A total of 59 seedlots from plus trees in Zimbabwe have been introduced and raised at Elburgon. The experiment is to be established at Elburgon with a replicate at Molo. The first half with 29 seedlots established in 1987 died due to less rain received in the region that year.

**Genetic Improvement of E. saligna**

P.O. Oballa, J. Kamiri, M. Kibuku, P.O. Wanjawa S. Thogo.

The work on *E. saligna* is still at initial stages, 4 plus trees were selected in the Muguga Estate and arboretum. The trees were cut down in December to produce vegetative propagation material for clonal multiplication. At the same time seeds were collected from the trees to establish short-term experiment on heritable variation in these half-sib progenies. The experiment was established in April 1988.

**Establishment and Management of Clonal Seed Orchards and Tree Banks.**

S. Thogo, P. Wanjawa, W. Abila, P. Oballa, J. Kamiri.

The section still strives to establish more seed orchards and a replicate of the present tree banks.

By the end of April, 1988 there were 2553 grafts prepared, out of which 500 grafts had healed.

**Breeding of Pinus radiata for Resistance to Dothistroma Pini**

P.O. Oballa, M. Kibuku, J. Kamiri, P. Wanjawa, S. Thogo.

The section still endeavours to revive *Pinus radiata* as a plantation species using planting

materials from selected resistant trees. In addition to 37 resistant trees selected earlier, there are 28 more trees selected in 1987 and 1988. The section has also surveyeed and confirmed that *Pinus radiata* can continue growing with very little disturbance from Dothistroma blight around Kaptagat, Timboroa and Keresoi areas. About 2000 seedlings were raised late 1987 for future grafting of all selected clones.

### Selection of Species of Poplars for Lowland Areas with Genetic Improvement Work on Populus denhardtiorum (Tana river Poplar)

P.O. Oballa, J. Kamiri, S. Thogo, P. Wanjawa.

Two species of Poplars have been chosen for this trial. That is *Populus denhardtiorum* (indigenous) and *Populus alba* (exotic). Much work has been accomplished on the propagation techniques, especially of the indigenous Tana River poplar. A total of 270 plantlets have been raised from cuttings and 200 plants from seeds. The raised plants will be used to expand an E.P. 161 at Yala Swamp. Understanding of propagation techniques is a prerequisite in future improvement and outplanting of the species.

An article on the propagation technique of Tana River Poplar was presented for KEFRI Newsletter No. 5.

### General Nursery Work

S.Y.S. Kaumi, J. Wambugu, P.O. Oballa.

Tree breeding nursery continued to raise seedlings of a few ornamentals, *Cupressus lusitanica, Aberia caffra, Grevillea robusta* and *eucalypts* both for sale at subsidized prices and free issue to the public. Approximately 8,000 seedlings were spared for this purpose of which the number offered for sale had raised Kshs. 5,175.00 by the end of April, 1988. Also, a limited number of grafted fruit trees have been produced and will be sold to the needy people later in the year. The fruits included are avocado, oranges, loquats and apples.

Under the same project the section has laid an experimental trial on the use of a loquat as a rootstock to pears and apples. So far, the healing and initial growth are faster but there is a tendency towards late incompatibility which needs further observation and improvement.

### Mist Propagator

This unit continued to give problems due to lack of spare parts.
This has slowed down the research work on vegetative propagation techniques of various species. The work here will resume as soon as a new mist control unit is fixed.

### Temporary Green House

Due to lack of space in glass houses available, the section constructed a temporary green house covered with polythene sheets. The house will be used for raising of plants which are not cold resistant, cuttings, and controlled pollination.

## FOREST ECOLOGY

B.N. Kigomo, M.M. Wairagu, J.M. Were, J. Awimbo, D.K. Muchiri, B. Owuor, W. Kipkemboi, F.N. Gachathi, L. Kihura, S. Wakaba, F. Muindi, R. Oywer, E. Achola.

### Brachyleana SPP Regeneration Studies

B. N. Kigomo

This is an ongoing project handled by Mr B.N. Kigomo. It involves growth, phenological and other ecological studies on *B. hutchinsii* and *B. huillensis* in Karura and Ngong Forests. The results are expected to go along way into development of management models for these and other indigenous tree species soon to be studied.

### Bamboo/Rattan Research Project

J. M. Were

Bamboo nursery trials ended the first phase in June 1988 and in the same month, the materials from the nursery were used (in mid-June) for establishment of field trials at Jilore, Penon, Timboroa, Kinale and Yala swamp sites Following a consultancy Review of the project we are now moving into phase II of the nursery trials and getting ready to try some exotic bamboos from Thailand, Japan and Malawi in the field.

### Hydrology Research

M. M. Wairagu

Mr. M. Wairagu who specialises in this field is taking his Msc. studies in Canada. Nevertheless in early August 1988, he was around and initiated some work in Katangi, Machakos District, which we are following up on his behalf.

### P.S.P (Permanent Sample Plots)

The indigenous plantations PsP's have not been attended during this time but some work is arranged to be done on the *Vitex keniensis* plots in Ragati and Cheha forests as terminal assessments to be followed by the data analysis.

### Conservation Work

J. Awimbo, D. Muchiri

A pilot study on the statusof Arabuko - Sokoke forests was initiated in early September. The main purpose of this is to carry out some 'model' work that will be used in other studies in other natural forests in different ecozones of Kenya within the main purpose of promoting awareness for need to conserve these forests.

The work is done by J. Awimbo and D. Muchiri in collaboration with Mrs. Robertson of NMK (National Museum of Kenya) Data and results from this work are yet to come.

### Advisory Services

We have continued to offer advisory services to interested parties both in and outside Kenya Forestry Research Institute (KEFRI) especially with respect to taxonomic work and issues dealing with bamboos in general.

## ARID AND SEMI-ARID LANDS AFFORESTATION

P.B. Milimo, Mulatya, G.N. Muturi, R.K. Chirchir, C. Nyandiga,G.N. Mwaura, J. Kioko, A.O. Ajuka, B. Muok, J. Lugadiru, O. Chailu, G. Wanyanja, M.M. Meso, A. Wekesa, J. Wandabwa, E. Bukasa and E. Adiba.

ASAL Division is now 2 years old and continues to improve its efficiency in formulating and initiating research projects to solve reforestation problems of marginal areas.

The Division has a number of regional centres. These are: Hola, Kibwezi, Ramogi and Lodwar. These centres located in diverse climate regions are bases for implementing KEFRI's dryland research policy. Results from these centres are applied to other regions with similar climates. The programme also collaborates and co-ordinate ASAL research activities by other internatinal agencies and NGO'S. These include:-

| | |
|---|---|
| ACIAR | Turbo, Gede, Baringo |
| NORAD | Turkana and Browse studies |
| FINNIDA | Bura irrigation studies |
| FAO | Baringo Projects |
| EMI | Projects in Isiolo, Embu and Meru |

### RESEARCH ACTIVITIES

The three year programme (1987 - 1989) of work for all ASAL regional stations was followed. Details of work done in addition to maintenance of already set trials is as follows:-

### HEADQUARTERS

The headquarters continued to coordinate field research activities. And also ASAL Forest Research Seminar (funded by EMI) was held at Embu in February. Proceedings of this seminar are now out.

Combination of all past research data was started and completed. This is to be printed and circulated. Some of the research activities at Muguga were:

1 Rural Tree Development support (RTDS) of the Swiss Development Co-operation through RAES supported and funded a *Melia volkensii* project. The objective was to study distribution and morphological variation distribution between different populations in the natural range in Kenya. Some of the findings on this one year project have been submitted for publication.

2. Collaborative research with Tsavo East was funded jointly by KEFRI and the National Park. It investigated the impact of game on regeneration of *M. volkensii* in the part. Enrichment planting plots were established within elephant exclosures as controls. But due to poor maintenance of the exclosures, all the seedling were destroyed. The experiment is to be repeated in April 1989.

3. Collaborative work with KARI(Animal Production Department): Work was stated to investigate the possibilities of using *M. volkensii* fruits, twigs and leaves as an animal feed.

This is a three year project funded by International Development Research Centre (IDRC) of Canada through the Dryland Agroforestry Project Katumani

## AUSTRALIAN CENTRE FOR INTERNÀTIONAL AGRICULTURAL RESEARCH (ACIAR)

The objective of the project is to determine through a series of Australian species (in the general Eucalyptus, Acacia, Casuarina and meloleuca) and also species indigenous to Kenya, that have potentials to offer most promise for reforestation.

Phase I of the project ended in December 1987 and phase II started in January 1988. The objectives for phase II are:

- To maintain existing trial plot established in phase I
- To undertake other provenance trials of Australia and Kenyan origin.
- To undertake management trials on the promising species in phase I.
- To examine the utilization potential of various promising species.
- To extend promising species in phase I to local communities on farm trials.

During the period under review, two experiments were established. These consisted:-

(a). consisting of Australian species and.

(b). Species indeginous to Kenya were established at Gede, Turbo and Loruk. Experimental plots were also maintained assesses.

During this period, an agreement between CSIOR/KEFRI and ODA (EMI) was reached to extend services of CSIRO/KEFRI to drier parts of Isiolo, Meru and Embu. This is to cover a variety of soil types. Similar arrangements are underway for Turkana.

### LODWAR

In Mid August 1987 the TRD (NORAD) KEFRI Project was inaugorated when an ARO was posted to Turkana. Initially work of taking over all research work established by Forest department was done. Some of the trials taken over and the others established include:

- Brownse trials in different ecozones of the district.
- research tree nursery raising seedlings to fill gaps in the older browse trials.
- regeneration studies trial. Its objective was to assess and demonstrate the natural regeneration capacities of different riverine tree species falling within enclosure (mainly *Acacia tortilis, A. eliator). Work with microcatchments was also started.*

### RAMOGI

**A species trial at Ramogi hill was established. However, low survival has been reported. Drought has been responsible for this.**

### KIBWEZI

Due to past extensive game damage, emphasis at the station now lies on establishment of research plots on farmers land. Under this, a mixed species trial was establisheed.

Additional work involved assesment and maintenance of experimental plots.

### HOLA

The following trials were established as part of the proposed 1987-1991 programme of work.

- species trials
- provenance trials (*Cassia siamea)*
- *provenance trials (Acacia tortilis)*
- irrigation trials *(Acacia albida)*
- weeding trial *(Eucalyptus camaldulensis)*

### OTHER ACTIVITIES

Collection of indigenous tree seeds in all the regions was done. This is to facilitate self sufficiency and allow exchange with the other station. Excess seed was submitted to the seed centre for storage.

## MAIN TIME SCHEDULE

| ACTIVITIES | 1987/88 | 1988/89 | 1989/90 | 1990/91 |
|---|---|---|---|---|
| Exotic species and provenance trials; | ..... | ---------- | | |
| Preliminary trials (seed collection, and planning of detailed programmes) | ..... | ---------- | | |
| Phase I: Preliminary phenology results, massive provenance and species trials and assessment for 1987/88 | | ..... | ---------- | |
| Refining of experimental methodologies, nursery techniques, writing up of interim reports and planning further investigations | | | ..... | ---------- |

N.B. The dotted lines are for Hola and Kibwezi while the broken lines are for Turkana and Ramogi.

