KENYA FORESTRY RESEARCH INSTITUTE

Annual Report and Record of Research

2023 - 2024

KEFRI is ISO 14001:2015 and 9001:2015 Certified

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and

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Published by:

Kenya Forestry Research Institute

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ACRONYMS

ASK	Agricultural Society of Kenya
ATC	Agricultural Training Center
CERP	Coast Eco-Region Research Programme
CHERP	Central Highlands Eco-Region Research Programme
DERP	Drylands Eco-Region Research Programme
DBH	Diameter at Breast Height
FY	Fiscal Year
GDP	Gross Domestic Product
GoK	Government of Kenya
HA	Hectares
HR	Human Resource
ISO	International Organization for Standardization
IUFRO	International Union of Forest Research Organizations
JICA	Japan International Cooperation Agency
KALRO	Kenya Agricultural & Livestock Research Organization
KBC	Kenya Broadcasting Corporation
KCFIC	Kenya Commercial Forestry Innovation Center
KEFRI	Kenya Forestry Research Institute
LVERP	Lake Victoria Basin Eco-Region Research Programme
MECCF	Ministry of Environment, Climate Change and Forestry
MOAs	Memoranda of Agreement
MOUs	Memoranda of Understanding
NGO	Non Governmental Organization
RVERP	Rift Valley Eco-Region Research Programme
SEKU	South Eastern Kenya University
SMEs	Small and Medium-Sized Enterprises

SERVICE DELIVERY CHARTER

No	Services/Goods	Requirements to obtain Services/ Goods	Cost	Timeline
1	Develop forest technologies	Research based on stakeholder needs	Depends on the technology	1-5 years depending on technology
2	Disseminate forest technologies	Formal Request	Free	Within 60 days
3	Production of quality tree seed	Demand for priority tree species	Depends on the tree species	Within 90 days
4	Production of high quality tree seedlings	Demand for priority tree species	Depends on the tree species	Within 90 days
5	Sale of high quality tree seed and seedlings	• Formal request • Filled seed order form	As per tree seed catalogue	Within 2 hours
6	Training on forest technologies	Formal request	Depends on the type of training	Within 90 days
7	Wood, plant and soil analysis	Formal request	As per analytical price catalogue	Within 10 working days
8	Advisory services	Formal request	Free	Within 5 working days
9	Contribute to policy formulation in the environment and forestry development	Formal request	Depending on the nature of the policy	1-5 years depending on the policy
10	Attachment of students	Acceptance letter from HR	Free	90 days
11	Consultancy in forestry and allied natural resources	Formal request	Free	1 week to 5 years
12	Establish linkages and partnerships	Formal request	Free	Within 90 days
13	Handling of customer complaints and compliments	Complaint / Compliment form	Free	Within 2 weeks after receiving the complaint

We value and welcome feedback and comments to enable use serve you better.
Complaints, compliments and suggestions should be sent to:

The Director Kenya Forestry Research Institute P.O. Box: 20412-00200, Nairobi Tel: +254 722 157 414, 724 259 781/2 Email: director@kefri.org contact@kefri.org Website: www.kefri.org	The Commission Secretary/Chief Executive Officer Commission on Administrative Justice P.O. Box 20414-00200, Nairobi Tel: +254 20 2270000/2303000/2603765/2409574/0777125818 Email: info@ombusman.go.ke/complain@ombudsman.go.ke

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HUDUMA BORA NI HAKI YAKO

STATEMENT BY CHAIRMAN KEFRI BOARD OF DIRECTORS

In the Fiscal Year 2023/2024, the KEFRI Board of Directors continued to provide leadership in designing and control of credible strategic intentions and implementation of obligatory global and national agenda for research and development in forestry and allied natural resources in our country.

The Board provided support through approval of work plans and budgets and in line with the performance targets set under the research themes namely: Forest Productivity, Tree Health and Improvement (FPT&HI); Forest Biodiversity, Climate Change and Environment Management (FBCCEM); Forest Products and Enterprise Development (FPED); Socioeconomics, Policy and Governance (SPEG); and Forest Research Support Services (FRSS). In addition, the Board provided resources to support tree seed infrastructural development in 18 centres countrywide.

Similarly the Board also continued to oversee the implementatiuon of KEFRI's 7th Strategic Plan (2022-2027). This Plan aligns KEFRI research and develpment activities to: Medium Term Plan IV of the Kenya Vision 2030; Kenya Governments Bottom-Up Transformation Agenda (BETA); MECCF Strategic Plan 2022-2027 and the Kenya Green Economy Strategy and Implementation Plan 2016 - 2030.

The Institute continued implementating key activities for provision of efficient and effective service delivery, the Board of Directors reviewed and analyzed the progress made towards achieving the Institute's mandate, national government objectives and directives towards the realization of the National Landscape Restoration Strategy by providing and distributing high quality tree seeds for the 15 billion tree growing programme.

I take this opportunity to most sincerely thank the Board Directors for ensuring leadership and good governance, financial stewardship, and discipline through prudent use of GoK funds as well as grants from Development Partners as guided by the Mwongozo Code of Governance for State Corporations. In this regard, the Board through its constituted committees ensured that management complied with set targets and suggested corrective measures to mitigate challenges encountered.

Special thanks to the National Government through the Ministry of Environment, Climate Change and Forestry, Ministry Departments and Agencies (MDAs), County Governments, Development Partners, my colleagues in the Board, entire KEFRI fraternity and all our stakeholders for the immense support which enabled the successful achievement of the research and development targets set for the 2023/2024 fiscal year.

Asanteni

Gen (Rtd.) Samson Mwathethe
Chairman - KEFRI Board of Directors

STATEMENT BY THE DIRECTOR

We are pleased to share the 2023/2024 Annual Report and Record of Research. KEFRI in line with the 7th Strategic Plan (2022-2027) continued to fulfil its mandate to carry out innovative research in forestry and allied natural resources for sustainable development, capacity building and technology transfer. The Institutes' flagship project is the development of quality forest and tree germplasm to support the national agenda of achieving and maintaining a minimum of 30 % tree cover by 2032. Development of forest and tree-based technologies and innovations for sustainable forest management, blue economy and climate change mitigation and adaptation; and improved forest-based livelihoods through gender sensitive Nature Based Solutions (NBS) for sustainable socio-economic development and wealth creation.

The Institute collected 70,000kg of tree seed from 86 different species, a 32.5% increase from 47,192kg in the year 2022 - 2023. To enhance access to quality tree seeds country wide, the Institute continued with the construction of eighteen seed centres across the country, packaging and distribution of seeds and potting tubes to various stakeholders, seedling production, documenting and monitoring tree growing activities through Jazamiti App; transfer of forestry technologies and information, engagement with strategic partners and stakeholders to expand linkages and leverage on available resources in addition to enhancing resource mobilization and capacity building. This initiative is part of the Government National Tree Growing and Rangeland Restoration Programme that aims to grow 15 billion trees to achieve at least 30% tree cover by 2032.

During the year under review, the Institute continued to profile the status of Africa's forestry in the global arena culminating with the International Council of IUFRO approving Kenya's bid to host the 29th World Congress (2029) in Nairobi, Kenya. This is a great opportunity for scientists and players in the forestry sector to showcase regional efforts to ensure that the aspirations of Africa as captured in the Agenda 2063 are on course. Additionally, KEFRI continued to improve research facilities in the headquarters and eco-regional centres, safeguard research trials and sourcing for land for demonstration of forestry technologies. The Institute also continued with policy formulation, implementation of the Enterprise Resource Planning (ERP) and completion of the data centre for automation to enhance digitization and research data safety.

However, the Institute faced challenges including staff resourcing, inadequate land for research, low funding which slowed down operations and maintenance activities. The Management sincerely thanks the Board of Directors for their continued strategic direction and oversight, our stakeholders and KEFRI staff for their dedication and commitment to achieving the Institutes mandate. We extend our gratitude to the Government of Kenya, through The National Treasury and the Ministry of Environment Climate Change and Forestry; Development Partners and other stakeholders for their cooperation and support towards achieving the Institute's mandate.

God bless you all.

Jane Njuguna (PhD)
Director, Kenya Forestry Research Institute

SENIOR MANAGEMENT

Dr. Jane Njuguna
Director and Board Secretary

Dr. M. T. E. Mbuvi
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Supply Chain Manager

CPA Kennedy Mungai
Internal Audit

Ms. Mary Miingi
GM, Enterprises

Mr. Phillip Kichana
Corporation Secretary &
Manager Legal Services

Ms. Betty Prissy Njoki
Asst. Director,
Partnership and Res. Mobilization

Background

Kenya Forestry Research Institute (KEFRI) is a State Corporation established in 1986 under the Science and Technology Act (Cap 250) which has since been replaced by the Science, Technology and Innovation Act No. 28 of 2013 to undertake research in forestry and allied natural resources, generate, promote and improve technologies for sustainable developed.

Vision

A research centre of excellence in forestry and allied natural resources for sustainable development

Mission

To conduct research in forestry and allied natural resources for sustainable development through innovations, capacity building and technology transfer

Mandate

- Conduct research and development in forestry and allied natural resources;
- Disseminate research findings;
- Build capacity of stakeholders in forestry and allied natural resources; and
- Establish partnerships and cooperate with other research organizations and institutions of higher learning in joint research and training.

Core Values

- Excellence
- Creativity and Innovation
- Integrity
- Teamwork
- Inclusivity
- Networking
- Customer Focus

CHAPTER ONE

1.0 TREE SEED DEVELOPMENT AND PRODUCTION

Trees and forests provide a range of environmental services such as: control of rainfall amounts and seasonality; temperature control; soil erosion control and protection of water-catchment; carbon storage and sequestration; biodiversity and provision of habitats for numerous species of wildlife and birds; and ecotourism activities. Forests also provide tangible goods including; timber, poles, woodfuel, and several non-wood products. It is noteworthy that forests and trees supply over 90% of Kenya's rural and peri-urban energy needs. Forests are therefore one of the key drivers of socio-economic development.

Forests in Kenya provide a livelihood base for over 82% of the countrys households and offers direct employment to over 4 million Kenyans besides contributing about USD 365 million (3.6%) to the Gross Domestic Product (GDP). Kenya's forests also contribute to more than USD 140 million worth of goods annually to other productive sector of the economy such as agriculture, fisheries, livestock, energy, wildlife, water, tourism, trade and industry. In addition, Water Towers Ecosystem of Kenya which include; Mount Kenya, Aberdares, Mau Forest Complex, Mount Elgon, and Cherangany Hills, provide necessary recharge for rivers draining into several water basins and providing water for domestic use, agriculture, wildlife and the manufacturing industry. This ecosystem interlinks well with agroecosystem that is the largest contributor to Kenya's GDP at 33% directly and 27% indirectly through agro-based industries and service sector (GOK, 2018a). Specifically, the agriculture sector in the agroecosystem employs more than 40% of the total population and about 70% of the rural population (GOK, 2018b). This proportion is largely dominated by small-holder farmers accounting for over 75% of the total agricultural output and over 70% of the marketed agricultural produce.

However, despite the benefits of forests, Kenya's forest face continuous threats from rapid depletion due to various factors includeing growing human population, poverty, lack of regulatory capacity, changes in production and consumption patterns, competing land uses, climate variation,. These challenges threaten the livelihoods of millions of Kenyans, especially the rural poor who depend on natural resources for their survival.

In order to increase production of products as well as restore over-exploited forests, potential for expansion of tree growing lies community woodlands/drylands and private farm, as well as replanting of mature and harvested gazetted forests. The Government of Kenya in 2022 launched "The National Landscape and Ecosystem Restoration Strategy 2023-2032". This is an ambitious 10-year Programme for growing of 15 billion trees by 2032. This Programme, anticipated to increase the national tree cover from the current 12.13 percent to 30 percent by 2032. KEFRIs role in implementation of the Programme lies in provision of quality seed and seedlings.

Research and development in tree seed development, production, storage, and distribution plays a key role in enabling this increase, with emphasis on production of both high quality and adequate amounts. Development, production and conservation of tree germplasm in KEFRI is continuous and involves: establishment of seed orchards and seed stands of various tree species that are in demand by stakeholders; seed collection; processing; sale or distribution and storage.