## TREE SEED TECHNOLOGY AND SEED QUALITY CONTROL

E.M. Kariuki, G. Rode, C. Schaefer, J.W. Wanyondu, Z.V. Siva, D.K. Musya, A. Mbora, D.K.M. Kahuthia, W.N. Mucheke, J.J.J. Munyao, D.M. Angaine, J. Obango, A. Ng'ang'a, J. Gichana, K. Wachira, L. Wambui.

The Tree Seed Centre and the Seed Collection Centres have to date made remarkable achievements. There is still alot of work to be conducted on the indigenous species, which is currently being undertaken.

### Objectives

(1) Identification of appropriate seed sources.

(2) To initiate and conduct studies on flowering, seeding and fruiting of all tree species that are incorporated in the programme.

(3) Collection of supply of sufficient amount of seed of important forestry and agroforestry species and improve the quantity of seed collected.

(4) Conduct research work on extraction, storage and germination of all species handled by the Seed Centre in order to optimize the procurement of the species.

(5) To initiate a computerized seed recording and information retrieval system.

(6) To provide training at all levels on seed handling, and the management of seed production stands and the indigenous vegetation.

### Construction of Buildings

A new prefabricated building was put up that has a conference room, two offices and a computer room. This was necessary because the office space in the older building that was set up in 1987 was not enough. A new drying unit was also set up that allows the drying of fruits more gradually, this is especially suited to indigenous

species from the highland forests.
Renovation of the old seed laboratory was completed and is now being used as a temporary store for seeds being supplied to the forest department since the old method of taking seeds to the forest department headquarters was found unsatisfactory.

## Tree Seed Centres and Sub-centres

There are Six Seed Collection Centres for seed ripening surveys, collection, extraction, establishment and maintenance of provenance trials and seed stands.

The Collection Centres are:

(1) Gede - Covers Garissa, Kilifi, Kwale, Lamu, Mandera, Mombasa, Tana River and Wajir.
(2) Kibwezi - Covers Kajiado, Kitui, Machakos and Taita Taveta.
(3) Nyeri - Covers Embu, Isiolo, Kirinyaga, Laikipia, Marsabit, Meru, Murang'a, Nyeri and Samburu.
(4) Londiani - Covers Baringo, Kericho, Nakuru, Narok, Nyandarua and Uasin Gishu.
(5) Kakamega - Covers Busia, Homa Bay, Kakamega, Kisii, Nandi, Siaya and Kisumu.
(6) Kitale - This was moved from Turbo and covers Baringo, Elgeyo Marakwet, Trans Nzoia, Turkana and W. Pokot.

In the above mentioned Collection Centres, construction and renovation work on extraction beds and equipment is being carried out to improve the seed extraction process. Plans are underway to construct stores for seeds in these centres.

## Equipment

The following equipment was purchased:
(1) Computer
(2) New germination cabinets
(3) X-ray machine
(4) Seed divider
(5) Water pump
(6) Seed Cleaner
(7) Office desks and chairs
(8) Seed containers
(9) Steel lockers
(10) Filing cabinets
(11) Petridishes and lunch packs
(12) Glasshouse.

### Vehicles

The programme has 7 vehicles, 6 of which serve the collection centres and the other serving the Seed Centre at Muguga.

## Suited Seed Stands

Selection and inspection of seed stands is an on-going activity in the Seed Centre. (Seed stands have been selected in Nyeri, Murang'a, Kiambu, Kilifi, Kakamega, Nairobi, Nakuru, Nyandarua, Embu, Machakos, Kwale, Baringo, Uasin Gishu and Meru). Not all the seed stands were checked and information on whether all the mentioned stands are still existing is difficult to obtain and hence plans are underway to inspect all the stands.

In order to meet the increasing demand of several agroforestry species in the future, seed stand establishment of these agroforestry species is an on going process. This is being done or has already been done at seven sites (at least 1ha per site) - these are at Kakamega, Taita Taveta, Kibwezi, Bungoma, Siaya, Nandi and Thika. Planting of *Calliandra calothyrsus, Gliricidia sepium, Prosopis chilensis* has been accomplished.

## Single Trees Selection

Selection of single trees of superior quality for seed collection is an on going process. The species that have been selected so far in the natural forests and semi-arid areas are:

| Species | Location |
|---|---|
| *1. Acacia tortilis* | Kibwezi |
| *2. Acacia xanthophloea* | Kibwezi |
| *3. Azadirachta indica* | Kibwezi |
| *4. Terminalia brownii* | Kibwezi |
| *5. Newtonia hildebrandti* | Kibwezi |
| *6. Olea welwitschi* | Kibujoi |
| *7. Olea welwitschi* | North (North South) |
| *8. Trichilia roka* | North (North south) |
| *9. Croton megalocarpus* | Ngong |
| *10. Croton megalocarpus* | Nandi(North South |

| | |
|---|---|
| *11. Chlorophora excelsa* | Kwale |
| *12. Prunus africana* | Nandi (North South) |
| *13.* " " | Kibujoi |
| *14.* " " | Kabarnet |
| *15. Podocarpus glacilior* | North Mt. Elgon |
| *16. Ekerbergia rueppeliana* | " " |
| *17. Trachylobium Verrucosum* | Gede |
| *18. Brachystegia Spiciformis* | " |
| *19. Afzelia quanzensis* | " |
| *20. Tamarindus indica* | " |
| *21. Terminalia spinosa* | " |
| *22. Manilkara zanzibarensis* | " |
| *23. Combertum Schumanii* | |
| *24. Warbugia ugandensis* | Kabarnet |
| *25. Warbugia ugandensis* | Ngong |
| *26. Aningeria aldolfi friedriciі* | Kibujoi |
| *27. Aningeria aldolfi friedriciі* | Kabarnet |
| *28. Ocotea usambarensis* | Chogoria |
| *29. Syzigium guineense* | Kabarnet |
| *30. Juniperus procera* | Maralal |
| *31. Antiaris toxicaria* | Kibiri |
| *32. Polyscias Kikuyuensis* | Kakamega |
| *33.* " " | Kabarnet |
| *34. Celtis africana* | Kabarnet |
| *35. Fagara macrophylla* | |
| *36. Casgeria bathiscombei* | |
| *37. Albizia gummifera* | |
| *38. Podocarpus milanjianus* | |
| *39. Olea hochstetteri* | |
| *40. Cassipourea malosana* | |
| *41. Anthocleista zambesiaca* | |

## Seed Orchards

There are eight seed orchards in Muguga, four of *Pinus patula* and four of *Cupressus lusitanica*. In Londiani there are two orchards one of each of the above mentioned species.

## Seed Collection and Processing

Seed collection has been extended considerably. Better and safer methods of seed collection have been incorporated. The Seed Centre stores at present 200 species with 6623. 16 kg compared to 139 species and 4071.21kg in June 1987.
In previous years 80% of the seeds collected were of *Cupressus lusitanica* and *Pinus Patula*. In recent years there has been an increase in collection of indigenous and agroforestry species.

There has been higher demand on seed, which has led to an increase in seed dispatch with an improved seed distribution system. These seeds dispatched to the forest stations are being collected from the Seed Centre in order to avoid loss of seed due to poor storage conditions in the Forest Department Headquarters.

To inform involved organisations and people, the Seed Centre periodically hands out seed stock lists which are sent to the Forest Headquarters and other interested organisations or groups.

New seed processing methods have been applied to a number of species. In Muguga the old seed laboratory has been renovated for extraction and cleaning and the drying beds have been repaired and equipment for extraction and cleaning have already been installed in order to improve the extraction and cleaning methods.

Seed drying units have been construted in some of the collection centres; for the other centres they are being constructed.

## Seed Testing

All the incoming seeds before storage or dispatch are tested for purity per cent, weight determination, moisture content and germination tests (Table I). The germination tests are conducted in the nursery, glasshouse and laboratory. In the laboratory the seeds are either germinated in petri-dishes, lunch packs or germination boxes on the benches, Rodewald apparatus, germination tank or germinator cabinets.
There is an on-going research work on species with germination problems, some recommendations have been listed in table I for some of the species that have been successfully pretreated.

Cutting tests are currently being conducted for all incoming seeds. Storage trials are being established for all the species, so as to determine the optimum storage conditions of a given species, and also the appropriate moisture content.

**Table 1.: SUMMARY LIST OF TESTS CARRIED OUT IN THE SEED CENTRE INCLUDING PRETREATMENTS (An extract)**

| Species | Origin | Purity | Wt determination Seed/ Kg | Moisture Content | Pretreatment |
|---|---|---|---|---|---|
| Aberia caffra | Ondiri | | 36866 | 7.4 | Cold water for 24 hrs (nursery) soaking in conc. $H_2so4$ for 10 mins (glasshouse) |
| Acacia abyssinica | Kitalale | 100 | 3833 | - | |
| Acacia albida | Kerio Valley | 100 | 7852 | 6.6 | Nipped (lab/ soaking in hot water till cool (nursery) |
| Acacia brevispica | Kitui | - | - | - | Nipped (lab) - nursery |
| Acacia gerrardii | Machakos | 98 | 10055 | 5.3 | Soaking in hot water for 16 hrs. |
| Acacia mangium | KWDP | - | - | - | Soaking in hot water for 3 mins. then soaking in cold water for 24 hrs. |
| Acacia mearnsii | Naivasha | 99 | 68788 | 3.4 | Soaking in hot water till cool. |
| Acacia melanoxylon | Sorget | - | - | 5.3 | Soaking in hot water till cool (lab + glasshouse) |
| Acacia mellifera | Kibwezi | - | | 9.3 | Soaking in hot water till cool. |
| Acacia nilotica | Katilu/ Lodwar | - | - | 6.8 | Nipped (lab/ soaking in hot $H_20$ till cool (nursery) |
| Acacia polyacantha | Kitui | - | - | 8.3 | Soaking in hot water till cool. |
| Acacia senagal | Kitui | - | 8406 | 13.9 | Soaking in conc $H_2s04$ for 40 mins. |
| Acacia tortilis | Riakanau/ Embu | - | 18055 | 6.1 | Soaking in hot water till cool |
| Acacia xanthophloea | Naivasha | - | - | 5.8 | Soaking in hot water till cool (lab + glasshouse) |
| Adonsonia digitata | Gede | 100 | 1818 | 8.2 | Soaking in hot water till cool (nursery) |
| Adenanthera paronina | Kibwezi | 100 | 3488 | 5.5 | Conc $H_2s0_4$ for 60 mins. |
| Albizia lebbeck | Mt. Elgon | 100 | 12325 | 9.8 | Soaking in conc $H_2s0_4$ for 15min (glasshouse) |
| Albizia lophantha | Kijabe | - | 10613 | 10.0 | Cold water for 24 hrs. |
| Araucarie angustifolia | Uplands | 100 | 146 | - | |

Table 1: SUMMARY LIST OF TESTS CARRIED OUT IN THE SEED CENTRE INCLUDING PRETREATMENTS (An extract)

| Species | Origin | Purity | Wt determination | M content | Pretreatment |
|---|---|---|---|---|---|
| Azadirachta indica | Kibwezi | | | 26.0 | Hot water till cool. |
| Balanites aegyptiaca | Kitui | 100 | 425 | 7.0 | Cold tepid water for 18 hrs |
| Caesalpinia spinosa | Tigoni | 100 | 3433 | 7.65 | Hot water till cool (nursery) |
| Calliandra calothyrsus | KWDP | - | | | Nipped (lab)/soaking in hot water for 3 mins. then soaking in cold $H_20$ 24 hrs (Nursery) |
| Callistermon coccineum | Muringato | - | - | - | - |
| Callitris robusta | Ramogi | - | | | |
| Cassia siamea | Isiolo | 96 | 39761 | 7.2 | Soaking in hot water till cool (lab + glasshouse)/ soaking in conc $H_2s0_4$ for 10 mins (nursery) |
| Cassia spectabilis | Gede | - | - | 10.1 | - |
| Casuarina equisetifolia | Kwale | - | - | - | |
| Casuarina stricta | Muguga | - | - | 9.6 | |
| Chlorophora excelsa | Kwale | 94 | 430108 | 9.65 | |
| Conocarpus lancifolius | Lamu | - | | 12.3 | |
| Cordia abyssinica | Kedowa | - | 2878 | 7.5 | Soaking in hot water till cool (nursery) |
| Croton megalocarpus | Elburgon | - | - | 6.3 | |
| Cryptomeria japanica | Kimakia | - | - | - | Soaking in cold water for 12 hrs. |
| Cupressus Lusitanica | Sokoro 2 (D) | - | - | - | Stratification in moist sand for 21 days at 30°C. |
| Dalbergia melanoxylon | Kitui | - | - | - | |
| Delonix regia | Taita Taveta | 100 | 2025 | 5.47 | $H_2SO_4$ for 2 mins. |
| Erythrophleum guineense | Kwale | | 1400 | 10.2 | Soaking in con $H_2SO_4$ for 15 min (glasshouse)/ soaking in hot water till cool (nursery) |
| Eucalyptus camaldulensis | Masaita | 26 | 2162162 | 9.2 | |

| Species | Origin | Purity | Wt. determination | Moisture Contents | Pretreatment |
|---|---|---|---|---|---|
| Eucalyptus saligna | Masaita | 43 | 1951220 | 9.8 | |
| Grevillea robusta | Njukiini | - | - | - | Soaking in cold water for 24 hrs. |
| Jacaranda mimosifolia | Njengo | - | 65413 | 8.7 | |
| Juniperus procera | Ngobi | 92 | 46948 | 8.1 | stratified in vermiculite for 7 days at 3°C |
| Leuceana leucosephala | Kibwezi | - | - | 9.5 | Soaking in hot water till cool (lab + glasshouse) |
| Melia azedarach | Machakos | 100 | 2710 | 10.2 | Soaked in cold tepid water for 24 hrs (nursery) |
| Melia volkensii | Voi | - | - | - | Soaked in soapy water for 18 hrs then radiele split |
| Olea africana | Londiani | - | - | - | Soaked in hot water till cool |
| Olea welwitschii | Kimilili | 100 | 3,560 | 8.5 | Soaked in cold tepid water for 24 hrs. |
| Parkinsonia aculeata | Kibwezi | - | | 8.9 | Soaked in hot water till cool (lab) soaked in boiling water and cooled for 12 hrs. (nursery) |
| Pinus caribaea | Kwale | - | - | - | Sown on vermiculite |
| Pinus patula | Nabkoi | 96 | 130506 | 9.3 | |
| Pithecellobium dulce | Kitui | - | - | - | Hot wire scarification |
| Podocarpus gracillior | Mt. Elgon | 100 | 1,186 | 7.2 | Seed coat cracked (nursery) |
| Polyscias Kikuyuensis | Kinangop (S) | 98 | 135,593 | 11.4 | Hot water till cool |
| Prunus africanum | Masaita | 100 | 5,001 | 17.9 | |
| Spathodea nilotica | Muringato | 99 | 134,694 | 6.1 | |
| Tamarindus indica | Mwatate | 100 | 1,510 | 15.1 | |
| Thevetia peruviana | Kwale | | 277 | 9.9 | Soaking in cold water for 12 hrs. |
| Vitex keniensis | Meru | - | - | - | cold water for 24 hrs |
| Liaburgia ugandensis | Kapteng | 98 | 10,561 | 4.8 | Cold water for 24 hrs |
| Ximenia americana | Katilu Lodwar | - | - | | Soaking in cold water for 24 hrs. |
| Ziziphus mauritania | Isiolo | 100 | 433 | 10.6 | Soaking in cold water for 24 hrs. |

| Species | Origin | Purity | Wt. determination | Moisture Contents | Pretreatment |
|---|---|---|---|---|---|
| Eucalyptus saligna | Masaita | 43 | 1951220 | 9.8 | |

# FOREST PROTECTON AND CONSERVATION PROGRAMME

## ENTOMOLOGY AND ZOOLOGY

M. Gichora, A.L. Owuor, M.K. Karanja, F.C. Mbugua, J.K. Mbathi, J.N. Nyamo, J.N. Kabute, H. Kuria, F. Mwaura

Effectiveness of *Tetraphleps raoi* ghauri (Hemiptera: Anthocoriadae) as an exotic of *Pineus pini* Gmel (hemiptera: *Adelgidae), the pine woolly aphid.*

To raise the base populations of the pest and predator, some young *Pinus patula* seedlings were placed in a glasshouse at Muguga and infestation with pine woolly aphid began. This was effected by attaching pest-infested twigs to the tips of the healthy seedlings. It was hoped that there would be rapid build up the pest population which would then be used to feed the predator. The level of infestation remained low however and by the end of the year, full scale indoor insectary work could not be supported. *Pinus patula* is one of the most resistant pine species to the pine woolly aphid. Seeds of *Pinus oocarpa* and *P. caribaea* both of which are highly susceptible to pine woolly aphid were sown in the nursery for future work. A proposal for field work was written in the course of the year. Field work commenced in June 1988 with the objective of determining how much *Teraphleps raoi* was actually responsible for the control of the Pine woolly aphid. Sample pine trees were selected at random in a plantation at Muguga. Data collected for a period of 24 months from these trees would be used to determine relations in predator-prey density as well as the impact Tetraphleps had (directly and indirectly) on its prey.

### Termites (Isoptera):

An experiment to test the efficacy of the chemicals available in the market for termite control was set up in Kibwezi during the short rains in December. This had the objective of testing the efficacy of Dursban 4EC, Aldrex 48 EC and Suscon G04005 Controlled Release Granules against termites in the area. *Eucalyptus maculata* was the test tree species and the experiment was set up in the farms of 2 co-operative local farmers. This minimised establishment costs, fire hazard and damage by game and livestock. This experiment was brought to an abrupt halt after a heavy drought in the area killed most of the seedlings within the first three months of the experiment.

There was need to investigate new areas in which the above experiment could be established and survive. Kitui Pilot Forest (JICA/SFTP/KEFRI Project) was proposed and so was Siaya. Kitui, being more accessible and having a slightly higher rainfall (510-760mm on average) than Kibwezi was settled for. Plans for planting in November, 1988 short rains were proposed to the parties concerned and these were accepted in principle. Work then started with the procurement of *Grevillea robusta* seeds which were to be used to raise seedlings for treatment. These were to be sown in August, 1988. In the meantime, a termite survey of Siaya was undertaken. This took place in March 1988 in Ukwala Division. Termites were found to be a great nuisance which killed many young seedlings especially during dry spells. The need for identification of the termite species responsible and the search for suitable termiticides to protect seedlings was evident. Plans were therefore to be formulated for future work in Siaya.

### Millipedes (Diplopoda):

Monitoring of the millipede population at Gede, in the Coast Province started in 1986. These giant pests have continued to be a threat to nursery seedlings where they have been known to attack the following tree species;

*Eucalyptus urophylla, E. territiconis, Delonix regia, Afzelia quanzensis, Leuceana leucocephala* and *Thavetia peruviana.* These species of millipedes responsible have been identified as:
- *Epibolus pulchripes* Gerstacker, spirobolida, Pachybolida.
- *Otostreptus* ssp spirostrepida, spirostrepidae
- *Archispirostreptis gigas* (Peters), Spirostrepida

Besides feeding on Ganoderma and other fungal species, the millipedes also feed on fallen fruits and cones of *Gmelina arborea* and *Casuarina equisetifolia* respectively. Fallen pawpaw fruits are also eaten in addition to leaves and fallen vegetable debris on the ground. The population dynamics were to be recorded for at least one year.

**Insect rearing and Identification:**

All the adult insect specimens collected during field trips were either locally identified or sent to C.I.E. for the purpose. For the same, immature stages were collected where available and were brought back to Muguga and reared further in the insectary. Further details in their life cycles were thus obtained and some successful ones reached the adult stages and were identified on their own merit. All identified specimens were incorporated into our insect Reference Collection.

**Advisory Service**

Many different parties consulted the Sub-programme seeking advice on how to control different insect pests attacking their trees. Others sought the identification of insect pests of concern to Forestry activities.

## TABLE I - VISITS AND SAFARIS

| DATE | PLACE VISITED | HOST PLANTS | NATURE OF DAMAGE | PEST RESPONSIBLE | RECOMMENDATION ACTION TAKEN |
|---|---|---|---|---|---|
| 16.10.87 | Ngong Hills Presidential Tree Plot.<br>Keserian Presidential Tree Plot | *Ficus* spp | Leaf rolling<br>" | Lepidoptera Larvae<br>Lepidoptera spp | Trees sprayed with Diazinon<br>Eggs and larvae collected for rearing |
| 23.10.87 | Masinga Dam, Yatta Machakos District.<br>Gategi, Mwea EMI tree ssp. trials | *Ficus* spp.<br>*Acacia Polyacantha* | Sap sucking<br>Stem Boring | Scale insects<br>*Taurotagus* sp. nr. brevipennis Gah. (Cerambycidae coleoptera) | Cultural control |
| 23.10.87 | Marianjau, Murang'a District. Presidential Tree Plot, | *Calodendrum capense*<br>*Ficus* spp.<br>Mururi | Gralled leaves<br>Defoliation | Lepidoptera larvae | Trees sprayed with Diazinon |
| 18.12.87 | College of Health Professions, KNH Nairobi | *Trichilia roka* | Bark Gindling at ground level.<br>Sap sucker (Light attack) | Larvae of Cocorynus spp. (Cetoniidae, coleoptera) | Larvae collected for rearing and indentification.<br>tree sprayed with Diazinon |
| 6.1.88 | EMI tree spp. trials, Gategi Embu | *Acacia polyacantha*<br>*Eucalyptus camaldulensis* | Boring of the stem<br>Boring of the stem | *Taurotagus* spp. nr. brevipennis GDH.<br>*Apate indistincta* | — |
| 25.2.88 | Marigat, Baringo | *Prosopis* spp. | Boring of the shoot | *Apate indistincta* (Bostrychidae, Coleoptera) *Darmasila* spp. (Buprestidae, Coleoptera) | Cultural control by prunning and removal of invested tree was recommended. |

| DATE | PLACE VISITED | PURPOSE OF VISIT | FINDINGS/ ACCOMPLISHMENTS |
|---|---|---|---|
| 28-30 July 1987 | Kibwezi Forestry Research Station | Pricking out of seedlings and preparation of potting soil for termite control in the nursery. | *Eucalyptus maculata* seedlings were pricked into polythene tubes containing soil pretreated with termiticides. |
| 18.11.87 | Kibwezi Forestry Research Station | To inspect progress of the termiticide trials in the nursery and to select sites for planting during Nov./ Dec. rains. | 2 Local farmers consentd to have the trials set up on their land. One site was selected on each of the 2 farms. |
| 7-8 Dec. 1987 | Kibwezi Forestry Research Station | Outplant seedlings for the termiticed trials. | There were enough seedlings to establish only one block for the trials. The rest had failed at the nursery stage. |
| March, 1988 | Ukwala Division Siaya District | Termite survey | A termite problem *did* exist in the area. Further investigations were needed. |
| 7.4.88 | Kitui Pilot | Selection of sites for termiticide trials | 4 sites were selected. |

# FOREST PATHOLOGY AND MYCOLOGY

E.J.M. Mwanza, L. Mwangi, J. Karinga, F.M. Munga, S.K. Waithaka, A. Mukwana, V.J. Mburu, A. Mulongo, T.M. Owiyo, B.O. Ng'anga.