1.1 Establishment of tree seed sources

KEFRI is a key player in the production of high quality tree seed to meet demand by various tree planting programmes. Establishment of seed orchards and seed stands guarantees provision of high quality tree seed in sufficient quantities. Emphasis of species to site matching is also a major consideration. During the year 2023-2024, KEFRI continued to undertake establishment and management of tree seed sources.

1.1.1 Establishment of seed orchards

KEFRI has established 145.5 Ha of seed orchards. During fiscal year 2023-24, KEFRI conducted maintenance activities on existing seed orchards as shown in Table 1.1. These orchards are managed by the Institute. Nevertheless, KEFRI has collaborated with partners in management of *Melia volkensii* orchards of interest, within Kitui and Kibwezi jointly managed with JICA and orchards in; Marimanti, Gaciongo, Makima, Kasigau, Voi, Kibwezi, Ikithuki - jointly managed with farmers and JICA. Maintenance activities undertaken included: slashing, pruning of lower branches, slashing and spot weeded, and where required creating a firebreak. Assessments were also undertaken on growth and phenology of all species.

Table 1.1: Seed orchards established / maintained by KEFRI in different Centres/sites in 2023-24

SPECIES	CENTRE / LOCATION	HECTARES (HA)
Gmelina arborea Seed orchard	*Arabuko Sokoke*	8
Melia volkensii Seed orchard	*Arabuko Sokoke*	4
Improved *Melia volkensii* Clonal seed orchard	Tiva - Kitui County	1.3
Melia volkensii PTS		3.3
Physiology plot		0.5
Improved *Melia volkensii* supplementary plot		0.5
Melia Sub PTS	Gaciongo	0.5
	Makima	0.5
	Voi	0.3
	Ikithuki	0.3
Melia PTS	Kasigau	1.7
	Kibwezi	1.7
	Marimanti	2.7
Terminalia. brownii PrT	SEKU	1.5
	Maiuni	1.0
Eucalyptus. camaldulensis	Kitui	1.0
Gmelina arborea	ATC Kitui	1.0
Cupressus lusitanica seed orchard	KARI gate	2
	Gene Bank	2 .5
	Gene Bank	1.5
Grevillea robusta seed orchard	Rumuruti	6.5
E. grandis seed orchard	Makutano	2
C. lusitanica seed orchard	Makutano	2
E.grandis cuttings	Turbo 2K	1.5
E.grandis ex-Zimbabwe	Turbo 2J	6.3
E. grandis seed orchard	Nzoia	4.2
E. grandis progeny trial (Australia)	Turbo 2J	1
E. grandis progeny trial (local)	Turbo 2J	1

1.1.2 Establishment of seed stands

During the year 2023-24, 25.6 ha of seed stands in the different eco-regions underwent maintenance as indicated in Table 1.2

Table 1.2: Tree seed stands established by KEFRI in different Centres in 2023 - 2024

Species	Centre / Location	Hectares (ha)
Casuarina equistifolia Seed stand	Buda Forest	1
Casuarina equistifolia Experimental plot	Arabuko Sokoke	1
Casuarina equistifolia Seed stand		1
Eucalyptus camaldulensis Seed stand	Arabuko sokoke	2
Eucalyptus europhylla Seed stand/Camcore		1.5
Seed stand/Camcore		1.5
Grevillea robusta Seed stand	Wundanyi	2
Milicia excels Seed stand	Arabuko Sokoke	1
Seed stand/arboretum		0.5
Tectona grandis Seed stand	Witu TCN	4
	Witu NYS	2
	Buda Forest	2
Terminalia spinose Seed stand	Arabuko Sokoke	1
Acacia tortilis seed stand	Tiva	3.6
	Kibwezi	2.5
Moringa oliefera seed stand	Kibwezi	1.0
Brachylenia huillensis	*Nyeri*	2.0
Eucalyptus urophylla seed stand (2017)	*Malal*	2
Eucalyptus urophylla seed stand 2014	*Kioni*	2
Eucalyptus urophylla seed stand 2015		1
Osyris lanceolata seed stand (2011)		2
Oyris lanceolata newly established seed stand	*Malare*	1
Vitex keniensis seed stand		1
Osyris lanceolate seed stand	*Rumuruti*	2
Pine hybrid progeny trial	Compartment 2J, Turbo	1.0
Pinus tecunumanii	Compartment 2J, Turbo	1.8
Grevillea robusta	Compartment 2K, Turbo	4.5
Liquibambar styriciflua	Lugari	1.0
Eucalyptus camaldulensis	Nyandiwa in Siaya County	2.0
Grevillea robusta	Sangalo	1.0
	Kaimosi	1.0
Eucalyptus grandis	Kaimosi	1.0
Gmelina arborea	Nyandiwa Got Jope	1.0
	Sangalo	1.0
	Vet Farm Maseno	1.0

1.2 Seed collection, processing and distribution

Production of high quality tree seed involves: seed survey, appropriate seed collection and processing, quality testing, and distribution or storage. These activities are undertaken within distinct ecological zones managed by through Eco-region research programmes. Each of the Eco-region handles tree species that thrive under the ecological conditions that prevail in the area to enable stakeholders in the region access the correct seed for that zone.

KEFRI through its Kenya Forestry Seed Centre, is the principle supplier of high quality tree seed. The Kenya Forestry Seed Centre collects tree seed from selected and established seed sources and seed orchards, covering all ecological zones around the country.

After collection, all the tree seed was processed and subjected to quality tests according to International Seed Testing Association (ISTA) rules, before any distribution was done to clients. For all stored seeds, retesting for viability is undertaken biannually.

The seed centres at KEFRI have capacity to supply adequate quantities of tree seeds to raise approximately 1 billion seedlings annually. In the fiscal year 2023 - 2024, KEFRI collected 70,000kgs of tree seed (Table 1.3) an increase from 47,192 kg in the year 2022 -2023. The seed was collected from a range of over 86 different tree species (Table 1.4).

KEFRI tree seeds are distributed to public and private institutions including; Kenya Forest Service, farmers, Schools, Prisons, NGOs, and individual farmer. The seeds are available through sales to stakeholders within and outside the country following proper protocols.

Table 1.3: Summary of tree seed collection and initial distribution in FY 2023-2024

No	Seed Collection Centre	Total collection (kg)
1	Migori	3078.5
2	Ramogi	907
3	Maseno	5570
4	Kakamega	4778
5	Londiani	6547.5
6	Turbo	2761.8
7	Marigat	1245
8	Turkana	1157
9	Muguga	6829
10	Nyeri	6425
11	Rumuruti	1137.7
12	Kitui	3887
13	Kibwezi	6573.5
14	Garissa	1794
15	Tiva	1460
16	Gede	3854.41
17	Taita	2116
18	Lamu	1965
19	Wajir	200

Table 1.4: Amount of seed collected per tree species in the FY 2023-2024

No	Species	Weight (kg)
1.	*Acacia elliator*	20
2.	*Acacia gerrardii*	2066.4
3.	*Acacia melanoxylon*	75
4.	*Acacia mellifera*	254.3
5.	*Acacia nilotica*	438
6.	*Acacia nubica*	808.3
7.	*Acacia polyacantha*	1256.9
8.	*Acacia senegal*	375.9
9.	*Acacia seyal*	137
10.	*Acacia sieberiana*	160.5
11.	*Acacia tortilis*	1207.2
12.	*Acacia xanthophloea*	103
13.	*Acrocarpus fraxinifolius*	47
14.	*Adansonia digitata*	760.42
15.	*Adenanthera pavonina*	201.06
16.	*Afzelia quanzensis*	972.75
17.	*Albizia coriaria*	190
18.	*Araucaria cunninghamiana*	4
19.	*Azadirachta indica*	669.26
20.	*Balanites aegyptiaca*	1045
21.	*Borassusaethiopium*	677.2
22.	*Calliandria callothyrsus*	4.5
23.	*Calodendrum capense*	55
24.	*Casuarina equisetifolia*	17.67
25.	*Casuarina jughuniana*	187
26.	*Cocos nucifera*	450
27.	*Combretum schuminii*	50
28.	*Cordia africana*	1407.8
29.	*Croton macrostachys*	180.7
30.	*Croton megalocarpus*	5822.6
31.	*Cupressus lusitanica**	1360.6
32.	*Delonix regia*	538.65
33.	*Dovyalis caffra**	217.4
34.	*Eucalyptus camaldulensis*	230
35.	*Eucalyptus europhylla*	5.6
36.	*Eucalyptus globulus*	300
37.	*Eucalyptus grandis*	195
38.	*Eucalyptus saligna*	668
39.	*Erytrophleum suaveoleum*	40.77
40.	*Gmelina arborea*	255
41.	*Grevillea robusta**	62.4
42.	*Harungana madagscarensis*	414
43.	*Hyphnae compressa*	506.09
44.	*Hyphaenea coriacea (palm spp)*	303.99
45.	*Jacaranda mimosifolia*	55.1
46.	*Jatropha curcas*	20
47.	*Juniperus procera*	229
48.	*Kigelia africana*	10
49.	*Leuceana lucocephala*	1087.24
50.	*Maesopsis eminii*	1652
51.	*Markhamia lutea*	182
52.	*Melia azedarach*	734
53.	*Melia volkensii (nuts gen)*	5513
54.	*Melia volkensii (nuts orch)*	
55.	*Melia seeds*	266.95
56.	*Moringa oleifera*	929
57.	*Ocotea usambarensis*	16
58.	*Olea africana*	663.6
59.	*Olea capense*	105
60.	*Osyris lanceolata*	3
61.	*Paramacrolobium coeruleum*	102.5
62.	*Parkinsonia spp (any species)*	40
63.	*Pinus patula*	195
64.	*Podocarpus falcatus*	1094.3
65.	*Polyalthia longifolia*	16.38
66.	*Psidium guajava*	80
67.	*Phoenix reclinata*	226
68.	*Prunus africana*	140
69.	*Sclerocarya birrea*	324
70.	*Senna siamea*	474.47
71.	*Senna spectabilis*	821.5
72.	*Sesbania sesban*	316.5
73.	*Sclerocarya birrea*	378.11
74.	*Spathodea campanulata*	170
75.	*Tamarindus indica*	1398.8
76.	*Tectona grandis*	302.18
77.	*Terminalia brownii*	1982.4
78.	*Terminalia mentalis*	228.4
79.	*Terminalia prunoides*	1054
80.	*Terminalia spinosa*	177
81.	*Vitex keniensis*	1825.5
82.	*Vitex payos*	180
83.	*Ximenia americana*	30.6
84.	*Waburgia ugandensis*	45
85.	*Ziziphus mauritiana*	392.3
86.	*Zizyphus mucronata*	200

Leucaena leucocephala

Leucaena leucocephala: Pods

Leucaena leucocephala: Seeds

Tree climbing equipment for seed collection

1.2.2 Improvement of Tree Seed Production Facilities

In the Fiscal Year 2023 - 2024 , KEFRI continued construction of phase II of Seed Centres in Muguga, Londiani, Turbo, Lodwar, Lamu, Wajir and Meru after the successful construction and handing over of eleven (11) Seed Centres. These seed centres are part of the KEFRI plan to establish a total of 18 new tree seed facilities to serve various ecological zones of the country. The Seed Centres will contribute to strengthening the Institute's capacity for collection, testing and distribution of tree seeds to contribute to the Country's goal of 30% tree cover by 2032.

Kibwezi seed centre

Muguga seed centre

Garissa seed centre

Nyeri seed centre

Kakamega seed centre

CHAPTER TWO

2.0 PRODUCTION OF PLANTING MATERIALS

KEFRI plays a key role in supporting the Bottom-up Transformation Agenda (BETA), particularly the government's goal of planting 15 billion trees by 2032. In view of this, the Institute has ramped up its efforts to produce adequate planting materials for various categories of tree species. They include highly demanded assorted tree species and difficult-to-propagate species.