## MYCORRHIZA RESEARCH

On-going phases of this project were monitored during the year and other experiments set up to provide basic information on: Interaction and persistance of various mycorrhiza types; determination of mycorrhiza types present in soils collected from the Coast supporting *Pinus caribaea* and *Afzelia* and their ability to infect both species; evaluation of various inoculation methods such as spore deposit on wet sand, hymenial spore suspension, dry spore print suspension, dry spores on pellets with a range of local mycorrhizal fungi on *P. caribaea* seedlings; establishment of *P. caribaea* at Muguga following infection with specific mycorrhizal fungi.

Field establishment plots at Kibwezi, Kwale, Msambweni and Muguga were monitored. At Kibwezi survival continued to decline mainly as a result of termite attack and drought. Aldrex was applied and watering intensified to maintain the remaining plants. In the *P. caribaea* trial plots at Kwale the trees are quite healthy and performing well with excellent survival (95%). Fruit bodies of *Pisolithus tinctorius* grew during the wet season (April-June) and remnants of them are still visible. The experimental plots were thinned in October to retain 13 trees out of the initial 25 in each plot. In the Msambweni trial plots, though all trees are healthy in all treatments, there appear to be microsite diferences with trees in the Southern Corner being superior to those in the middle and Northern parts of the site. Watering was undertaken during the dry season. Fruit bodies of *P. tinctorius* were observed in the plots during the wet season.

The trial plots at Muguga established in May 1987 were assessed for growth and survival in October. Interim observations indicated higher survival and growth in mychorrhiza treated plants.

Interaction and persistence studies in the glasshouse suggest that different mycorrhizal forms complete each other and vary in persistance on the host plants. In seperate inoculation tests after one year, *Rhizopogon* sp. was dominant over *Thelephora* sp, *Pisolithus tinctorius* and *Scleroderma* using *P. caribaea* seedlings.

In soil assays for various mycorrhizal types Muguga *Pinus radiata* and Kwale *P. caribaea* soils yielded Rhizopogon sp and *Thelephora* sp, Jilore *P. caribaea* soil gave *Scleroderma* sp and *Thelephora* sp, Gede *Afzelia* soil had *Rhizopogon* sp. while *Pisolithus tinctorius* was only recovered from Jilore *Afzelia* soil.

In the evaluation of various inoculation methods, the hymenia spore suspension, spore deposit on wet sand and dry spore print suspension were quite effective with *Hebeloma cruistoliniforme*, *Scleroderma bovista* and *Suillus granulatus*. Infection was least with *Cortinarius* sp. and unsuccessful using *Inocybe lanuginella*.

Funding of this project by EEC terminated in December 1987 and a new proposal has been submitted through collaborating scientists (Dr.s R.B. Pearce and M. H. Ivory) at the Oxford Forestry Institute inculcating our proposals after Dr. M. H. Ivory's visit in May 1987.

## ACTINOMYCETE - CASUARINA

### Nitrogen Fixation

Inoculation trials using crushed nodule inoculum from *Casuarina equisetifolia* 3 year old plantation at Msambweni were undertaken on *Casuarina equisetifolia*, *C. cunninghamiana*, *C. stricta* and *C. cristata* under glasshouse conditions to determine if the endophyte has potential to nodulate other *Casuarina* spp. A parallel study was set up in the glasshouse using soils collected from different sites at the Kenyan Coast to determine the occurence of the endophyte in the soils, precise age at which seedlings start to nodulate and isolation of the endophyte. Inoculation trials established that the crushed nodule inoculum could nodulate seedlings of *C. equisetifolia*, *C. stricta* and *C. cristata* but not *C. cunninghamiana*. When seedlings of the above species were raised in different soils from the coastal region, only *C. Equisetifolia*, *C. stricta* and *C. cristata* nodulated in these soils. As with the crushed inoculum *C. cunninghamiana* did not nodulate in any of the soils. This suggests that there could be host-endophyte specificity. Cultural isolation of the endophyte is still in progress though this has generally been retarded by faster growing filamentous yeasts.

### Timber Decay

This experiment was concluded. It had been set up to compare the natural decay resistance of five species of Eucalyptus *(E. grandis, E. saligna, E. microcorys, E. Camaldulensis, E. globulus) E. globulus)* with *Juniperus procera* both under laboratory and field (graveyard) conditions. IN In the laboratory test, heartwood samples of the test timbers were inoculated with brown and white rot fungi using the soil/block technique. The field trial exposed the timbers to attack by soil microflora and termites under conditions likely to be encountered in nature. In the laboratory test, timbers of *E. microcorys* and *J. procera* were more resistant than the other timbers of *E. microcorys* and *J. procera* were more resistant than the other timbers assayed. . After five years in the field, butt billets of *E. saligna* and *E. grandis* had incipient rot while those of *E. globulus, E. camaldulensis E. microcorys* and *J. procera* only had superficial mycelium. Termite attack at the site was severe on *E. saligna* moderate on *e. globulus* and *E. Saligna* and slight on *E. microcorys, E. camaldulensis* and *J. procera.* Overall findings suggested that timbers of *E. microcorys* and *J. procera* do not differ in resistance to decay.

### Plantation Disease

## CYPRESS CANKER

Maintenance of sibling progenies of *Cupressus lusitanica* from African "Plus Trees" resistant to *Monochaetia unicornis* (Cypress canker) at Muguga continued.

### Armillaria Root Disease

Both indigenous and exotic trees are susceptible to Armillaria root rot. Cultural studies were under taken during the year on some local isolates of Armillaria by Mr L.M. Mwangi as part of an Msc Thesis to ascertain if different strains exist in Kenya and possible variations and differences in virulence of the isolates.

### Breeding P. Radiata For Resistance To Dothistroma Pini Needle Blight

This is a joint project between Tree-Breeding and Pathology Sections. Selection of "resistant" trees at Uplands was jointly undertaken in April and will be extended to Timboroa. Establishment of rooted cuttings is being undertaken by Mr. P. Oballa of the Tree-Breeding section.

## PATHOLOGICAL ACTIVITIES WEST OF THE RIFT VALLEY

Turbo and Londiani research units continued to monitor disease surveillance in both indigenous and exotic forests together with nurseries in the region. No significant disease outbreaks were encountered.

### Seedborne Disease Of Tree Seed

Following the establishment of the Tree Seed Centre there were several reports on seedborne fungal/bacterial problems during viability tests. Investigations were initiated to identify the causal organisms, determine whether they cause disease of economic importance and explore control/treatment measures. Preliminary control studies indicated that growth of most seedborne micro-organisms can be checked by pre-treatingseed with Fernisan D.

## ADVISORY SERVICE

The section provided free consultancy services to the Forest Department and Non-governmental organisations involved in afforestation programmes. Among the organisms associated with seedling mortality in several nurseries were:-

a) *Fusarium* sp and *Pestalotiopsis* sp on necrotic foliage of *Polyacantha* ex Molo Forest Nursery.
b) *Alternaria, Cladosporum* and *Pestalotiopsis* on necroticf foliage of *Eucalyptus maculata ex Kitui Social Forestry Nursery.*
c) *Fusarium* sp, *Pestalotiopsis* and *Phomopsis* on P. *patula* seedlings.
d) *Fusarium lateritium* and *Sclerotium* sp on *Eucalyptus grandis* ex Limuru Mabrokie Tea Estate.
e) *Pestalotiopsis* causing leaf spot on Grevillea *robusta* ex Kitui.
f) *Melampsora* leaf rust and stem of Populus ex Muguga EAAFRO Nursery.
g) Furasium wilt and die-back in *Pinus caribaea* seedlings ex Gede Forest Nursery.

Plantation disease included Armillaria root rot in *Vitex keniensis* Ragat; *Botryodiplodia theobromae* canker on stems and twigs of *Acacia* sp ex Kikume in Turkana; and Phomopsis lef leaf spot and necrosis on *Eucalyptus terreticornis* ex Ruanda.

# FOREST PRODUCTS RESEARCH PROGRAMME

B. Chikamai, T. Kabii, J. Githiomi, D. Mikile, P. Odhiambo, A. Museke, J. Katuva, M. Lukibisa, R. Shanda, L. Wanamo.

**Research Work**

The following research projects were undertaken in this period; Project F3; LD3, Preservation and charcoal.

**Project F3**

**Photomicrography** Phase one of this Project which included the determination of specific gravity was completed and the data is being analysed.

Phase 2 involves the Tracheid length measurement and is now in progress. This work had been slowed down by a lack of microscopic projection attachments with the dealers.

**Project LD3.**

Involves the preparation and testing of dry specimen. Work on determination of the physical properties of the logs already tested was still going on at the time of reporting and is expected to be completed by the year end. A total of 73 logs have had their specimen tested for strength.

**Fancy Items Production Research.**

Work was initiated on Fancy Items production research where timber lamination is being studied in relation to gluability, effect of varnishes and workability to produce items of various uses. These items have been a good revenue generator.

**Charcoal Production Research.**

In January Charcoal conversion methods were introduced by a Japanese charcoal expert. These methods are the drum kiln, portable metal kiln, Japanese brick kiln and the sawdust carbonising kiln. And since then the division has been engaged in studying the general suitability lost and efficiency of these methods.

The conversions have been made for the Japanese brick kiln but gave very low recovery due to overburning of charcoal as a result of porous bricks.

15 stacks of *C. Lusitanica* were collected and left to dry before conversion.

**Preservation**

191 Fence posts for C.C.C. treatment continued to flow in from Muguga. A total volume of 38.5m$^3$ has been treated for KEFRI headquarters while other posts are still drying awaiting preservation.

**Sawing Production**

205 logs of 45.553m$^3$ volume from Muguga were sawn and 11 beams of 1.883m$^3$ volume from TPPC were resawn. 20.7m$^3$ of unsorted timber was sawn with the revenue collected from sales of timber and sawing services amounting to Kshs. 17,043.10. While timber officially issued out volume 110cm$^3$.

**Maintenance of Machine and Equipment.**

The compartment kiln which has not been used since being installed had its wiring system repaired and its steam flow and air exchange checked. Only a temperature/moisture gauge is not working to date but has been ordered from the manufactures.

**Top Pan Analytical Balance.**

This one had its illiminating bulb burnt out and has not been replaced to date due to unavailability of such a bulb from the dealers.

**Other Machines**

Most other machines remained in good working conditions, but there is a need to have them calibrated since they are overdue. The Bomb Calorimeter is still out of service due to lack of some components.

# SOCIAL FORESTRY RESEARCH AND TRAINING DEVELOPMENT PROGRAMME

## AGROFORESTRY SYSTEMS

D.O. Nyamai, R.J. Mwendandu, J.H.O. Otieno, D.M. Njiru, J. Amwatta, F.M. Kanja, C.J.M. Ochieng, M.N. Odongo, R.M. Mutunga, P. Juma J.A. Malanga, M.K. Changwony, M. Etindi, O. Okumu, C. Agidho, T. Omondi, A. Abol, S.R. Odemba

The growing awareness of the importance of agroforestry has led to the decision by KEFRI to give more research priority in agroforestry. The realization to start intensive research programme in agroforestry by KEFRI has come

as a result of the fact that in Kenya, the need to feed a rapidly burgeoning population has led to widespread natural resource deterioration. Therefore improved agroforestry methods are needed to meet food production requirements and maintain environmental stability on which agricultural productivity is based.

**Research**

Agroforestry research programme expanded considerably this year with the implementation of AFRENA programme in Maseno and the initiation of the 3 experiments/demonstration plots at Muguga.

**On-Station Experiments/Demonstration plots at Muguga**

(i) An alley cropping investigation incorporating *Lauceana eucocephala* and *Calliandra calothyrsus* was set up in May this year in a 2-way spacing systematic design.
The test crop for the first and second cropping season is bean crop *(Phaseolus vulgaris).*

(ii) Tree/grass combination on contour bund investigation was started. The tree crops included are *Leucaena* and *Calliandra* with Napier grass.

(iii) Multipurpose tree/shrub and grasses selection for promising species particularly legumes with considerable potential for fodder are currently being established for screening purposes.

**Dryland Agroforestry Research Project Machakos-Katumani Station (KEFRI/MIDP /ICRAF)**

A number of experiements have been initiated both at the on-station in Katumani and at on-farm located in Kakuyuni catchment area. In the second phase of the project, the following trials have been started: on-farm alley cropping with *Gliricidia sepium* and *Cassia siamea;* additional on-farm fodder bank trials were also laid out with *Leuceana leucocephala* as the principal species.

The previous experiments started before the beginningof phase II are continuing as have been reported in the previous research reports with the exception of on-farm micro-plots of MPTs for screening in the grazing land which wound up in 1986 and changed into grazing land package in the same year.

The on-farm and on-station experiments have been supported by project tree nurseries at Kakuyuni dam, and at DFO's office in Machakos respectively.

**CARE-KEFRI Agroforestry Research trials/demonstration in Siaya District**

Six trial/demonstration plots representing the different agroecological zones started in 1985 and are continuing. Good progress has been achieved on data collection some of which have been analysed and written up (see preliminary report prepared by Dr. Nyamai for discussion at the CARE-KEFRI meeting held in March this year at Kisumu CARE office). However, soil data are largely lacking although samples have been taken ever since the trials were started.

Plans are underway to expand the scope and philosophy of these trials for the second phase. This is in response to progress and experience gained so far. Discussion are also in progress to expand similar trials to other Districts where CARE is currently involved in agroforestry extension like South Nyanza.

**Eastern Africa AFRENA Zonal Project at Maseno.**

It is important that in this project, a considerable amount of work and information have been achieved within a relatively short period of time. This has been possible as a result of the good collaboration between KEFRI and ICRAF. In total, 7 Experiments and 3 observation plots have been established in the two rainy seasons i.e. April/May and October/November this year. The exact nature of trial is summarized below.

1. Multipurpose tree species selection/ screening for alley cropping technology.

2. Tree/shrub incorporation with napier on contour bunds for supplementary fodder production, soil conservation and green manure production.

3. Investigations in the effects of *Leucaena* mulch application alone, mulch removal and mulch and fertilizer applications combined but at different fertilizer on the performance of maize crop.

4. Studies to determine the optimal cutting height for *Leucana* tree on biomass yield.

5. Detailed studies on the selection/screening of a wide range of MPTs for various agroforestry technologies. This trial focuses on woody perennials mainly.

6. Studies leading to selection/screening of a number of multipurpose shrubs for

various agroforestry technologies.
This trial is similar in design and objectives to Experiment 5 except that it emphasizes research mainly on shrubs as distinct from woody trees in Experiment 5.

7. Effects of varying Leucaena hedge density and espacement within the row and between the hedgerows.

These experiments and the observations plots have been depended on the project tree nursery located at Maseno for seedling production.

**Project Buildings**

With the exception of the Dryland Agroforestry Research Project, the Maseno Zonal Project and the CARE/KEFRI ollaborative projects have no provision in the budgets for building constructions. The Maseno Project will however be accommodated by the GTZ funded project on MPT selection and breeding programme which is also located in Maseno. The CARE/KEFRI Project in Siaya has continued to rely on the hired office in Siaya by CARE. The status of the Dryland Agroforestry Office is however not good at the moment. The timber office is currently infested with termite attack.

**Vehicles and Plants**

Transport facilities for the Machakos, Maseno and the Siaya based projects are currently adequate. However, the availability of a 4-wd pick-up motor vehicle would be extremely helpful especially in the case of Maseno where only staff van is available without the pick-up facility for carrying seedlings, soil and other goods.

The Dryland Agroforestry Research recently acquired a double cabin 4wd Toyota hilux pick up which has tremendously eased transport of goods, equipments and seedling. The double cabin is supported by 2 Suzuki 4 wd motor vehicles and 4 motor bikes. Following the accident which occured on the Suzuki KUL 737 last year in Muguga, it has been lying inthe KEFRI Garage in Muguga unrepaired without any progess report on it. In addition, one bike was also involved in a road accident involving Mr. Daniel Mugendi and a matatu.

The Project nurseries at Maseno and Machakos, DFO's office continue to rely on the water provided by the forestry Department. In case of the Maseno project, signifcant financial support towards the running of the water pump at Maseno is being provided for from project funds. However, the Kakuyuni on-farm nursery in Machakos acquired its own pump from MIDP financial assistance to the project.

## ADVISORY AND CONSULTANCY SERVICES.

KEFRI's lead among national Institutions in agroforestry research at both on-station and on-farm levels is clearly demonstrated by the large volume of advisory and consultancy services it offers to national Institutions, NGOs and to some extent International Organizations. KEFRI has accumulated a lot of information and experience from the many projects it is handling. Personnel development is crucial in strengthening this position. Given the multidisciplinary nature of agroforestry science, training in the relevant disciplines (agriculture and forestry sciences) should be given priority.

★ More on Page 42

## SOCIAL FORESTRY RESEARCH AND TRAINING

K. Watanabe, Y. Watanabe, T. Niino, Y. Yanagihara, H. Yamashita, O. Edazawa, H. Hotori, N. Noda, S. Takabatake, M. Arai, C. K. Kiriinya, E. K. Kireger, L. O. Sabaya, M. O. Mukolwe, Kigwa, D. O. Otieno, J. S. Mutange. J. C. Njuguna, G. K. Kimani, C. N. Ong'weya, S. A. Othuon, S. Atanas.

This subprogramme, a JICA aided project comprises 2 subprojects; social forestry training and social forestry pilot. The main thrust of the programme is to develop social forestry in Kenya as a measure to avert the rural energy crisis, conserve the environment and implement efficient land and forest resources utilization. The initial thrust focuses on the most vulnerable (and the one called for immediate action); semi-arid land areas.

# SOCIAL FORESTRY TRAINING SUB - PROJECT.

K. Watanabe, Y. Yanagihara, H. Noda, Y. Yamashita, H. Hatori

The subproject is scheduled and set to start its training activities in August 1988. The project constitutes two training institutes at Muguga and Kitui. It organizes courses in social forestry and conducts research and development with the objectives below.

(a) Long term

To develop capabilities for social forestry training in Kenya at the national and regional levels, but eventually aiming at the promotion of self reliance in tree planting activities at the grass roots' level in order to alleviate fuelwood crisis, environmental degradation and loss of forest and other natural resources.

b) Immediate

To carry out training in social forestry at the national and regional level.

The subproject during its preparatory phase of two years, identified a strategy for resolving problems in developing social forestry in Kenya which could be summarized as follows:

a) Among various ecological zones, the most vulnerable (and the one called for immediate action) is the semi-arid land area. This area which has been experiencing an influx of population of animals and people from the already overpopulated high potential land areas, is marked with a harsh environment, low biological productivity, and inappropriate land use practices that are likely to lead to irreparable environmental damages. Development of social forestry on a country-wide basis is not discounted. But the initial thrust will focus on the semi-arid areas.

b) Although it was envisaged at the begginning that training in nursery operation would be the central activity of the project, the result of the project surveys on training needs revealed that the training should not be confined to nursery activities but be extended to cover planting, tending and management operations of social forestry in general including soil conservation, agroforestry, charcoal making, horticulture, apiculture, etc. It should also be noted that the needs vary greatly by locality and by ecological conditions, therefore prohibiting considerations for stereotype approach.

Given the Muguga and Kitui centres as two bases, one at the national and the other at a regional level, for the future activities, the project would concentrate on the following activities.

(i) The Muguga National Centre Training, promotional activities, and research and development (R & D) on selected subjects in social forestry, all these being at national level.

(ii) The Kitui Regional Centre Training, a more systematic, and demonstration of social forestry in a semi-arid land area.

The training is responsible for all training activities to be carried out by the project at Muguga and Kitui centres.

The target groups of training would be the following

(i) Senior field and headquaters-based officers of the forest Department (PFOs, DFOs and Forestry Department headquaters staff)

(ii) Intermediate level field officers of the Forest Department.

(iii) Extension officers and nursery supervisors of the Forest Department.

(iv) Agricultural extension staff at the location and sub-locational levels.

(v) Leading or active farmers at the village level.

(vi) Officers in non-governmental organizations and institutions involved in tree planting activities.

The training subproject is scheduled to hold courses 8 times a year at each centre commencing August 1988 at the Muguga National Training Centre.

# SOCIAL FORESTRY PILOT FOREST SUB-PROJECT

Y. Watanabe, T. Niino, O. Edazawa, M. Arai, C. K. Kiriinya, E.K. Kireger, J. C. Njuguna, G. K. Kimani C.N. Ong'weya, S.A. Othuon, S. Atanas

**Research Activities**

*Silvicultural Operations:*

The following silvicultural operations were carried out during the year under review.

**Pricking Out:**

2000 seedlings of *Eucalyptus paniculata*, a few of *Callitris robusta, Newtonia hildebrandtii,*

*Jacaranda mimosifolia* and about 400 of *Melia azedarach* were pricked out during the year under review.

**Slashing:**

Around 65 hact. of plantation was done during the year under review.

**Spot Weeding:**

This was done during the month of May to reduce competition to the young seedlings.