2.1 Highly demanded tree species

During the fiscal year 2023/2024, the Institute prioritized production of assorted tree seedlings for commercial purposes to support afforestation in its diverse eco-regions. The major plantation species produced at the nurseries are; *Pinus patula. Cupressus lusitanica, Eucalyptus grandis, Grevillea robusta* and *Casuarina equiesetifolia.* Indigenous species raised in the nurseries included: *Croton megarlocarpus, Olea africana, Makhamia lutea, and Vitex keniensis.*

Seedlings of species raised in the nurseries for the high rainfall areas during the year comprised plantation species and indigenous species. The major plantation species produced at the nurseries are; *Pinus patula. Cupressus lusitanica, Eucalyptus grandis, Grevillea robusta* and *Casuarina equiesetifolia.*

Indigenous species raised in the nurseries included: *Croton megarlocarpus, Olea africana, Makhamia lutea,* and *Vitex keniensis.*

Species of seedlings raised in nurseries in the drylands included the following:
Acacia tortilis, Acacia polyacantha, Acacia senegal, Azadirachta indica, Acacia elatior, Acacia geradii, Acacia mellifera, Vitex payos, Acacia seyal, Acacia xanthophloea, Annona cherimoya, Balanites aegyptiaca, Carica papaya, Carissa edulis, Commiphora myrrha, Croton megalocarpus, Dalbergia melanoxylon, Delonix regia, D. strictus, Desert rose, Dovyalis caffra, Eucalyptus camaldulensis, E. tereticornis Faidherbia albida, Gmelina arborea, Grevillea robusta, Jacaranda mimosifolia, Kigelia africana, Lawsonia inermis, Leucena leucocephala, Mangifera indica, Markhamia lutea, Moringa oleifera, Osyris lanceolate, O. abbysinica, Parkinsonia aculeate, Passiflora edulis, Persea americana, Phoenix reclinata, Psidium guajava, Saraca asoca, Sclerocarya birrea, Senna siamea, Senna spectabilis, Seraca asoca, S. campanulata, Syzygium cuminii, Tamarindas indica, Terminalia catappa, Terminalia brownii, Terminalia mentally, Terminalia spinose, Thevetia peruviana, Vetiver grass, Ximenia americana, Ziziphus macronata.

Tree nursery in the drylands

Production of seedlings in the various Eco-regions is as summarized in the table below.

Eco-regions	Sub Centres	No. Produced	Total number produced per Ecoregion
CERP	Gede	281,047	**425,204**
	Taita	70,000	
	Lamu	74,157	
CHERP	Muguga	467262	**586,593**
	Nyeri	61941	
	Rumuruti	57390	
DERP	Kitui	76158	**213,925**
	Tiva	48134	
	Kibwezi	64447	
	Garissa	16850	
	Wajir	5436	
	Hola	2900	
LVERP	Maseno	441735	**750,975**
	Kakamega	164600	
	Migori	67064	
	Ramogi	55100	
RVERP	Londiani	184,514	**486,166**
	Marigat	87,522	
	Turbo	162,734	
	Turkana	37,400	

2.2 Difficult to propagate species

During the fiscal year 2023/2024, the Institute prioritised the propagation and production of 75,900 planting materials of difficult to propagate tree species. They included assorted bamboo species, *Osyris lanceolata, Melia volkensii, Xemenia americana, Terminalia brownii,* and *Vitex payos.* The table below shows the total number of seedlings for difficult-to-propagate species produced during the fiscal year.

Species site	Site of production	No. Produced per site	Total number produced
Assorted Bamboo species	CHERP	10525	41,848
	DERP	1800	
	LVBERP	6000	
	RVERP	13272	
	CERP	10,251	
Osyris lanceolata	CHERP	2692	4,697
	DERP	2005	
Vitex payos	DERP	2687	2,687
Ximenia americana	DERP	308	308
Xanthoxylum gilettii	LVBERP	5191	5,915
	RVERP	724	
Olea africana	LVBERP	6000	6,000
Dalbergia melanoxylon	DERP	1400	4,600
	CERP	3200	
Sclerocarya birrea	DERP	401	401
M. excelsa	CERP	5823	5,823

CHAPTER THREE

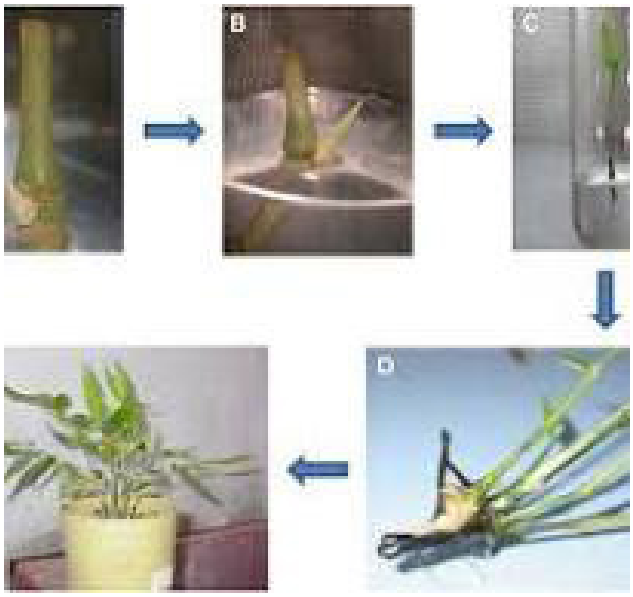
3.0 DEVELOPMENT OF FORESTRY TECHNOLOGIES

During the financial year 2023/2024, the institute developed a total of forty forestry technologies to promote the propagation of difficult to propagate species, tree breeding technologies for species improvement, technologies for management of tree pests and diseases, refined the existing forestry technology guidelines for propagation key indigenous species and assessed potential of various other tree species in offering important ecological goods and services. The Institute also launched an inaugural app, JAZA MITI, that keeps track of the progress made towards achieving the government's goal of planting 15 billion trees by 2032 and help in species-to-site matching.

3.1 Technologies for difficult-to-propagate tree species

3.1.1 Propagation of bamboo

Bamboo which was designated as a cash crop in Kenya, hence increasing demand for seedlings. However, bamboo propagation has been a challenge. The culm cutting techniques were refined and used to propagate exotic bamboo species, whereas a new propagation protocol using tissue culture method was developed for propagation of *Oldeana alpine* the only indigenous bamboo in Kenya.



Experimental illustration of Bud break recorded as early as 7 days of shoot initiation

3.1.2 Propagation of *Osyris lanceolata*

During the year 2023/2024, the Institute refined the existing propagation technologies for *Osyris lanceolata* by identifying more host species such as *Casuarina, Cajanus cajan* and *Acacia nilotica* which are due for introduction into the propagation process. Additional seed sources for the propagation of *Osyris lanceolata* have been identified and new seedling-producing methods using marcots have also been developed as an alternative to seed. The Institute further developed seed collection, handling, and germination protocols to enhance *Osyris lanceolata* propagation.

3.1.3 Propagation of *Melia volkensii* through stem cuttings

During the financial year 2023/2024, the Institute embarked on vegetative propagation of *Melia volkensii* from cuttings. The methods utilize specific vegetative parts of plants such as the stem, roots, or leaves. The cuttings are treated with a rooting hormone and propagated in a growth media. Unlike natural regeneration, vegetative propagation is simple, easy, and convenient for mass propagation.

The success rate of the rooting ability of Melia stem cuttings is dependent on size and age of the cuttings, type and concentration of hormone treatment, growth medium, and the season the cuttings are harvesting. Based on the findings of previously conducted trials, an experiment was set-up to assess the efficacy of using various rooting hormones to propagate *M. volkensii* stem cuttings. *Melia volkensii* cuttings were able to successfully root with the treatment of 1% IBA when inserted in sand medium and later transplanted in coco-peat.

Figure 3.2: Root formation in *M. volkensii* stem cutting 38 days (a) and 4 months after set-up respectively (b)

Propagation of *Vitex payos*

Vitex payos is one of the indigenous fruit tree species of importance in dryland areas whose development is crucial to the improvement of the general well-being and livelihoods of Kenyan communities living in the drylands. However, the seed of the tree species has proved hard to germinate due to a hard seed coat. The Institute developed seed pre-treatment procedures to increase the seed germination rate. The procedure included cycles of seed hydration and dehydration for 3, 7, 14 and 21 days before sowing. In addition, the effects of covering the sowed seed using clear polythene were explored. Results indicated that both treatments significantly enhanced seed germination percentage and shortened the days to first emergence.

3.1.4 Propagation of *Ximenia americana*

Ximenia americana is one of the species of importance in the drylands of Kenya due to its numerous uses. Its fruits, being pleasant to eat raw, can as well as be used to make juices, jams and jellies, or an intoxicating drink, young leaves are edible after thorough cooking, firewood and charcoal are the chief uses of the wood, bark and roots are used for tanning, the seeds yield oil used as a body and hair oil, heartwood contains an essential oil used for fumigation and the flowers have an essential oil that could be a good substitute for orange blossom. in places like South Africa, the fruits have been used to make beer, bark and crushed fruit rind are applied to sores on domestic animals and to keep off fleas, leaves and twigs are used to treat fevers, colds, headache, as a mouthwash for toothache, as a laxative and an eye lotion, angina, and as a poison antidote, roots treat skin problems, headaches, leprosy, hemorrhoids, sexually transmitted diseases, guinea worm, sleeping sickness and oedema and the fruit is useful in treating habitual constipation.

During the fiscal year 2023/2024, the institute prioritised the refining of its propagation protocols. Due to the continuous low germination percentage observed over time, the seed-nipping treatment method to improve germination percentage was prioritized. Notably, a higher germination percentage was obtained from nipped treatment.

3.1.5 Propagation of *Dalbergia melanoxylon*

Dalbergia melanoxylon is an important timber species in its native areas; it is used in the manufacture of musical instruments and fine furniture. It is also used for carving and making quality handcraft, which competes in the world market. The tree species has been over-exploited by wood carvers to the extent of digging out their underground roots from the dry old stumps, to get carving materials. As such, populations, and genomic resources for genetic biodiversity maintenance in parts of its native range are threatened by over-harvesting due to poor or absent conservation planning and by the species' low germination rates. To avoid the extinction of *D. melanoxylon* caused by over-exploitation, refining of propagation protocols continued during Financial year 2023/2024.

3.1.6 Propagation of *Sclerocarya birrea*

Sclerocarya birrea, commonly known as Marula, has been identified as a key species to support development of rural enterprises based on fruit, beer, oil, or nuts, and consequently as a species for potential domestication. Despite the numerous benefits of Marula, the tree remains underutilized by the local population in Kenya. In addition, there is a minimal attempt to promote it onfarm and its products are harvested from the wild. Such wild harvesting is threatened by rapid human settlement activities, which have over the years led to destruction of the Marula trees and erosion of its genetic resources. The situation is further exacerbated by its difficult-to-propagate attribute and its seedlings not readily available for use in afforestation and agroforestry.

During the fiscal year 2023/2024, the Institute tested four pre-treatment methods to improve germination of *S. birrea* seed; removal of operculum, soaking in cold water, oven drying, and control. The operculum removal gave the highest germination percentage compared to the other treatments. Soaking *S. birrea* seeds in cold water also showed a promising germination percentage. However, there is still need to validate these pre-treatment methods using higher quantity of seeds and to explore further studies for additional dormancy-breaking treatments for *S. birrea* that farmers can adopt.

3.2 Tree breeding technologies for tree species improvement

3.2.1 Improving the Genetic Quality of Sclerocarya birrea as a Commercial Tree Crop in Drylands of Kenya

There has been little effort to improve on *S. birrea* despite its multi-use attributes. Thus, in the fiscal year 2023/2024, the institute explored selecting and improving superior germplasm *S .birrea* to allow its commercialization. Overall, 118 *S .birrea* trees distributed across Ikanga/Mutomo (25), Makueni (31), Mwingi (31) and Endau (31) were evaluated. Out of the evaluated trees, a total of 51 superior trees based on the ability to produce fruits, the size of the fruits, the quantity of fruits produced and the taste of the fruit were selected for further development and improvement.

3.2.2 Growth Assessment of *Terminalia brownii* Provenance Trial at Mbumbuni and SEKU

The institute seeks to promote the propagation and establishment of *Terminalia brownii* as an alternative for agroforestry, rehabilitation, and wood fuel in the drylands. In its effort to improve the species, two provenance trials were established to determine the growth performance of *T. brownii* species from different provenances. Assessment has been ongoing since their establishment and continued during the 2023/2024 FY with results across the two sites (SEKU and Mbumbuni) showing Kimose provenance performed the best in terms of both horizontal and vertical growth. In addition, the species demonstrated a high survival rate and general good health status with the application of Silvicultural management i.e., weeding and pruning. It is also important to note that despite browser invasion and pest attack at the SEKU provenance trial site, the interventions applied

(fence repair and chemical control of the pest), proved efficient as the trees were sprouting back. The institute will subsequently consider Kimose trial site as a potential and ideal seed source for further propagation and improvement of *T. brownii.*

3.2.3 Assessment of the potential of *Tamarindus indica* for food security, nutrition, and bioenterprise development

Tamarindus indica produces edible fruits. The fruit has also extensively been used to produce juices, apart from the tree itself being a reliable source of charcoal, firewood, timber, fodder etc. In a bid to promote the tree species in the fiscal year 2023/2024, KEFRI embarked on research on the propagation of sweet and sour tamarind to enhance its propagation. Specifically, the institute carried germination tests of sweet Tamarind from Thailand and carried out grafting trials. A 90% germination rate of *T. indica* was achieved after the seeds sown were pre-treated with hot water overnight while the graft trials are currently being monitored to establish the technology's success rate.

3.2.4 Assessment of *M. volkensii* progeny and sub-progeny trials

KEFRI continues to make satisfactory progress in the development of high quality drought tolerant varieties of *M. volkensii.* The Institute planted a series of progeny trials of *M. volkensii* to determine superior and inferior clones. To this effect continuous assessments of the progenies are done every six months. During 2023/2024 Financial year assessment of all *M. volkensii* progeny and sub-progeny trials was done The assessment covered six basic parameters namely: diameter at 50cm, height, diameter at breast height (DBH), tree form, health status and wood density. The Institute endeavours to continue the assessments to the near future with the sole purpose of developing a highly tolerant variety of species.

In addition, the Institute established a genetic gain trial in Tanganyika and additional sites selection across six Agro-ecological zones. A genetic gain refers to the expected or realized change in the average breeding value of a population over at least one cycle of selection for a particular trait or index of traits. To demonstrate the gain realized, a genetic gain trial was established in Tanganyika (Tiva) through collaboration with a stakeholder. A total of 400 improved and 100 unimproved *M. volkensii* seedlings were established. An additional six sites have been selected for scheduled establishment of genetic trials in the Northern, Eastern and Southern regions of Kenya.

3.3 Improve testing techniques for seed germination and improve seed storage life

Seed germination requires adequate supply of moisture, the supply of oxygen, appropriate temperatures, and in some instances the presence or absence of light and exogenous hormones. In addition, the application of pre-sowing treatments is important for germination in some species, with pre-treatments dependent on the nature of dormancy. Provision of optimal conditions to maximize seed germination is important when germinating seed in nurseries or in seed testing facilities. Maintaining longevity and viability during storage low moisture content is critical. During the year the following studies were undertaken;

- Effects of sowing conditions on germination of eucalyptus seed
- Characterizing tree seeds based on oil and starch content and validation of moisture content testing procedures for oily seeds

3.4 Technologies for the management of tree pests and diseases

i. ERWINIA blight

A new disease has been observed in Eucalyptus seedlings in nurseries Migori County.
The disease was initially on E. grandis but currently observed on *E. camaldulensis* in proximity. The symptoms have also been observed on shoots of guava, especially in new coppices as well as Syzigium species.
Samples analysed in KEFRI laboratories attribute the disease to bacteria of the genus Erwinia

Preventive measures remain the first line of action to reduce infestation within nurseries. Clear any existing sick trees around the nursery.

- Host plants with infections be isolated away from healthy plants and treated or destroyed. Destruction of sick plants must be by burning and not burying or composting.
- Movement of infected plants into the healthy growing zones MUST be restricted.
- In the nursery, the healthy plants must be attended to first before going into the infected zone.
- Tools used in handling infected plants must be disinfected before they are used in the healthy plants zone.
- Clear any existing sick trees around the nursery.
- Acquire nursery soils from locations away from existing guava and eucalypt plantations. Attempt fumigation of soils intended for raising nursery seedlings using a combination of metam sodium, 1,3-dichloropropene, and chloropicrin to rid soil of wilt bacteria.

Although plant disease management has relied heavily in the use, their has to be tested against the target pests. Currently, no records of effective pesticide against this bacterial pathogen is available. However research is on-going to test efficacy of pesticide against the Erwinia blight

ii. Developed guideline and demonstrated control and management of (Castha species):

Cassytha filiformis species is a vine and has been documented be widespread in most regions of the county suppressing ground vegetations, farmland crops and also in some cases forest.

iii. Pest and disease management on *Melia volkensii* seed orchard (2nd generation) in Tiva

Distinguishable Stem form, flowers, fruit and seed characters of *Cassytha filiformis*

3.5 Development of a compendium of major pests and diseases of trees in Kenya

Research on forest pests and diseases in Kenya followed the establishment of softwood plantations in 1953. Since then, a large amount of information has been gathered on various pests and diseases attacking trees. Some of these pests and diseases have continued to attack trees where management strategies have not been very effective. Moreover, new pests and diseases have been introduced or spread into Kenya. Some of these pests and diseases have had a major impact on forestry. So far, 27 entries of both pests and diseases have been collated into a KEFRI Compendium and hosted on Kenya Commercial Forestry Investment Centre (KCFIC)

3.6 Demonstration of Restoration Technologies of Degraded Forest

Forest restoration efforts have increased in these current United Nations decade on Ecosystem Restoration to safeguard biodiversity and ecosystem functioning while also promoting local livelihoods. Kenya has committed itself to various regional and national initiative in restoration of deforested and degraded landscapes. Through the AFR100 Kenya has committed to rehabilitate 5.1M ha within the country, and has developed the “national landscape and Ecosystem restoration strategy 2023-2032”.

In the year 2023/2024 KEFRI contributed to this strategy through the following rehabilitation strategies.

- Establishment of 5 Ha Forest Rehabilitation Model in Mau Forest complex
- Demonstration of Restoration Technologies of Degraded Forest Lands at Kibaara, South West Mau
- Restoration of Chepalungu Forest through promotion of sustainable grazing practices
- Determination of appropriate nature-based technologies for rehabilitation of degraded water catchments in Kenya: a case study of Thiba dam, Kirinyaga County

3.7 Conservation and restoration of riparian selected ecosystems

Riparian zones have the ability to retain a significant proportion of water, sediment and nutrients and return chemically more pure water to the stream or river as a result of ecosystem processes such as sediment trapping, nutrient cycling and flood mitigation. The ability of riparian areas to perform these duties is closely related to their condition and presence of vegetation. The Institute piloted technologies to restore the ecological integrity of river systems through rehabilitation of riparian zones for improved water supply and community livelihoods, as follows.

- Demonstrated restoration of 1.5ha along R. Nzoia
- Demonstration of riverine rehabilitation technologies covering 15ha along River Sabaki in Garashi, Kilifi County.
- Monitoring of technologies for conservation and management of riparian ecosystems of River Lumi in Taita Taveta County
- Development of technologies for rehabilitation & restoration of L. Kenyatta, Lamu county for livelihood improvement and biodiversity conservation
- Demonstrate riverine rehabilitation technologies covering 15ha along River Sabaki in Garashi, Kilifi County.

3.8 Mangroves research for provision of ecosystem services, biodiversity conservation and enhanced livelihoods

Mangrove forests along the Kenyan coast cover approximately 61,271ha. The species plays an important role in reducing vulnerability to natural hazards and increasing resilience to climate change impacts. However, unsustainable extraction of tangible goods like, poles, woodfuel, and timber have resulted in mangrove ecosystems. During 2023/2024 Financial year KEFRI has enhanced research findings in the following aspcets of Mangroves: protocols for propagation and rehabilitation; determination for sustainable mangrove off-take levels through scientific and ITK; review and managemnent of pest and diseases affecting mangroves, rehabilitation of about 20 ha of mangroves and capacity build of about 200 local community members in Kilifi and Lamu on mangrove restoration.

Heavily degraded mangrove sites due to overexploitation and poor waste management in Lamu

Rehabilitation of mangrove degraded sites in Lamu

3.9 Development of strategies for sustainable management of Kaya forests for biodiversity conservation and livelihood improvement

Protection of the Kayas remains deeply entrenched in traditional Mijikenda culture; they are managed by a council of Kaya elders who employ a system of taboos and traditional rules to protect them. To ensure biodiversity conservation the Institute supported the development of conservation strategies for threatened and endangered species in the Kaya forests and the assessment of the effectiveness of existing governance systems in sustainable management of Kaya forests.

3.10 Technologies for conservation of tropical lowland forests and woodlands

Kenya's lowland forests and woodlands provide a number of ecosystem services and are centers of endemism for a wide variety of globally threatened fauna and flora. These woodlands are of critical importance to the socio and economic development of the country especially for the provision of fuel-wood, poles, timber, logs for carving, water, grazing fields for livestock, herbal medicine, butterflies and honey. In the reporting year KEFRI undertook the following;

- Development of technologies for rehabilitation /restoration of forests and woodlands
- Development of tree species site suitability maps for soils within the ecosystems
- Capacity building and supporting community groups to do conservation within the ecosystems
- Development conservation strategy for various endangered species in Taita Hills
- Resource assessment and mapping of Syzygium fruits in Taita Taveta County Investment Centre (KCFIC).

3.11 Management and Control of Invasive Tree Species

Invasive species are of concern due to their ability to rapidly spread and colonize degraded lands. During the fiscal year 2023/2024, KEFRI examined various invasive species and evaluated technologies for their control and management. Strategies for control and management improvement included utilization and mechanical removal as follows:

i. *Prosopis juliflora* Management for Decent Green Jobs and Livelihood Support to Host Communities and Refugees in Garissa and Tana river counties

KEFRI in partnership with other institutions and Development Partners promoted the management of *Prosopis juliflora* in Garissa and Tana River counties through an initiative dubbed' '*Prosopis juliflora* management for decent green jobs and livelihood support'. The initiative aims at enhancing livelihoods and building resilience of local community through sustainable use and exploitation of the economic benefits of the invasive *Prosopis juliflora* Through the initiative KEFRI identified intervention sites, developed community engagement strategy/ plan, developed four key Employment Intensive Investment Programs (EIIP) which included; Community-Based Prosopis Control and Management, Skills Development and Entrepreneurship, Market Development and Value Chain Enhancement Initiative, and Decent Green Jobs Creation. *Prosopis juliflora* is also being controlled through utilization in Baringo and Turkana counties through the Woody Weeds initiative.

ii Assessment of the distribution and ecological impacts of *Opuntia ficus-indica and Opuntia stricta* in Laikipia County

Initially introduced for ornamental and hedging (live fencing) purposes, Opuntia species has become aggressively invasive in overgrazed communal rangelands, along riverbeds and water points of Laikipia county. *Opuntia stricta* spread reduces the benefits gained from livestock production, and impacting on people's health. The assessment established that the hybrid method of controlling *Opuntia stricta* is the most effective.

iii Utilization of *Ipomoea hildebrandtii, Solanum incanum* and cow dung as alternative bio-energy feed stocks used to produce briquettes

During the fiscal year 2023/2024, KEFRI carried out capacity building of selected community group members in Kajiado County on the utilization of *Ipomoea hildebrandtii, Solanum incanum* and cow dung for briquette production for improved livelihoods and environmental protection and conservation. Through utilization, the community is able to reduce the spread of I*pomoea hildebrandtii* and *Solanum incanum* across the ecosystem, thus limiting its allelopathic effect on grasslands and other vegetation of importance to the community.

3.12 Developing allometric equations to estimate biomass and carbon sequestration of on-farm bamboo species in agricultural landscapes

Allometric equations for estimating forest biomass have been developed for many geographical regions, but they mostly focus on large tree species. In Kenya, previously developed models for biomass estimation in agricultural landscapes have mainly focused on *Grevillea robusta* and Eucalyptus species. KEFRI is currently undertaking development of allometrc equations for estimating aboveground biomass of major bamboo species in agricultural landscapes. The current fiscal year KEFRI focused on evaluation and applicability of the developed allometric models in estimating biomass and carbon sequestration of bamboo in agricultural landscapes.