**Seed Collection:**

Seed collection was conducted at different times during the year under review. The following are the species collected.

| *Species* | *Qty. (kg)* |
|---|---|
| *Cassia siamea* | 19 |
| *Croton megalocarpus* | 132 |
| *Acacia nilotica* | 34 |
| *Erythrina abysyssinica* | 15 |
| *Mangifera indica* | 136 |
| *Acacia Plyocantha* | 22 |
| *Melia volkensii* | 432 |
| *Dalbergia melanoxylon* | 15 |
| *Parkinsonia aculeata* | 19.5 |
| *Grevillea robusta* | 14.5 |
| *Aberia caffra* | 12 |
| *Leuceana leucocephalla* | 17.5 |
| *Acrocrpus fraxinfolia* | 12.5 |
| *Tecoma glandii* | 24 |
| *Balanites aegytiaca* | *61.5* |
| *Prosopsis juliflora* | 19 |
| *Acacia brevispica* | 12 |
| *Terminalia brownii* | 11.5 |
| *Eucalyptus paniculata* | 17.5 |

**Seed Sowing:**

Great number of different species were sown during the year under review.

**Site preparation/planting & issue of seedlings.**

**Planting:-**

Most planting took place in the year under review. We managed to plant about 80,700 seedlings of different species of which are listed hereunder.

| **Species** | **Total Planted** |
|---|---|
| *Balanites aegyptiaca* | 8610 |
| *Tamarindus indica* | 11800 |
| *Acacia polyacantha* | 6631 |
| *Acacia albida* | 3465 |
| *Acacia tortilis* | 740 |
| *Acacia nilotica* | 828 |
| *Croton megalocarpus* | 4408 |
| *Leuceana leucocephala* | 1018 |
| *Melia azadirachta* | 3430 |
| *Eucalyptus camaldulensis* | 3217 |
| *Melia volkensii* | 1594 |
| *Callitris robusta* | 1026 |
| *Grevillea robusta* | 2214 |
| *Prosopsis juliflora* | 3676 |
| *Eucalpytus citriodora* | 1864 |
| *Sesbania sesban* | 1742 |
| *Cassia siamea* | 5987 |
| *Eucalyptus paniculata* | 3546 |
| *Acacia xanthophlea* | 6428 |
| *Cassia spectabilis* | 3864 |
| *Parkinsonia aculeata* | 1674 |
| *Azadirachta indica* | 1432 |
| *Tecoma stans* | 260 |
| *Jacaranda mimosaefolia* | 140 |
| *Carica papaya* | 628 |
| *Delonix regia* | 122 |
| *Acacia mellifera* | 25 |
| *Acacia senegal* | 315 |

**Seedlings raised at Tiva Nursery**

| Species | Total | Plantable |
|---|---|---|
| *Acacia polyacantha* | 14,980 | 14,980 |
| *Acacia albida* | 4,520 | 4,520 |
| *Acacia nilitica* | 750 | 320 |
| *Acacia xanthophloea* | 9,610 | 9,610 |
| *Acacia tortilis* | 3,360 | 840 |
| *Acacia mellifera* | 35 | 35 |
| *Acacia seyal* | 480 | 480 |
| *Aberia caffra* | 2,080 | 2,080 |
| *Afzelia quanzensis* | 74 | 74 |
| *Azadirachta indica* | 699 | 699 |
| *Balanites aegyptiaca* | 20,000 | 20,00 |
| Bahuinia thorningii | 1,480 | 1,480 |
| *Croton megalocarpus* | 13,910 | 13,910 |
| *Cassia siamea* | 15,299 | 6,860 |
| *Cassia spectabilis* | 13,788 | 5,170 |
| *Callitris robusta* | 3,020 | 3,020 |
| *Casuarina equisetifolia* | 3,110 | 750 |
| *Calsaperia dicapiplata* | 3,110 | 1,170 |
| *Carica papaya* | 1,600 | 1,600 |
| *Delonix rigia* | 1,100 | 700 |
| *Eucalyptus tereticornis* | 7,870 | 6,320 |
| *Eucalyptus camaldulensis* | 6,426 | 4,380 |
| *Grevilla robusta* | 4,988 | 3,620 |
| *Jacaranda mimoseafolia* | 13,400 | 6,000 |
| *Melia volkensii* | 700 | 640 |
| *Melia azadirach* | 9,560 | 2,060 |
| *Desert rose* | 35 | 35 |
| *Leuceana leucocephala* | 5,268 | 5,268 |
| *Newtonia hildebrandtii* | 1,080 | 1,080 |
| *Prosopsis juliflora* | 4,280 | 3,940 |
| *Parkinsonia aculeata* | 12,370 | 12,370 |
| *Sesbania sesban* | 10,070 | 10,070 |
| *Tamarindus indica* | 18,800 | 18,800 |
| *Terminalia brownii* | 47 | 40 |
| *Psidium guajava* | 60 | 60 |
| *Terminalia mentalis* | 1,110 | 1,110 |
| *Markhamia platycalyx* | 180 | 180 |
| *Tecona stans* | 960 | 960 |
| *Kigelia africana* | 140 | 140 |
| *Spathodea nilitica* | 1,300 | 1,300 |
| *Terminalia cattappa* | 36 | 36 |
| *Azanza garkeana* | 3 | 1 |
| *Eucalyptus paniculata* | 17,300 | 7,640 |
| | 228,788 | 174,348 |

| Seedlings distribution: Primary Schools | Number of seedlings |
|---|---|
| Kiliko | 845 |
| Kwa-vonza | 770 |
| Tanganyika | 770 |
| Masaani | 445 |
| Ndumoni | 628 |
| Ngoleni | 1,296 |
| Manzie Itumo | 972 |
| Kyuusyani (Yatta) | 540 |
| Mulutu and Tiva | 1,944 |
| Kwa Mutonga | 1,944 |
| Thiani | 702 |
| Ngamione, Parents & AIC | 1,944 |
| Masaani & Parents | 2,538 |
| | 15,338 |
| **Secondary Schools** | |
| St. Lukes | 540 |
| Wikilye | 648 |
| Tiva | 1,754 |
| St. Angelas | 3,911 |
| | 6,853 |
| **Individuals and Others** | |
| Individuals | 21,952 |
| **Others** | |
| M.O.T.C. Kitui | 450 |
| Kaseve AIC | 420 |
| Mashambani self help | 2,000 |
| Ukai project | 1,614 |
| Kathuma self help | 648 |
| Tanganyika chiefs baraza | 1,944 |
| JICA Workers | 13,848 |
| | 20,924 |

Total number of seedlings distributed 65,067

**Protection:**

(i) *Fire* N.T.R.

(ii) *Diseases:* a Few cases were reported on termite attacking seedlings in the nursery especially to spp. Like *Eucalyptus* spp. *Posopsis* and sap suckers also attacked *Melia azadirach.* Immediate action was taken to get rid of them by use of aldrin and samples taken to Entomology subprogramme in Muguga.

(iii) *Game and wild Animals:* There were less cases of wild animals and domestic animals entering the plantation since there was a good fence. Also a number of patrol men were deployed to cover the planted areas.

## PLANTS AND EQUIPEMENTS:

**Vehicle general.**

All vehicles gave satisfactory performance during the year under review.

# SOCIAL FORESTRY NURSERY MUGUGA

**L.O. Sabaya, M.O Mukolwe, Kigwa, D.O. Otieno, J.S. Mutange**

### INTRODUCTION

The operation of the new Social Forestry tree nursery at Muguga was stated on 3 November 1987. The prime objectives is to establish and develop potentialities in terms of qualities and quantity of plant genetic resources of both indigenous and exotic trees; ornamental plants and shrubs , fruit trees, flowers etc, for plantation development, research and training local and individual plantings, ceremonial and urban area plantings not to mention soil conservation sites. Some of the seedlings so raised are dispatched as free issues or sales to farmers and interested organizations.

The operations of the Social Forestry Nursery also extends to landscaping and ceremonial tree planting activities, for example, the commemorative tree planting and National tree planting along Mombasa road and at Karai, respectively. The nursery also has it extension at Ossen in Kabarnet as a source of wildling collection.

### PRODUCTION

The tree nursery has production capacity of 1 million seedling and slightly over 1/4 of this has been realised. (see Annex 1). The special diversity is satisfactory, now standing at about 160, of which 2/3 are indigenous and naturalised species. However, the target and diversity has to be surpassed in order to meet the changing demand on seedlings. The nursery is geared to producing what people need in terms of right quality and right quantity seedlings at the right time. Production of seedlings has been by germinating seeds, wildlings collection and vegetative propagation. Often some quality mother plants were purchased and planted as future seed source.

Peat which had been a major component of the soil mixture used in the nursery had to be omitted because of the dangers involved in its acquisition from the source at Ondiri in Kikuyu. A new ratio of 4: 1:1 (Forest top soil; Farm Yard Manure; 1/4" ballast) was adopted. The new mixture proved to be satisfactory in end use but required more watering.

# RESEARCH SUPPORT UNITS PROGRAMME

## CHEMISTRY AND BIOTECHNOLOGY

J.G. Mwangi, D.W. Odee, M.M. Yonga, N.M. Wairagu, L.M. Mwaura, E.T. Makatiani, B. Khasiala, E.A. Adongo, N.A. Chieng, W. Mauta, S.G. Muriithi, J.N. Mwororo, M.M. Onyiego, D.K. Kiberenge, P.M. Ndungu.

The Microbiological resources studies in the subprogramme which have been going on since 1986 involved work on Biological Nitrogen Fixation by nitrogen fixing tree Rhizobium

### Rhizobium Biotechnology

#### 1. Most probable Number (MPN)

In order to be able to estimate the natural rhizobial population in a given area a zone, a composite soil sample from the area-zone is

## ANNUAL NURSERY STATEMENT

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| CATEGORY | PRODUCTION | | | | DISPATCH | | | | |
| | No B F JUNE '87 | FROM SEEDS No | VEGETATIVE PROPAGATION No | WILDINGS No | TOTAL | STATION USE No | FREE ISSUE No. | SOLD No | TOTAL | NET BF JUNE (1+5) |
| INDIGENIOUS SPP. | 27,096 | 12,500 | — | 66,180 | 78,680 | 2,039 | 825 | — | 2,864 | 102,91 |
| EXOTIC SPP | 41,010 | 80,000 | — | — | 80,000 | 4,500 | 1,200 | 6,710 | 12,410 | 10,860 |
| FRUIT TREES | 4,426 | 1,775 | — | 200 | 1,975 | 60 | 45 | — | 105 | 6,291 |
| ORNAMENIAL PLANTS, SHRUBS, FLOWERS & GRASSES | 53,753 | 45,095 | 10,500 | 500 | 56,095 | 36,000 | 1,000 | — | 37,000 | 72,840 |
| | 126,285 | | | | 216,750 | | | | 52,379 | 290,65 |
| OSSEN NURSERY (INDEGENOUS SPP) | — | 1,000 | — | 20,000 | 21,000 | — | — | — | — | 21,000 |
| | 126,285 | | | | 237,750 | | | | 52,379 | 311,650 |

used to inoculate host plant species; this technique is known as the "Plant Infection Test":

*Acacia albida (-)*
*Acacia mearnsii (+)*
*Albizia gummifera (+)*
*Leuceana leucocepha (-)*
*Sesbania grandiflora (-)*
*Sesbania sesban (+)*

(+) nodulated, (-) Not nodulated

The soils gave varying natural rhizobial population sizes except for two host species that gave negative results. It tentatively follows that the specific *Rhizobium* for the two host species namely *Leucaena leucocephala* and *Sebania sesban* are lacking in the soil. MPN tests are still going on with other soils.