3.13 Promotion of bamboo through improving bamboo research on ecology and utilization

Bamboo is fast-growing and a versatil species and has been promoted globally due to its high potential as one of nature's substitutes for endangered rainforest hardwoods. KEFRI aims to encourage the growing and use of bamboo by both local communities and industries in order to spur economic growth and development. The following initiatves have been promoted dueing fy 2023/2024;

- Integrate bamboo species site matching into the KEFRI tree species site matching platform/ application: This information is essential in assisting bamboo growersto accurately plant the right species of bamboo in their ecological zone. The information has been incoporated into the JAZAMITI App and is expected to promote widespread adoption of the appropriate bamboo species.
- Evaluating long term effects of growing bamboo on soil quality and hydrology
- Promotion of Bamboo conservation and development for domestic and industrial use and housing

3.14 Developing Farm Level Tree Cover Assessment Tool

Research has highlighted that agroforestry can reap substantial economic and environmental benefits, producing more output and proving to be more sustainable than forestry or agricultural monocultures. It is important to assess the amount of trees on-farm to estimate the ceonomic and ecological planning. The Institute seeks to develop a tool to estimate tree cover at the farm level using Landsat, Sentinel-2 and digital globe images and develop a model relating to processed images with tree variables such as crown diameter and height. Finalization of this tool is ongong.

3.15 Design payment for ecosystem models and national accounting frameworks

In Kenya the forest sector contributes KES 7 Billion annualy. This is based on economic activities which draw and depend upon natural capital, while affecting their stock. At the same time, activities undertaken in one area such as emissions and land use changes will influence conditions for people in othere areas. Climate change, changes in water quality, and biodiversity loss are examples of how people impact other's lives and livelihoods. There is need for infromation to guide development of polcies based on the intimate relationship

between the ecosystems, economy, and human well-being. Accordingly, KEFRI in the finacial year continued to design

- Frameworks for natural capital accounting (NCA) for consideration and adoption by the National Treasury and Economic Planning (NTEP).
- Framework for payment for ecosystem services (PES) for consideration and adoption by the Ministry of Environment, Climate Change and Forestry (MoECCF).
- PES Strategy for Trans-boundary Riverine Forest Ecosystems: The case of River Lumi, Kenya

3.16 Development livestock grazing threashhold in Kenya

In Kenya, forest adjacent communities and forest user groups' have the right to grass harvesting and grazing in the forest ecosystems. However, these rights have been unmanaged and abused with people keeping large herds of livestock which has resulted to overgrazing and subsequent degradation of the forests. The Institute has over the years promoted sustainable grazing through defining allowable grazing threshholds: This has been undertaken through;

- Ecological studies of forest grazing in moist and dry forests of Kenya
- Development of grazing management plans for Chepalungu and Kiptogot forests
- Assessment of livestock grazing within Witu Forest Ecosystem

Witu Forest

CHAPTER FOUR

4.0 FORESTRY INNOVATIONS AND PRODUCT DEVELOPMENT

The Institute recognizes the significant contribution of value - added forest products to improving rural households and promoting local, regional, and national economic growth. In response to the rising demand for non-timber forest products (NTFP) with natural ingredients. These initiatives are geared towards efficient processing of forest products, job creation, improved livelihoods, and enhanced biodiversity conservation.

The Institute in the year under review developed nine (9) forest products. The Institute aims to link these developed products to SMEs, a crucial step in ensuring their uptake and commercialization. Developing a market for diverse forestry products helps in spreading economic benefits across different regions and stakeholders.

4.1 Developed Forest products

4.1.1 Extraction of herbal tea from *Zanthoxylum chalybeum* Plant

During the fiscal year 2023/24, the Institute developed a new herbal beverage from *Zanthoxylum chalybeum.* Interest in herbal beverages, ' teas ' is on the rise among health-conscious consumers. Local communities have long exploited aromatic leaves, shoots and fruits of *Z. chalybeum* in making local brews and beverages rich in antioxidants. The species has great potential for value addition and commercialization. Accordingly, the Institute aims to link the developed product to small and medium-sized enterprises (SMEs) for uptake and livelihood improvement

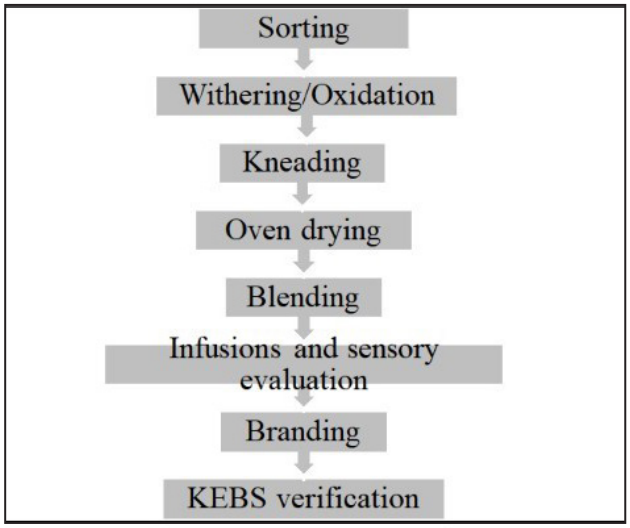


Figure 4.1: Harvesting *Zanthoxylum chalybeum* leaves

4.1.2: Developing natural dye from mangrove bark

The Institute developed natural dyes from mangroves, focusing on bark extracts from Rhizophora, Bruguiera, and Ceriops species, leaf extracts from Lumnitzera species, and sap from young Avicennia shoots.

These natural dyes were developed to capitalize on their environmentally friendly nature as an alternative to synthetic dyes, utilization of traditional knowledge and practices, and creation of economic opportunities for coastal communities.

These natural dyes: provided sustainable source of colorants for textiles; offered a range of shades using various parts of mangrove plants, explored use of metallic salt mordants to enhance color yield, shade variety, and fastness properties.

The Institute is actively working to link these developed natural dyes to small and medium-sized enterprises (SMEs) for uptake and commercialization. This crucial step aims to capitalize on the unique properties of mangroves while promoting their conservation and sustainable use.

Figure 4.3: A sample of the mangrove tree

Figure 4.4: Natural dye in powder form extracted from the mangrove tree bark

4.1.3 Developing jam from cape gooseberry fruits

Cape gooseberry known as *Physalis peruviana* L. (Solanaceae), is herbaceous, perennial plant, and classified as an underutilized fruit in Kenya (KALRO, 2010). KEFRI developed jam from cape gooseberry fruits to capitalize on it's rich nutritional profile and potential health benefits. Including Vitamins C, A, and B complexes, minerals of nutritional importance, fructose. These fruits contain polyphenols with anti-inflammatory and antioxidant properties. In developing the Jam, the Institutes anticipates creating an avenue for creation of economic opportunities.

Figure 4.5: Jam processing from Gooseberry fruits

4.1.4 Other Developed products

They include;

- Body lotion from *Ximenia americana* seed oil to capitalize on the species' potential economic and environmental benefits. The lotion exhibited good skin moisturizing and revitalizing properties.
- Value addition to Guava fruits through development of jam to capitalize on the high nutritional value of the fruit.
- *Ximenia americana* leaf extracts,
- Charcoal briquettes from Ipomea invasive species
- Aloe vera-based body care products.
- The developed forest products are being linked to small and medium-sized enterprises (SMEs) for uptake and livelihood improvement.

Figure 4.6: Processed jam from guava fruits

Figure 4.7: Soap from Bamboo

4.2 Refining developed forest products

4.2.1 Refining black soap from bamboo leaves

The Institute developed an activated charcoal soap using bamboo waste as primary raw material. The activated charcoal-based bathing soap, capitalized on the movement towards creating natural and organic alternatives in the cosmetics industry. Activated charcoal, also known as activated carbon, is processed by carbonizing natural materials such as bamboo at elevated temperatures in a kiln to form a lightweight mass of carbonaceous charcoal. This process creates a porous surface that can trap toxins, making it an effective ingredient for skincare products. By utilizing bamboo waste, which is readily available and affordable, the Institute sought to create a sustainable and cost-effective alternative to commercial activated charcoal

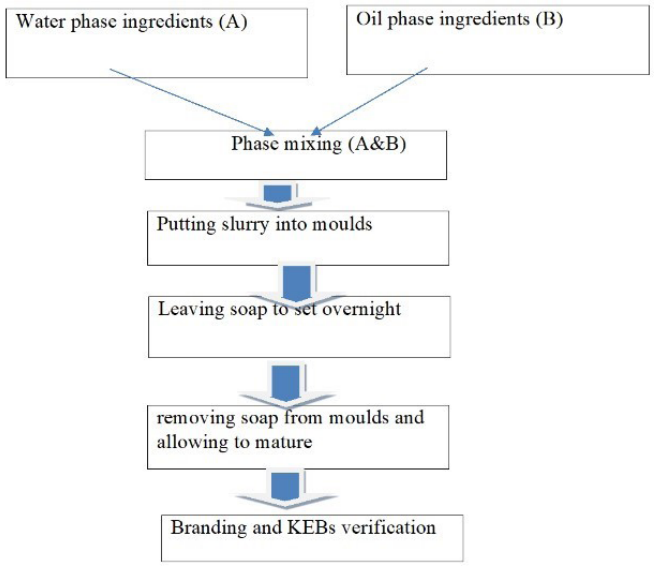


Figure 4.8: Flow chart illustrating the process of refining bamboo black soap from bamboo leaf

Figure 4.9: Black Soap extracted from bamboo leaf

4.3 Linking Developed Forest Products

4.3.1 Linking Cape Chestnut Lotion to stakeholders in Nyeri County

In March 2024, KEFRI organized a hands-on training program in Kieni, Nyeri County, aimed at equipping local communities with the skills to process Cape Chestnut oil into body lotion. The Cape Chestnut *(Calondedrum capense)*, is locally known as Mururua or Murarachi. This training, attended by 10 participants (5 men and 5 women), focused on demonstrating the process-from extracting the oil to formulating and packaging the lotion.

The lotion, rich in antioxidants like vitamin E, ascorbic acid, flavonoids, and minerals such as copper, magnesium, manganese, and zinc. The product contains local, sustainable, natural ingredients.

The training empowered participants with practical skills for creation of small and medium enterprises (SMEs) in the region. By utilizing the Cape Chestnut, the initiative aims to foster economic growth in Kenya's Central and the Rift Valley regions.

Figure 4.10: Training session for the extraction of Cape chestnut lotion from Cape chestnut seeds

4.3.2 Linking of *Ximenia Americana* Soap in Mwingi, Kitui County

In March 2024, KEFRI conducted a training program on soap production using *Ximenia american* oil also known as ''Wild olive or Plum'' in English or ''Ndula'' by the Kamba to empower a group of 10 women in Mwingi, Kitui County. The tree which is a drought-torelant medicinal plant widely distributed in tropical and temperate regions produces Ximenia oil is valued for its antibacterial and skin-soothing properties, making it an ideal ingredient in cosmetic products like soap.

Participants were guided through the production process, from oil extraction to soap molding and were provided with raw materials to ensure the continuity of production.This initiative promotes the use of locally available resources and helps create sustainable income-generating opportunities for rural communities.

Figure 4.11: Illustration of soap production process using oilextracted from *Ximenia Americana*

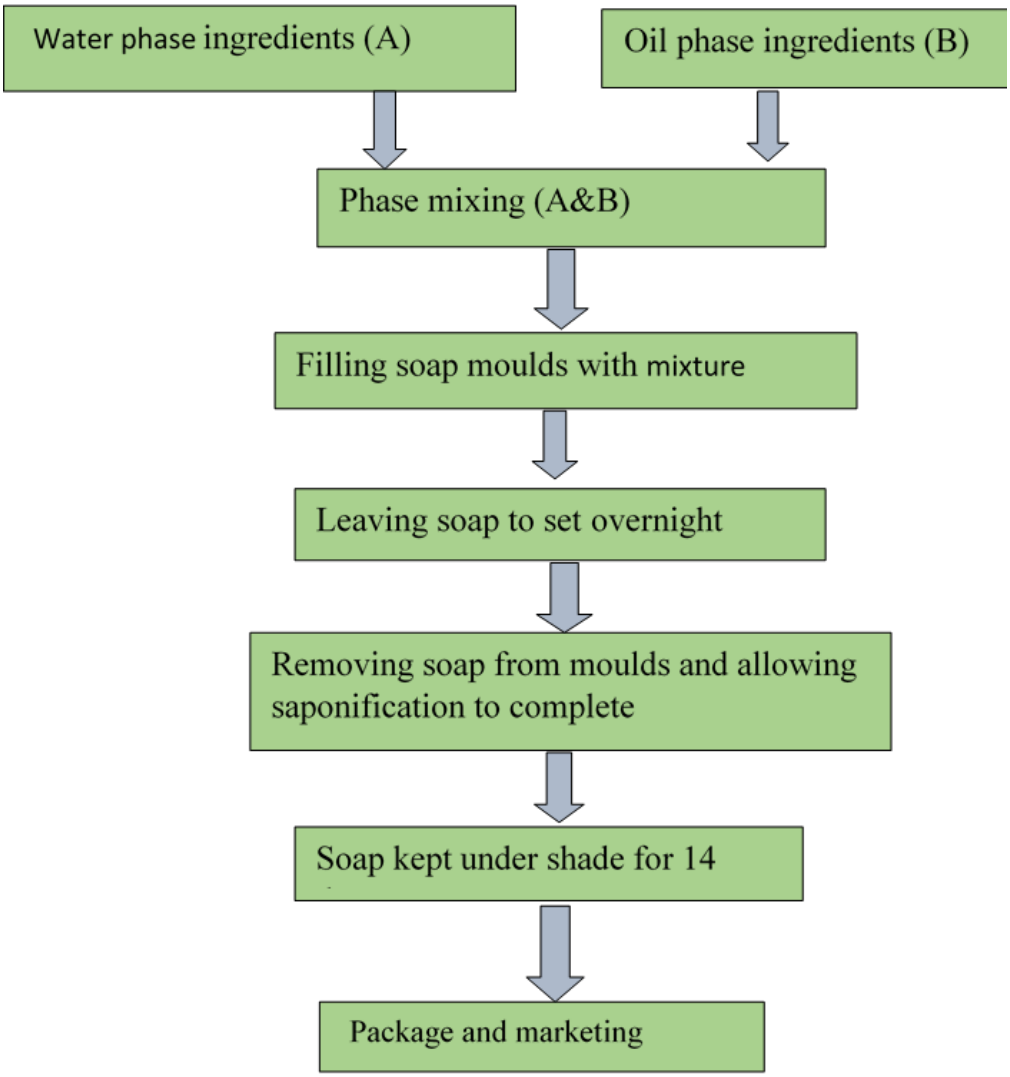


Figure 4.12: Participants proudly display the innovative products developed during the training, demonstrating their newfound skills and creativity

CHAPTER FIVE

5.0 DISSEMINATION AND PUBLICITY

In 2023/2024, the Institute carried out 70 dissemination activities including; 47 field days across all eco-regions, exhibiting forestry technologies in 8 Agricultural Society of Kenya (ASK) shows in Nairobi, Kisumu, Mombasa, Nakuru, Eldoret, Migori, Machakos and Nyeri.

KEFRI also engaged their stakeholders through radio and TV talks, excursions to demonstration plots and trial sites to promote or showcase forestry technologies.

Field days

The Institute hosted the following field days across the eco regions demonstrating;

1. Forest rehabilitation techniques in Gwassi Hills, Homabay County
2. Mine closure and rehabilitation techniques in Rosterman, Kakamega County
3. Management of *Acacia polyacantha* for charcoal production in Rarieda, Siaya County
4. Tree selection for restoration of riparian ecosystems in Kisii County
5. Tree-crop integrations on-farm in Muhoroni, Kisumu County
6. Integration of local bio-enterprises in green economy in Bungoma County
7. *Prosopis juliflora* management and utilization at Balambala, Garissa County.
8. *Melia volkensii* propagation, management and utilization at Kwa Vonza, Ikutha and Kibwezi in Kitui and Makueni counties.
9. Baobab propagation, establishment, and utilization at Ikutha and Kibwezi in Kitui and Makueni counties.
10. Bamboo propagation and establishment for riverbank stabilization (held 2) in Kibwezi and Kitui counties.
11. Osyris propagation and utilization: (held 1) in Wote, Makueni County
12. River bank and dam rehabilitation using Bamboo and Vetiver grass at Kinyambu in Kibwezi, Makueni County
13. The potential of growing and management of *Melia volkensii* in Nachu, drier parts of Kiambu County
14. Fruit tree agroforestry technologies in Kangema, Muranga County for food and nutrition security and attainment of 30 percent tree cover by 2032
15. Establishment and management of commercial tree nursery and urban forestry in collaboration with youth groups in Mukuru kwa Reuben in Nairobi County
16. Establishment and management of commercial tree nursery and urban forestry in collaboration with one youth group in Rumuruti Town, Laikipia County
17. Establishment and management of a commercial eucalyptus woodlot in collaboration with a tree growers association in Olkalau, Nyandarua County
18. Management of *Prosopis juliflora* through utilization in Kamukuru, Kajiado County
19. Rehabilitation of wetland areas of Enkong Enkare Swamp using suitable Bamboo species, vetiver grass and indigenous tree species
20. Technologies in Wambugu ATC farm, Nyeri County
21. *Prosopis juliflora* management and utilization at Logologo and Masalani, in Marsabit and Garissa counties respectively
22. *Melia volkensii* propagation and management and utilization at Logologo, Kiritili and Gaciogo, in Marsabit,Embu and Tharaka Nithi counties respectively
23. Baobab propagation, establishment, and utilization at Kasaala in Ikutha, Kitui County
24. Bamboo propagation and establishment for riverbank stabilization at Mui in Mwingi, Kitui County

25. Riverbank and Dam rehabilitation using indigenous tree species at Kisayani in Kibwezi, Makueni county
26. Promoting on-farm trees through modern best nursery practices in conjunction with the Nuts and Oils Directorate of the Food and Agriculture Authority (AFA) in Siembeni, Makueni County
27. Propagation and utilization of *Casuarina equisetifolia* in Teso, Kilifi County
28. Management and utilization of mangroves in Uyombo, Kilifi County
29. Propagation and management of *Tectona grandis* in Gede, Kilifi County
30. Propagation and management of *Melia volkensii* in Baolala, Kilifi County
31. Propagation and management for *Casuarina equisetifolia* at Hindi, Lamu County
32. Establishment, management and utilization of *Gmelina arborea* in Mpeketoni, Lamu County
33. Management and utilization of mangroves in Mkunumbi, Lamu County
34. Establishment and management of *Grevillea robusta* in Wundanyi, Taita Taveta County
35. Establishment and management of *Melia volkensii* in Marungu, Taita Taveta County
36. Propagation and utilization of *Casuarina equisetifolia* in Msambweni, Kwale County
37. Aloe value addition at Kalemungorok in Turkana County
38. Tree Establishment and Management at Keringet, Nakuru County
39. Suitable forest rehabilitation techniques in South west Mau, Kericho County
40. Propagation, Planting, and Management of *Melia volkensii* in Eldama Ravine, Baringo County
41. Control and Management of Invasive Species *(Cestrum Aurantiacum)* in Kuresoi, South West Mau Forest
42. Forest technologies at Turbo, Uasin Gishu County
43. Management of *Prosopis juliflora* at Lake Bogoria National Reserve, Baringo County
44. Aloe, Briquetting Technology & Gum and Resins in Tana river County
45. *Mondia whytei* value addition, Bamboo and Charcoal briquetting technologies Malakisi Bungoma County
46. Sustainable harvesting, grading of gum arabic and resins from Commiphora and Boswellia species

5.1 Exhibition at ASK shows

During the Fiscal Year 2023/24, KEFRI participated in the Agricultural Society of Kenya (ASK) shows in Kisumu, Migori, Kakamega, South Eastern Region Machakos, Eldoret, Nairobi International Trade Fair, Central Kenya Nyeri Show, Mombasa International Show, and the Nakuru National show under the theme "Promoting Climate Smart Agriculture and Trade Initiatives for Sustainable Economic Growth".

KEFRI staff celebrating their win during the Nyeri ASK Show

Performance in ASK shows

Region /Venue	Theme int.	R& D	SP&Mkt	Ino & Inv	AEQS	Non Agr. SB	Gov Stand	Comm Proj/Service
Machakos	2	1	1	3	1	-	-	1
Nakuru		2	3			3		
Eldoret		2	3		1		2	
Kisumu	-	-	-	-	-	-	-	-
Mombasa					3			
Nyeri	1		2	2				
NITF			3		3			

KEY:

Theme int. - Theme Interpretation
R&D- Research and Development
SP&Mkt- Seed production and marketing
Ino & Inv- Innovation and Invention
AEQS- Application of Environmental Quality Standards
Non Agr. SB-
Non Agricultural statutory board
Gov Stand- Government stand
Comm Proj/Service- Community service projects

The Institute held 6 radio talks and 6 Tv appearances on mainstream media. The topics covered in the radio talks included:-

- Tree establishment
- Protection and management in the drylands
- Use of Bamboo in enhancing livelihood of rural communities
- Baobab as a source of food security and income generation in the drylands

Topics covered in the Tv appearances included:-

- Importance of species site matching
- Restoration of wetlands using Bamboo
- Suitable tree species for drylands
- Use of JazaMiti App

Radio interviews aired on KBC Swahili, KBC English Service 95.6 FM, and Radio Taifa 92.9 FM frequencies publicized: KEFRI mandates, ongoing empowerment of stakeholders for green jobs; capacity building of the communities; and availability of quality tree seeds and seedlings for achieving the 15 Billion trees directive by the year 2032.

Engage Media houses to Publicize KEFRI technologies and information

Subject	Media Station/ Date	Link
Bamboo	Radio talk KBC 14th Sep 2023	Promoting Bamboo plantation Presenter Gordon Sigu
Bamboo propagation, utilization and adoption on farm	Citizen TV 14th Dec 2023	https://youtu.be/G36nXe_QGcg?si=TMsgJ4bPn1MIwTe
KEFRI and Lukenya university MoU signing	KTN & TV 24/7 15th Dec 2023/	https://youtu.be/dFPei1anGGY?si=QOEJuvG4Oedbw6 VZ
Strategic Plan	KTN TV 14th Dec 2023	https://youtu.be/9Oihr9cehcE?si=a6NaFPfvy5Ho_udA
Launch of KEFRI 7th Strategic Plan	Kameme TV 14th Dec 2023	https://youtube.com/watch?v=l_zJbw40oU4&si=BYFvuxVv4wFM7yW
National tree planting	Star Newspaper 13th Nov 2023	https://www.the-star.co.ke/.../2023-11-13-explainer.../
Issuing seedlings for National tree planting	Witu, Makueni 12th Nov 2023	https://youtu.be/Ozeqj-UhggI?si=iMvmkrJ5LLqhAByl
5th International Congress on Planted Forests	CIFOR- ICRAF Kenya 10th Nov 2023	https://www.youtube.com/watch?v=KkC6NvJIVd8
Kenya Government targets to plant 15 billion trees	Star article 25th Nov 2023	https://www.the-star.co.ke/.../2023-11-13-explainer.../
Kitui farmer growing tree seedlings	Daily Nation Article 11th Nov 2023	https://nation.africa/.../kitui-seedling-farmer-drives...
Baringo residents utilizing Mathenge tree	NTV 16th Oct 2023	https://youtu.be/Ot_BcYesaT8?si=coY39HWCyArHx9 iZ

Stakeholder dissemination activities:

Event Name/ Date	Theme	Venue
7th edition Kaptagat Annual Tree Planting - 1st July, 2023		Kessup Forest block, Elgeyo Marakwet County
World Bamboo Day - 18th September , 2023	Bamboo for Landscape Restoration and Protection	Kanyonga, Embu County
World Desertification and Drought Day - 17th June, 2024	United for Land!Our Legacy!Our Future	OlKinyei Primary School - DolDol Laikipia County
World Environment Day - 5th June, 2024	Land Restoration, Desertification and Drought	Embu County
World Wetlands Day - 2nd February, 2024	Wetlands and Human Wellbeing	Lake Narasha, Uasin Gishu County
International Day of Forests - 21st March, 2024	Forests and Innovation: New Solutions for a Better World	Lariak Forest Block, Laikipia County
1st County Resilience Knowledge Fair		Garissa University, Garissa County
Farmers' Expo		Musila Gardens, Mwingi- Kitui County

Capacity Building: Implementation of First Pilot on-demand Training

KEFRI in collaboration with Japan International Cooperation Agency (JICA) conducted the first pilot on-demand training titled "Promoting Climate Change Resilient Forestry in Sub-Saharan Africa" this was implemented from 6th to 24th May 2024 at KEFRI Headquarters-Muguga. The course attracted 10 participants drawn from seven (7) Sub-Saharan African Countries; Burundi, Ethiopia, Kenya, Malawi, South Sudan, Tanzania, and Uganda. The training aimed to bridge technical knowledge gaps clustered into four themes: tree germplasm, tree and fruit growing management, livelihood improvement, dissemination of information.