**II. Authentication**

We now boast of the KEFRI culture collection. More than 40 cultures have now been authenticated (i.e shown ability to form nodules on appropriate host plant grown under bacteriological conditions). Some of the cultures have shown high $N_2$ - fixing potential by visual observations. However, comparative studies will be undertaken so as to relatively quantify their $N_2$ - fixing potentials.

KEFRI culture collection numbers will be issued as soon as all the necessary information regarding source, host and characteristics of the culture is collected. The authenticated cultures are shown in Appedix I

## Timber Preservatives (Methodology)

This involves testing methodologies to develop an accelerated method of testing new wood preservations. The current methods of testing timber preservatives are very slow and extremely time consuming. As a result, Biotechnology Division is in the process of developing as much accelerated method. The programme was started in March 1986 and is due for completion in June 1988 after which the confirmatory results will be obtained.

**Biodegradation and Biodeterioration of Timber**

We are mainly involved with the revision of literature on biodeteriogens of Kenya's structural timber. A lot of work has been done in the past, on this subject. The programme commenced in April 1986 and has just been completed.

**Testing Natural Durability of Timber**

The durability of many of Kenya's Timbers has not been calibrated, leading to underutilization of the material. The programme is however, trying to develop and accelerated method of testing the natural durability of timber. This programme has been on since June 1986 and is to end in June 1988 for this is when we intend to collect the final data.

**Shooting and Rooting of Melia Volkensii in vitro**

The main objective here was to encourage growth of indigenous trees using *in vitro* methods. The technology for shoot growth has been developed and is now being used routinely. However, further work on accelerated growth still continues. Rooting has now been achieved but further work on proliferation of roots is still being done.

The plants grown *in vitro* are then transferred to the soils (in vivo) i.e. from the artificial culture media to soil. The plants are currently growing from the soil. However, techniques for mass production are being investigated.

**Low cost Method of Treating Timber**

The treated timber currently in the market is very expensive due to use of expensive machinery. In the Biotechnology sub-programme simple tools coupled with the right technology are used in order to reduce treatment costs of timber. The method uses creosote as the preservative but the equipment needs slight improvement for probably automation.

Appendix I

| Host | Locality | No. of Cultures |
|---|---|---|
| *Acacia albida* | Mbita point | 1 |
| " " | Katangi | 1 |
| *A. auriculiformis* | Turbo | 2 |
| *A. lahai* | Turbo | 1 |
| *A. mearnsii* | Turbo | 4 |
| *A. "* | Muguga | 1 |
| *A. nilotica* | Bura | 2 |
| *A. tortilis* | Mbita Point | 2 |
| *Albizia coriania* | Ramogi | 1 |
| *Calliandra calothyrsus* | Wundanyi | 3 |
| *Leucaena leucocephala* | Katangi | 1 |
| " | Hola | 1 |
| " | Kakamega | 3 |
| " | Homa Bay | 3 |
| " | Mbita Point | 3 |
| " | Kisumu | 3 |
| " | Kwale | 1 |
| " | Wundanyi | 1 |
| " | Ramogi | 1 |
| *Prosopis juliflora* | Katangi | 2 |
| *Sesbania grandiflora* | Magarini | 2 |
| *Sesbania sesban* | Kabete (Lower) | 3 |
| " | Turbo | 2 |
| " | Katangi | 1 |

# FOREST SOILS

C. K. Serrem, A.C. Yobterik, D.M. Kamau, G.K. Mbuthia, J.K. Lelon, G.N. Ngigi, A.K. Korir, Z. Ogara, S. Kirui, J.A. Sigei.

## SOIL SAMPLING

Part of the success of soil analysis depends on the techniques of soil sampling since are never of the same quality. Thus sampling has to follow certain rules which ensures that the sample is a real average of the lot and also represents the whole site. The number of drawn samples depend on the topography of the area and the number of different soil types existing. Normally, trained skilled people are needed for sampling. Before these samples are sent to the labs they are reduced to a workable sample (about 1 kg per soil sample). However the minimum weight depends on the nature of site sampled.

## SOIL CHEMICAL ANALYSIS

**Objectives:**

To evaluate the nutrient elements status of the soils in relation to the growth of the mentioned tree species and plants. Routine soil chemical analysis is carried out in the laboratory on:- PH, % organic carbon, Phosphorus, Calcium Magnesium, Potassium, Zinc, Iron, Manganese and Copper.

**Methods of analysis**

Conventional methods used in the laboratory.

| Nutrient element | Method of determination |
|---|---|
| PH | Ratio of 1:2.5 Soil: 100 Calcium Chloride |
| Organic Carbon | Walkley method |
| Nitrogen (Total) | Kjedhal flask method Markham still for digestion and distillation respectively |
| Phosphorus (1) | Bray - P2 |
| Phosphorus (2) | AL-method (ppm) |
| Potassium, Calcium & Magnesium | " |
| Trace elements Copper, Zinc, Manganese, | EDTA method (ppm) |

**Katumani (Dryland Agroforestry) Research Project**

On station trials with leaves from *Leiceana leococephala, Cassia siamea and Terminalia brownii* with the objective of observing the effects of continued green manuring on the same piece of land.

A research report No. 6 was published. The report was entitled "Mineralization aspects and maize growth and yield", by C.K. Serrem, F.K. Arap Sang, and D.A. Hoestra. This report presented some solutions to some anomalies found in the mineralization of *Terminalia brownii* as reported in DARP, Research Report No. 1.

In the report Leucaena 2, Terminalia 1, and Cassia 2 gave the best results for height growth, leaf area index and grain weight. Hence Terminalia 2 treatment showed some sort of an inhibitory effect on all growth parameters.

The first cropping two season were a failure in terms of crop yield although leaf mulch was applied in both cases. Soil sampling was thus dorein the third cropping season (October 1984). Consequently, when soil analysis was carried out, there was a high residual nutrient level for the three elements Nitrogen, Phosphorus and Potasium which are the 3 critical elements in plant growth. Soil analysis data for the 4th cropping season (March 1985) indicated a new trend of equilibrium between mineralization and uptake of nutrients.

The residual effect of N and K in Terminalia 1 was higher than that of Terminalia 2 at the beginning of the 3rd cropping season. This explains the anomaly observed earlier where Terminalia 1 gave the best growth results.

In season 4 the trend was again reversed (i.e. Td2 gave higher yield than Td1). The reason for this was clearly indicated in the reverse order of the graph (fig. 4) where Td1 had the least residual Nitrogen compared to all other species.

Meanwhile Season 5 and 6 continues.

## (SIAYA) CARE (K) KEFRI (PROJECT)

Trials to examine the possibilities for maintaining or increasing the productivity of cropping system by establishing an alley cropping system using *Calliandra calothyrsus, Leucaena leococephala, Markhamia platycalyx* and *Gliricidia sepium* continues with the view of monitoring the effects on the nutrient status and productivity of a site.

Two Research reports were published in the year. One entitled "First Season Results": by C.K. Serrem and A.C. Yobterik; and the other "preliminary results - Biomass, Growth rate and woodlots data analysis for 4 species in 5 sites by C.K. Serrem, D.M. Kamau and J.H.O. Otieno.

## GENERAL CONCLUSIONS MADE

Refer to APPENDIX II, Tables 1 (a), (b) and (c)

**From Table 1 (a) the following conclusions can be made:**

(i) Generally, *l. Leucocephala* produced more biomass than other species in plots where other species were planted.

(ii) The maize yields datas for the various species showed higher yields than the controls in all the 5 sites which was expected.

Apart from Sigomre plots where yield differences among species was not statistically significant all the other sites showed significance among the species at either 5 or 1% C.L. However yield differences within the species were not statistically significant. Field observations indicated that the establishment of *L. leococephala* in 1985 in the Sigomre plot totally failed due to termite attack.

(iii) The biomass production in the Abayo plot for the 2 species planted L. Leucocephala & *C. Callothyrsus* were quite high as compared to other sites with the same species. Similarly the maize yields under this treatment was high.

**From Table 1(b) the following conclusions can be made:-**

### NYASANGA

The growth of *M. lutea* is lower than that of *M. lutea* in other plots. This could be due to poor site factors. However statistical analysis showed that there was a significant difference at 5% C.L. between the maize yield of *M. lutea* in comparison with the control yield.

### SIGOMRE

The growth of *M. lutea* was also slow as compared to Abayo and Bondo plots. There was however no significant difference between *M. lutea* and control yields.

### BONDO

Field observations indicated that *M. lutea* on this site had grown (from the DBH values).

Statistical analysis showed a significant difference at 1 per cent C.L. between the maize yield of *M. lutea* in comparison with the control yield. Surprisingly the control had 201.7 per cent higher yield than that of *M. lutea*. This perhaps could be attributed to the suppression of the maize growth of *M. lutea* on the site.

## ABAYO

The growth of *M. lutea* on this site was excellent (DBH of 2.77 cm). There was statistical significance at 5 per cent C.L. between *M. lutea* and the control. However as in Bondo the *M. lutea* seems to have suppressed the growth maize resulting to a 36.7 per cent lower maize yield than the control. This could be a negative interaction and needs close attention in the season to follow.

**From Table 1 (c) the following conclusions can be made:**

## NYASANGA

(i) Field observations showed that although *E. saligna* seemed to show the best growth, it is most susceptible to temite attack.

(ii) *C. siamea* showed good growth and is termite resistant but is found to suffer from die-back at a rate of 15 - 20 per cent in this site.

## BONDO

(i) *(E. saligna* shows superiority in growth to the other two species planted.

(ii) Termite problem is experienced by the species in the site. As observed in Nyasanga die-back disease is still prevalent (10 per cent).

## ABAYO

(i) *E. saligna* showed the best growth as in Nyasanga and Bondo, while *C. equisetifolia* showed the least growth.

**NOTE:** There was no establishment of woodlot in Sigomre and Nyasanga.

For further clarification refer to SIAYA-CARE/KEFRI Research report No. 3.

It should be noted that Season 3 and 4 is still ongoing.

### Kuinet-KEFRI DDC/International fellowship-Clergy Project

This project is intended to enhance government district focus for rural development with the aim of developing rural community development centre. The problems being addressed to are:

- shortage of fuelwood, building materials and fencing materials (currently the only source of fuelwood is roots of papyrus reed in swamps, dried cowdug and maize stover).

- the best research extension method to be deployed in establishing woodlots and boundary planting as well as living fences.

## TESTS AND ADVISORY SERVICE

Apart from carrying out soil analysis received from other places, the division is generally called to assist in soil sampling in various parts of the country. In the year 1987, soil samples were received from other subprogrammes, forest stations, etc.

These are:-

**Biotechnology subprogramme**

**Pathology**

**Machakos (Katumani),**

**Turkana (Lodwar),**

**Hola, etc.**

The criteria of essentiality has been the evaluation of the element nutrient status of the soils in relation to the plant growth of agroforestry tree species and crops. A report on soil analysis findings and advisory services is usually written for all analysis carried out.

The tables of analysis done on soil samples from different sites in the year 1986–87 and test results for the same sites are given in APPENDIX 1, (a) and (b) respectively.

## APPENDIX I

(a) ANALYSIS DONE IN 1987

| Year | Lab. No: | Site | Analysis Done | | | | |
|---|---|---|---|---|---|---|---|
| | | | pH | Carbon | Nitrogen | EDTA | Bray P2 |
| 1986 | 934-1010 | Machakos (3) | all | all | none | all | none |
| 1986 | 1081-1178 | Abayo (Yimbo) | all | all | all | all | all |
| 1986 | 1179-1265 | Bondo | all | all | 19 | none | none |
| 1986 | 1266-1344 | Nyabeda | all | all | none | all | all |
| 1986 | 1345-1410 | Sigomre | all | all | none | none | none |
| 1986 | 1411-1598 | Nyasanga | all | all | none | none | all |
| 1986 | 1599-1600 | Emali | all | all | - | - | - |
| 1986 | 1601-1642 | Firestone | all | all | none | none | all |
| 1987 | 1643-1712 | Karai | all | all | all | - | - |
| 1987 | 1713-2347 | Machakos (4) | all | all | none | none | none |
| 1987 | 2348-2352 | Kitalale | all | all | none | all | none |
| 1987 | 2353-2367 | Murang'a | all | all | none | none | none |
| 1987 | 2368-2370 | J.K.A. | all | all | none | none | none |
| 1987 | 2371-2407 | Turkana | all | all | none | none | none |
| 1987 | 2408-2415 | Hola | all | all | none | none | none |

NB: No AI - analysis was carried out in 1987.

(b) TEST RESULTS (1987) Range of values obtained

1986 Samples

| Site | PH | Carbon | Bray P2 | Nitro | EDTA (ppm) Copper | Mangan | Zinc | Iron |
|---|---|---|---|---|---|---|---|---|
| District: Siaya | | | | | | | | |
| Abayo | 4.8-6.8 | .4-2.3 | - | .02-.4 | .01-1.8 | 80-185 | .2-1.6 | - |
| Bondo | 5.0-6.0 | .5-1.3 | - | - | - | - | - | - |
| Nyabeda | 4.9-5.9 | .7-1.3 | - | - | 1.7-2.7 | 85-142 | .3-.8 | 5.7-9 |
| Sigomre | 4.9-5.4 | .6-1.3 | - | - | - | - | - | - |
| Nyasanga (Sea. 2) | 4.6-5.8 | .4-1.2 | - | - | - | - | - | - |
| Nyasanga (Sea. 1) | 3.6-5.2 | .04-3.2 | - | - | - | - | - | - |
| District: Machakos | | | | | | | | |
| Katumani (Sea. 3) | 5-5.8 | .6-1.7 | 49-630 | .1-.2 | 2.5-7 | 115-345 | 3-12 | 70-370 |
| Emali 1987 | 5.0-5.8 | - | - | - | - | - | - | - |
| Katumani (Sea. 4) | 4.3-6.5 | .4-2.4 | - | - | - | - | - | - |
| Other Districts | | | | | | | | |
| Firestone | 5.6-7 | .4-2.4 | 4-320 | .1-.17 | 4.0-24 | 210-610 | 2-22 | - |
| Karai | 4-5.2 | 1.1-4 | 1.4-60 | - | - | - | - | - |
| Kitalale | 7.0-7.3 | | - | - | .7-1.3 | 108-121 | 1.4-2 | 9-10 |
| Gategi | 7.4-7-6 | .7-1.1 | - | - | - | - | - | - |
| Muranjau | 4.3-5.0 | .8-5.7 | - | - | - | - | - | - |
| Masinga | 6.3-7.3 | 1.4-1.6 | - | - | - | - | - | - |
| J.K.A. | | 1.6-4.3 | - | - | - | - | - | - |
| Lodwar | 6.7-8.9 | .06.54 | - | - | - | - | - | - |
| Hola | 6.0-8.0 | .27.81 | - | - | - | - | - | - |

**APPENDIX II**

SIAYA RESEARCH PLOTS DATA

**Table** 1 (a)

MEANS OF TREE BIOMASS AND MAIZE YIELD IN KG (1987) PER SITE

| Species<br>Site | Leucaena<br>Leucocph. | Calliandria<br>Callothyrsus | Gliric Sepium | Sesbania<br>Sesban | Control |
|---|---|---|---|---|---|
| Nyasanga | | | | | |
| Biomass | 260.00 | - | 115.67 | - | - |
| Maize Yield | | | | | |
| Mean | 13.67 | - | 16.00 | - | 8.00 |
| Std | 7.37 | - | 6.93 | - | 7.21 |
| Nyabeda | | | | | |
| Biomass | 198.00 | 275.00 | - | - | - |
| Maize Yield | | | | | |
| Mean | 14.67 | 20.67 | - | - | 9.00 |
| Std | 9.87 | 19.50 | - | - | 11.27 |
| Abayo | | | | | |
| Biomass | 507.67 | 401.33 | - | - | - |
| Maize Yield | | | | | |
| Mean | 18.17 | 24.17 | - | - | |
| Std | 6.20 | 2.38 | - | - | 2.82 |
| Bondo | | | | | |
| Biomass | 440.33 | - | - | 117.67 | - |
| Maize Yield | | | | | |
| Mean | 13.08 | | - | 11.25 | 10.32 |
| Std | 1.23 | - | - | 2.78 | 2.04 |
| Sigomre | | | | | |
| Biomass | 102.17 | | - | - | - |
| Maize Yield | | | | | |
| Mean | 58.33 | - | - | - | 23.67 |
| Std | 18.93 | - | - | - | 4.16 |

**Table** I (b)

MEANS OF DBH (cm) AND MAIZE YIELD (Kg) PER SITE

| Species | Markhamia Lutea Control | Control |
|---|---|---|
| Site | | |
| NYASANGA | | – |
| DBH (cm) | 1.43 | |
| Maize Yield | | 8.00 |
| Mean | 10.67 | |
| Std | 1.53 | 7.21 |
| SIGOMRE | | |
| DBH (cm) | 1.80 | – |
| Maize Yield | | |
| Mean | 50.83 | 23.67 |
| Std | 20.87 | 4.16 |
| BONDO | | |
| DBH (cm) | 2.33 | |
| Maize Yield | | |
| Mean | 3.42 | 10.32 |
| Std | 0.95 | 2.04 |
| ABAYO | | |
| DBH (cm) | 2.33 | |
| Maize Yield | | |
| Mean | 10.92 | 17.25 |
| Std | 4.05 | 2.83 |

**Table** I (c)

MEANS OF FUELWOOD/WOODLOT EXPERIMENT (Two years old species)

| Species | Grevillea Robusta | Eucalyptus Saligna | Cassia Siamea | Cassuarina Equisetifolia |
|---|---|---|---|---|
| Site | | | | |
| NYASANGA | | | | |
| Height (m) | 3.4 | 6.5 | 5.1 | 2.3 |
| DBH (cm) | 2.3 | 4.9 | 4.5 | 1.4 |
| BONDO | | | | |
| Height (m) | 4.3 | 6.25 | 4.0 | – |
| DBH (m) | 4.1 | 5.15 | 5.1 | – |
| ABAYO | | | | |
| HEIGHT (M) | 6.8 | 9.3 | 5.6 | 5.3 |
| DBH (cm) | 5.3 | 7.3 | 6.2 | 2.7 |

J.K. Cheboiwo, H.K. Kariuki, R.K. Mutwol,

The programme carried out the following research work among others during the period:-

a) Forest Research Needs for South Nyanza District.
KEFRI and South Nyanza Afforestation Project jointly conducted a survey to identify the research needs of the region and areas of collaborative work in July 1987.

Three scientists from ASAL, Agroforestry and Forest Economics research Programmes participated. The report was completed in May 1988 and a follow up tour was conducted in the same month. The subjects covered in the report were Agroforestry, species and provenance elimination trials, protection and rehabilitation of natural vegetation, social economics research and soil sampling.

b) **Socio-Economic Survey: Yatta B2 LOCATION**

The programme in conjunction with Pilot Forestry Scheme Forest Extension sub-project in Kitui District carried out a base line socio-economic survey in January-April 1988. The general survey work carried out in 1986, recommended an indepth survey of the households in the target area. The survey is part of the Extension Research work in the location and other neighbouring locations to the Pilot Forestry Scheme. (The draft report was completed at the end of June and has been circulated).

c) **Survey on Management and Marketing of Acacia Mearnsii (Black Wattle)**

The programme as part of its objective popularising tree growing as a cash crop by rural farmers does accumulate management costs and benefits of tree crops. Black wattle is a well established tree crop grown by farmers as a cash crop. The survey was to establish existing management options, market structures, processing industries and the relationship between the farmers and processing industries. The survey covered the following districts: Kakamega, Nandi, Trans Nzoia, Nyeri and Kiambu. East African Tanning and Extract Company (EATEC) and Kenya Tanning and Extract (KETE) at Eldoret and Thika respectively were visited. The survey covered seed procurement, establishment, silvicultural operations, harvesting utilization sectors and existing marketing structures. It covered mostly the black wattle growing by small farmers in the various regions, the report is in the process of completion.

d) **Other Work**

The programme worked closely with other programmes in all aspects of economical management research of productive resources and system options.

---

## i) Dryland Agroforestry Research Project (Sponsored by IDRC)

## D.O. Nyamai

The Project is located in Machakos semi-arid parts. The Project's major achievements in the first phase include identification of a number of promising tree species and low input technologies for Eastern Kenya's semi-arid small farms. Through a combination of on-station and on-farm research some results have been finalized and implemented on several farms, including species for live fencing and a grazing land improvement package. Other research have examined fast growing species for the protection of soils, enhancement of fertility and improvement of crop productivity, and tree shrub and grass species for grazing lands as a strategy to provide dry season forage for livestock and fuelwood production. Several small scale farmers have actively participated in this work.

Phase II will dwell on the screening of additional species for use in alley cropping and the refinement of on-farm technologies. An expansion of earlier efforts on suitable arid zone fruit tree species will allow opportunities for dietary improvements and limited cash cropping for farm families. In addition to increasing the number of experimental farmers involved in grazing land improvements, specific management recommendations are to be developed to ensure long-term sustainability of grazing land resources.

The second phase has active dissemination and implementation components and will look

at effective mechanisms for ensuring direct community participation.

### ii) Agroforestry Research Networks for Africa (AFRENA) Located in Maseno (Supported by USAID)

AFRENA Project is now in its implementation phase. Several experiments have been initiated last year. The different areas of investigation require different field design consideration, for instance, experiments on the screening of multipurpose tree and shrub species and provenances have been designed to accommodate large entries with provisions for replication in space and time. There are also management experiments for specific agroforestry technologies (e.g. cut and carry fodder, alley cropping etc. type of experiments) which also call for different field designs altogether. Other areas of investigation include tree-crop interphase experiments and prototype trials of alley cropping which all require specific designs different from those above. Over and above these trials, there will be separate tree breeding experiments for agroforestry purposes.