KEFRI and JICA since 1985 continue to undertake research and development, provide information and technologies in forestry, and allied natural resources. The research output has been shared widely in Sub-Sahara African (SSA) through capacity building undertaken by the Third Country Training Programme (TCTP). This course was carried out, to address emerging challenges due to; climate change, extensive landscape degradation, biodiversity losses and desertification.

The four themes lay the foundation for the on-demand pilot training which aims at sharing knowledge and technical skills, experiences, and technologies on high-quality tree germplasm development, fostering implementation synergies for sustainable measures against climate change threats at both policy and implementation levels.

The course objectives were met through in-house presentations and excursions to selected field sites in Muguga, Kereita Forest, KEFRI Dryland Eco-region Research Programme (DERP) Kitui and Kibwezi, KALRO - Kiboko and Katumani, as well as selected farmers.

Participants shared "Country Reports" and developed individual Action Plans which will be useful during monitoring to gauge the impact and application of lessons learnt from the training.

Tree seed Training to Botswana at National Tree Seed Centre

KEFRI, Japan Forest Technology Association (JAFTA) and JICA jointly held a specialized training for four (4) participants from Botswana National Tree Seed Centre from 15th January to 2nd Feb 2024 at KEFRI headquarters. The purpose of the training titled' Training in Tree Seed and Long-Rooted Seedling Production for Seed Collection Officers, and Capacity Building for A Manager' was to build capacity of the officials to overcome challenges, produce highquality tree seeds, and contribute to environmental conservation and reforestation efforts in Botswana.

The initiative to conduct this training was prompted by challenges faced by the Botswana National Tree Seed Centre such as; shortage of skilled personnel and lack of equipment.

CHAPTER SIX

6.0 RESOURCE MOBILIZATION AND PARTNERSHIPS

KEFRI through partnership and resource mobilization established strategic networks and linkages that leveraged collaborative and funding partners willingness to complement research and development initiatives. The process of identifying the strategic partners is guided by exclusive mutual interest and negotiations on areas of cooperation. The partnerships are formalized through memorandum of understanding (MoUs) and memorandum of agreements (MOAs). Currently, KEFRI has 126 strategic partners categorized as: government ministries, state corporations, universities, international organizations, county governments, non-governmental organizations, private companies and community-based organizations.

In the FY 2023/2024, the Institute through Partnership and Resource Mobilization improved resource mobilization strategies and increased revenue, through winning grants from 3 strategic partners.

6.1 Linkages and partnerships with stakeholders.

The Institute signed 12 MoUs, and 8 MoAs with respective partners namely; Solubag Africa Ltd, Chebororwa Agricultural Training College, National Forestry Resources Research Institute (NAFORRI) of the National Agricultural Research Organization (NARO), St. Paul's University, The Centre for Coordination of Agricultural Research and Development for Southern Africa, Kenyacof Limited, ARTAGRO, The East African Natural History Society (Nature Kenya), Kilifi Moringa Estate, German Imaging Technology (GIT), Climate Change Research And Advisory Centre (CCRAC), and Earthban.

By the end of reporting period, the following MoUs were in progress: Kenya Water Institute, Nature Based Solutions (NBS), Smart Cities, The Kenya Highland University, Radeecal Community, Agricultural Food Authority (AFA), Kenyatta University, St Paul University, Kisii University, Pwani University, Nakuru Water Sanitation Services Co. Ltd (Nawasscoal), Laikipia County and Makueni County. Similarly, KEFRI MoAs with Sigona Thomas Foundation was in progress.

CHAPTER SEVEN

7.0 HUMAN RESOURCE, ADMINISTRATION AND WORKPLACE ENVIRONMENT

During the fiscal year 2023/2024, the Institute undertook both routine and performance contracted activities. The activities undertaken included; human resource planning, recruitment and staff selection, training and development, performance management, reward management, employee relations, personnel administration, employee separations and provision of medical services at the KEFRI clinic.

Human Resource

7.0 Human Resource Planning

The KEFRI Board of Directors approved the Staff Replacement Plan for 2022/23 and 2023 /24 FY and the same was submitted to the Principal Secretary, Ministry of Environment and Forestry for onward forwarding to the National Treasury and SCAC for approval.

7.1 Training and Development

During the period, the Institute undertook the following activities under the Training and Development function:

7.1.1 Induction

The Institute coordinated induction for one hundred and thirty-four (134) attachees and thirty-five (35) interns during the period July 2023 to June 2024. Induction also took place for the eighty-five (85) newly recruited employees.

7.1.2 Training

Various staff attended continuous professional development trainings organized by various institutions including Kenya School of Government, Institute of Certified Public Accountants of Kenya (ICPAK), Kenya Institute of Management (KIM), Kenya National Secretaries Association (KENASA) amongst other training institutions.

7.1.3 Internship and attachment

During the Financial Year 2023/2024, under the Youth Internships/Industrial Attachments/Apprenticeships, KEFRI offered two hundred and thirty-five (235) attachment opportunities to students from institutions of higher learning and TVETS. Fifty-eight (58) internships were also offered to graduates for a period of one year.

7.2 Staff Establishment

The Institute as at 30th June 2024 had **821** employees out of which **607** are on permanent and pensionable terms of service whereas **214** are on contract

Staff Establishment

S/no	Cadre	No. staff
1	Research Scientists	143
2	Technologists	66
3	Technicians	27
4	Foresters	32
5	Finance	35
6	Audit	6
7	HR	7
8	Administration	40
9	Supply Chain	26
11	Other Support	439
	Total	**821**

7.3 Recruitment and selection

During the period, the Institute conducted a recruitment exercise based on the staff replacement plan approved by the National Treasury for 2021/22 FY. The Institute also recruited staff for the Seed Infrastructure Project and drivers. A total of ninety-five (95) positions were advertised and interviewed, out of which 92 were on contract terms while 3 were appointed on permanent and pensionable terms.

7.4 Performance Management

During the year under review, the Institute implemented the full Board approval of performance evaluation recommendations for 2023/2024 where by promotions, merit increments, commendations, cautionary letters and performance improvement plan (PIP) were enacted accordingly.

7.5 Medical

7.5.1 Health and wellness management

A total premium of **KShs. 83,723,968.00** (Eighty Three Million, Seven Hundred and Twenty Three Thousand, Nine Hundred and Sixty Eight Shillings) was paid to GA Insurance for the year. An additional premium of **KShs. 5,091,263.00** (Five Million, Ninety One Thousand, Two Hundred and Sixty Three Shillings) was paid in respect to the Eighty (80) newly recruited staff.

7.5.2 Group Personal Accident /WIBA Plus

The Institute purchased a Group Personal Accident insurance cover for its Eight Hundred and sixty Seven Staff (867) at a cost of **KShs. 1,037,872.00.** It also purchased a Work Injury Benefit (WIBA) plus insurance cover for its staff on Casual terms of service at a cost of **KShs. 132,925.00.**

7.5.3 Employee Separations

The Institute exited Eighty (88) staff: sixty (60) on retirement upon attaining the mandatory retirement age, five (5) through early retirement, fifteen (15) through resignation, four (4) through translation of terms; and three(3) through death.

7.6 Compensation and Benefits Management

A total of KES. 917,605,166.11 was paid as remuneration during the period.

7.7 Clinic Services

During the period under review, clinic attended to a total of 1716 clientele as indicated below:

CATEGORY	MALE	FEMALE	TOTAL
CLIENT > 5Yrs	46	21	67
CLIENT < 5Yrs	763	886	1,649
TOTAL	**809**	**907**	**1,716**

In addition, three hundred and one (301) clinical laboratory tests were carried out during this period and a total of one hundred and thirty-four 134 mental health cases were handled during the period under review.

7.8 Infrastructural Development

During the year 2023 -2024 the Institute continued with the construction of phase II of the seed centres in Muguga, Londiani, Turbo, Lodwar, Lamu, Wajir and Meru respectively.

The Institute partnered with various the County Governments of Laikipia, Migori, Tana River, Wajir, Baringo and Narok resulting in the allocation of land towards construction of model tree nurseries, offices, laboratories and farmers resource centres.

Through technical backstopping from the Valuation Department in the Ministry of Lands, the Institute successfully carried out valuation of land and property. The Centres covered included Rumuruti, Migori, Taita Taveta, Lamu, Kitui, Headquarters, Muguga, Karura, Garissa &Turkana.Administration division carried out renovation of various office blocks, water and electrical lines and staff houses. In line with diability mainstreaming, the division has installed ramps for ease of access to the Institutes facilities as well as installed disability friendly sanitary facilities.

Before renovations

After renovations

7.9 Improvement of Work Environment (ISO/OSHA)

The Institute is cognizant of the fact that embracing international standards and compliance to legal and regulatory frameworks positions it as a Centre of excellence in execution of its mandate of conducting research in forestry and allied natural resources.

Over the last fifteen years, the Institute has adopted and implemented two ISO standards in environmental and quality management. These are ISO 140001:2015 and ISO 90001:2015. These standards have played a critical role in ensuring uniformity of procedures across the Institute and continue to enhance service delivery.

Compliance with the requirements of the Occupational Safety and Health Act, 2007 has opened opportunities for improvement of the safety and health of all workers and stakeholders within the Institute's premises. Notable areas of continuous improvement include consistent work environment audits and inspections and ensuring implementation of recommendations in the audit and inspections reports.

It is thus evident that the efforts put in place to create a conducive working environment has been enhanced by adoption of international standards and compliance with legal and regulatory frameworks geared towards ensuring staff health and safety.

APPENDIX 1: KEFRI Publications (FY 2023-2024)

Peer review journal papers

Choge S. K., Ojunga S. O., Dokata D. I., Chepkirui W. K., Musau J., Muniale F. M., & Kiptui I. K. (2024). Floristic Composition, Population Structure, and Recruitment Status of Plant Species: A Case Study of Farmer-Managed Natural Regeneration Practices in Arid and Semi-Arid Lands in Kenya. Open Journal of Forestry, 14, 141-154. https://doi.org/10.4236/ojf.2024.142010 Received: January 18, 2024 Accepted: April 27, 2024 Published: April 30, 2024

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Vangueria rotundata (Burch) subsp. rotundata (Robyns and Berchemia discolor (Klotzsch) Hemsl in Eastern Kenya. Scientific African Journal

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Mokua R., Nadir S., Osore Melckzedeck, and Teucher M. (2024). Integration of remote sensing in watershed studies: A case study of Chawia & Fururu forested watersheds in Taita Hills, Kenya. Kenya Aquatica Journal. 9 (01): 75 - 90

Mugula B.B., Omondi S.F., Curto M., Samuel Kuria Kiboi, Kanya J.I., Egeru A., Okullo P. and Harald Meimberg. (2023). Microsatellites reveal divergence in population genetic diversity and structure of *Osyris lanceolata* (Santalaceae) in Uganda and Kenya. BMC Ecology and Evolution

Muigai P., Agevi H., Otuoma J., Muyekho F.N., Onyango C.A and Ayaga G. (2024). Tradeoffs in Tree Species Selection and Carbon Offset on Farms Adjacent to Kakamega-Nandi

Forest Ecosystem in Kenya. Tropical and Subtropical Agroecosystems 26 (2023): #090 1-17. http://doi.org/10.56369/tsaes.4774 Musyoki J.K., Ming''ate M.L.F., Muriithi J., Musingo M.T. Mbuvi., Kagombe J. (2024). Factors Impacting Benefits of Participatory Forest Management in Upper Imenti Forest,

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Appendix II: Statement of financial performance for the year ended 30th June 2024

KENYA FORESTRY RESEARCH INSTITUTE

ANNUAL REPORT AND FINANCIAL STATEMENT FOR FY ENDED 30TH JUNE 2024

STATEMENT OF FINANCIAL PERFORMANCE FOR YEAR ENDED 30TH JUNE 2024

STATEMENT OF FINANCIAL PERFORMANCE

FOR THE PERIOD ENDED 30TH JUNE 2024

	Note	2023-2024 Period ended 30/Jun/24 Kshs.	2022-2023 Comparative Period 30/Jun/23 Kshs.
REVENUE			
Revenue from non-exchange transactions:			
Government Grants	3	1,792,775,063	1,478,987,007
External Grant for Research	4	81,305,619	126,676,315
Deferred Income from Donors	5(b)	16,766,435	18,140,179
Revenue from exchange transactions:			
Other Income	6	121,160,995	112,316,746
TOTAL REVENUE		**2,012,008,112**	**1,736,120,247**
EXPENSES			
Employee Costs		(1,190,955,571)	(1,209,837,910)
Operating Expenses	8	(711,973,328)	(488,386,495)
Board of Management Expenses	9	(21,864,902)	(7,227,142)
Establishment costs(Sinking fund)	10(a)	(5,000,000)	(5,000,000)
Depreciation	5(a)	(71,577,731)	(80,356,688)
Amortization on Intangible Asset	11	(1,548,402)	(1,935,502)
TOTAL EXPENSES		**(2,002,919,934)**	**(1,792,743,737)**
OTHER GAINS/(LOSSES)			
Exchange Gain/(Loss)	12(b)	(1,013,926)	(5,163,270)
		(1,013,926)	**(5,163,270)**
Surplus/(Deficit)		**8,074,252**	**(61,786,760)**

Dr. Jane W. Njuguna
Ag. Director KEFRI
Date 26/9/24

FCPA Rose Osoro
Deputy Director F & A
ICPAK No.:4555
Date 26/9/2024

Gen (Rtd) Samson Mwathethe
Chairman: KEFRI Board of Directors
Date 26 Sep 24

Appendix III: Statement of Financial Position as at 30th June 2024

KENYA FORESTRY RESEARCH INSTITUTE

ANNUAL REPORT AND FINANCIAL STATEMENT FOR FY ENDED 30TH JUNE 2024

STATEMENT OF FINANCIAL POSITION AS AT 30TH JUNE 2024

STATEMENT OF FINANCIAL POSITION AS AT 30TH JUNE 2024			
		2023-2024 Period ended 30/Jun/24 Kshs.	2022-2023 Comparative Period 30/Jun/23 Kshs.
ASSETS	**Notes**		
CURRENT ASSETS			
Cash and cash equivalents	13	396,175,457	509,906,910
Receivables from exchange transactions	14(a)	58,806,123	48,326,314
Receivables from non- exchange transactions	14(b)	11,179,242	704,903
Receivables from State Department of Forestry	14(c)	254,160,133	-
Inventories	15	134,068,326	144,379,080
		854,389,282	**703,317,207**
NON-CURRENT ASSETS			
Property, Plant & Equipment	5(a)	5,935,149,925	5,844,888,912
Intangible Assets	11	6,193,606	7,742,008
		5,941,343,531	5,852,630,920
TOTAL ASSETS		**6,795,732,813**	**6,555,948,126**
LIABILITIES			
CURRENT LIABILITIES			
Payables from exchange transactions	16	8,021,769	4,494,276
Auditor General- accrued audit fee	16(c)	660,000	660,000
Commisioner of VAT- Accrued VAT	16(d)	66,733,804	-
Medical Scheme Funds	17	345,205	345,205
Unexpended External Donor Grants	4	56,969,217	57,824,314
		132,729,994	**63,323,795**
NET ASSETS			
Government Grants for capital assets	18(a)	1,772,788,425	1,598,716,690
Deferred Income on Donated Assets	5(b)	459,593,563	476,359,998
Sinking Fund	10(b)	44,490,996	39,492,061
Revaluation Reserves	18(b)	4,467,199,488	4,467,199,488
Revenue Reserves	18(e)	(81,069,654)	(89,143,906)
		6,663,002,818	**6,492,624,331**
TOTAL NET ASSETS & LIABILITIES		**6,795,732,813**	**6,555,948,126**

Dr. Jane W. Njuguna
Ag. Director KEFRI

Date 26/9/24

FCPA Rose Osoro
Deputy Director F& A
ICPAK No.:4555

Date 26/9/2024

Gen (Rtd) Samson Mwathethe
Chairman: KEFRI Board of Directors

Date 26 Sep 24

Appendix IV: Statement of cash flows for the Year Ended 30th June 2024

KENYA FORESTRY RESEARCH INSTITUTE

ANNUAL REPORT AND FINANCIAL STATEMENT FOR FY ENDED 30TH JUNE 2024

STATEMENT OF CASH FLOWS FOR THE YEAR ENDED 30TH JUNE 2024

	NOTES	2023-2024 Kshs.	2022-2023 Kshs.
Cash Flows from Operating Activities			
Cash from Recurrent Grants	3	1,498,416,665	1,441,000,000
Cash from Development Grants	3	190,500,000	215,612,405
Cash from donor grants	4	90,072,403	121,397,425
Cash receipt from customers -Exchange Transaction		229,338,875	128,847,323
Cash receipts from Insurance		6,934,884	4,495,013
Cash paid to employees(Salaries)	8	(1,190,373,756)	(1,209,837,910)
Cash paid for operations		(708,181,284)	(492,893,015)
Cash paid to board members	9	(21,864,902)	(7,596,942)
Cash refund to donor		(4,417,071)	(95,912,024)
Cash paid to employees as outstanding imprest	14(b)	(11,080,182)	(213,040)
Cash paid to employees as outstanding Salary advance/ Inadvance		(99,060)	(491,863)
Cash paid for Prepaid Motorvehicle, Personal accident Insurance & Building Insurance		(28,584,398)	(29,140,960)
Cash paid to suppliers(Payables)		(1,705,727)	-
Cash paid to employees for personal accident		(602,755)	(3,620,088)
Net cash from operating activities		**48,353,691**	**71,646,324**
Cash Flows from Investing Acticities:			
Purchase of property, plant, and equipment	5(a)	(162,085,144)	(159,925,240)
Purchase of Intangible asset	11	-	-
Net Cash from Investing activities		**(162,085,144)**	**(159,925,240)**
Net increase in cash and cash equivalents		(113,731,453)	(88,278,916)
Cash and cash equivalents at beginning of period	13(a)	509,906,910	598,185,826
Closing Cash and cash equivalents at end of period		**396,175,457**	**509,906,910**

Jane W. Njuguna (PhD)
Ag. Director KEFRI
Date: 26/9/24

FCPA Rose Osoro
Deputy Director Finance
ICPAK Member Number:4555
Date 26/9/2024

Gen(Rtd) Samson Mwathethe
Chairman: KEFRI Board of Directors
Date 26 Sep 24

Appendix V: Statement of Changes in Net Assets for the Year Ended 30th June 2024

KENYA FORESTRY RESEARCH INSTITUTE

ANNUAL REPORT AND FINANCIAL STATEMENT FOR FY ENDED 30TH JUNE 2024

STATEMENT OF CHANGES IN NET ASSETS FOR THE YEAR ENDED 30TH JUNE 2024.

	2023-2024					
	Government Grants for Capital Assets Kshs	Deferred Income on Donated Assets Kshs	Revenue Reserves Kshs.	Revaluation Reserves Kshs	Sinking Fund Kshs.	Total Kshs.
Balance as at 1st July 2022	**1,421,091,292**	**494,500,177**	**(27,357,146)**	**4,467,199,488**	**34,493,126**	**6,389,926,938**
Prior period adjustment						-
As restated	**1,421,091,292**	**494,500,177**	**(27,357,146)**	**4,467,199,488**	**34,493,126**	**6,389,926,938**
Surplus/(Deficit) for the year	-		(61,786,760)			**(61,786,760)**
Adjustments						-
Transfers from Sinking fund						-
Sinking Fund expenses					(1,065)	**(1,065)**
Additions during the year	215,612,405				5,000,000	**220,612,405**
To Income & Expenditure	(37,987,007)					**(37,987,007)**
Deferred Income for the year	-	(18,140,179)	-	-	-	**(18,140,179)**
Balance as at 30th June 2023	**1,598,716,690**	**476,359,998**	**(89,143,906)**	**4,467,199,488**	**39,492,061**	**6,492,624,332**
Balance as at 1st July 2023	**1,598,716,690**	**476,359,998**	**(89,143,906)**	**4,467,199,488**	**39,492,061**	**6,492,624,332**
Prior period adjustment						-
As restated	**1,598,716,690**	**476,359,998**	**(89,143,906)**	**4,467,199,488**	**39,492,061**	**6,492,624,332**
Surplus/(Deficit) for the year	-		8,074,252			**8,074,252**
Adjustments						-
Transfers from Sinking fund						-
Sinking Fund expenses					(1,065)	**(1,065)**
Additions during the year	272,076,800				5,000,000	**277,076,800**
To Income & Expenditure	(98,005,065)					**(98,005,065)**
Deferred Income for the year	-	(16,766,435)	-	-	-	**(16,766,435)**
Balance as at 30th June 2023	**1,772,788,425**	**459,593,563**	**(81,069,654)**	**4,467,199,488**	**44,490,996**	**6,663,002,819**

Appendix VI: Statement of Comparison of Budget and Actual Amounts for the Year Ended 30th June 2024

KENYA FORESTRY RESEARCH INSTITUTE

ANNUAL REPORT AND FINANCIAL STATEMENT FOR FY ENDED 30TH JUNE 2024

STATEMENT OF COMPARISON OF BUDGET AND ACTUAL FOR THE YEAR ENDED 30TH JUNE 2024

	Original Budget ksh.	Adjustments ksh.	Final Budget ksh.	Actual ksh.	% of Utilization Cumulative to Date	Explanation of Material Variances
Revenue						
Government Grants :						
Recurrent	1,671,000,000		1,671,000,000	1,670,999,998	100%	
Development	443,576,800		443,576,800	272,076,800	61%	Development Funds were not fully disbursed
Other grants	23,770,000		23,770,000	23,770,000	100%	
Development Patners : Research Grants	82,000,000		82,000,000	81,305,619	99%	
Deferred Income	16,800,000		16,800,000	16,766,435	100%	
Sale of Forestry Produce	16,126,199		16,126,199	16,126,199	100%	
Services Rendered : Hire of Training Facilities	77,000,000		77,000,000	76,651,323	100%	
Sale of Tree Seeds	15,500,000		15,500,000	15,027,924	97%	
Other Income	13,500,000.00		13,500,000.00	13,355,550	99%	
Sub Total	2,359,272,999.00	-	2,359,272,999.00	2,186,079,846.52		
GOK Development Grants for Capital Assets	283,000,000.00		283,000,000.00	174,071,735.01		
Total Income	**2,076,272,999**	-	**2,076,272,999**	**2,012,008,112**		
Expenses						
Compensation of Employees	1,200,000,000	80,000,000	1,280,000,000	1,190,955,571	93%	Recurrent Budget enhanced through Supplementary II
Goods and Services			-			
Other Operation Expenses	498,759,834		498,759,834	481,427,638	97%	
Insurance of Property & Motor Vehicles	9,000,000		9,000,000	8,862,618	98%	
Contracted Professional Services	30,000,000	10,000,000	40,000,000	37,738,332	94%	
Audit Fee	1,000,000		1,000,000	937,347	94%	
Repairs & Maintenace Expenses	46,000,000	6,000,000	52,000,000	52,253,560	100%	
Research Expense	135,000,000		135,000,000	129,992,838	96%	
Board Expenses	25,000,000	500,000	25,500,000	21,864,902	86%	
Bank Service Comission and Charges	760,995		760,995	760,995	100%	
Establishment Cost (Sinking Fund)	5,000,000		5,000,000	5,000,000	100%	
Exchage Loss	1,013,926		1,013,926	1,013,926	100%	
Depreciation & Amortization Expenses	73,126,133		73,126,133	73,126,133	100%	
Total Expenditure	2,024,660,888	96,500,000	2,121,160,888	2,003,933,860		
Surplus/(Deficit) for the period	**51,612,111**			**8,074,252**		

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