KENYA FORESTRY RESEARCH INSTITUTE

Training Curriculum
On Production, Processing and Marketing of Forest Products

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July 2019

Cover page pictures:

Top Left: Aloe products and prosopis pods

Top Middle: Charcoal produced from drum kiln

Top Right: Bamboo Products

Bottom left: Gum Arabic from Merille, Marsabit County

Bottom Right: Tamarindus fruits

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Kenya Forestry Research Institute (KEFRI)
P.O. Box 20412-00200, NAIROBI, Kenya
Tel: +254 722 157 414, +254 724 259 781/2
Email: director@kefri.org
Website: www.kefri.org

Contributors:

Joseph Githiomi, James Kimondo, Meshack Muga, George Muthike, Nellie C. Oduor, Violet Oriwo, Rose Chiteva, Oscar Mayunzu, Collins Obonyo, Emily Kitheka, Norman Wachira, Samson Mogire, Moses Lukibisi, James Kimwemwe, Charles Gitau, Dominic Mikile

Layout and design
Violet Oriwo

FOREWORD

Forest products are important in various sectors including construction, pulp and paper, pharmaceutical and biomass energy among others. These products contribute significantly to the Kenyan economy through income generation and employment creation.

Forest products research in KEFRI in undertaken by the National Forest Products Research Programme (NFPRP). The NFPRP research priorities focuses on generating technologies to: ensure sustainable production and management of the wood- and non-wood- forest products; promote use of bamboo as a handicraft, furniture and construction material; ensure efficient production and utilization of biomass energy in form of charcoal, briquettes and promotion of efficient gasification stoves among others

The technologies and information generated through research play a major role in sustainable conservation of environment and improvement of community livelihoods. These technologies and information are disseminated to various stakeholders/end uses mainly through training. However, the trainings have been using varied formats. This training curriculum has been developed to standardize the format of the trainings in forest products and allied products

This curriculum will guide trainers on the scope; duration of the trainings; courses' content; necessary materials and assessment tools. This curriculum will go a long way in promoting and developing the forest products based enterprises.

Joshua Cheboiwo (PhD)
Director, Kenya Forestry Research Institute

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CHAPTER 1: TRAINING ON PRODUCTION, PROCESSING AND MARKETING OF FOREST PRODUCTS

1.1 Introduction

Forest products are broadly classified into; wood and non-wood products. Wood products include; timber, furniture, poles, posts, wood fuel, pulp, paper, wood composites, wood carvings and bamboo. Non-wood forest products (NWFPs) are goods of biological origin other than wood. Non-wood forest products include; plant gums, resins, essential oils, dyes and tannins, indigenous fruits, medicinal and pharmaceutical plant products.

KEFRI is mandated to conduct research in forestry and allied natural resources; disseminate research findings to stakeholders; build capacity of stakeholders; and establish partnerships and cooperate with other research organizations and institutions of higher learning in joint research and training.

KEFRI undertakes its research and development activities in these programmes through five thematic areas namely; Forest Productivity and Improvement, Forest Biodiversity and Environment Management, Forest Products Development, Socio-Economic Policy and Governance, and Technical Support Services

The research undertaken addresses several strategic objectives as outlined in the Strategic Plan 2018-2022. Strategic objective 4 seeks to develop technologies for efficient processing and utilization of wood and non-wood forest products under the Forest Products Development Theme. Research and development in forest products contributes to sustainable forest management through development and promotion of efficient technologies for harvesting, processing and utilization of forest resources. The research and development further contributes to improved livelihoods of Kenyan communities through development of wood and Non-Wood Forest Products (NWFP) as alternative sources of income.

Research and development on forest products is mainly undertaken at National Forest Products Research Programme (NFPRP). NFPRP has developed technologies in efficient production, processing, value-addition and utilization of forest products; efficient production and utilization of wood fuel, and adoption of alternative forms of renewable energy. Over the years, the Programme has been carrying capacity building activities in these areas to promote the development of small and medium scale forest products based enterprises.

In the current devolved governance, the Programme has realized a growing demand of these capacity building needs aiming at utilizing specific forest products. To meet these demands, the Programme has developed a training curriculum to deliver quality training on production, processing and marketing of forest products.

1.2 General Objectives of the Training on Forest Products

The general objectives of the trainings are to:

- Develop skills which will be responsive and relevant to participants requirement
- Impart skills which will enable participants to manage local enterprises in a sustainable and profitable way
- Address challenges and opportunities for production, processing and marketing of selected forest products
- Promote new methods of production, harvesting and post- harvest handling and processing for selected products
- Promote value addition for enhanced trading and marketing in selected forest products
- Create awareness on relevant policies in forestry, environment and allied natural resources
- Create awareness on issues such as climate change, gender roles and group dynamics that affect sustainable production and utilization of forest products

1.3 Training Curriculum and Courses in the Training Programme

The purpose of the training curriculum on production, processing and marketing of forest products is to guide trainers on the scope; duration of the trainings; courses' content; necessary materials and assessment tools.

The training courses are divided into four as follows:

1. Non Wood Forest Products (NWFP)
2. Biomass Energy Production and Utilization
3. Bamboo Propagation, Management and Utilization
4. Timber Processing and Utilization

CHAPTER 2: TRAINING CURRICULUM ON NON WOOD FOREST PRODUCTS (NWFP)

Course Code: 001

2.1 Introduction

Non-wood forest products (NWFPs) are goods of biological origin other than wood, derived from forests, wood lands and trees outside forests (FAO, 1995). The NWFPs are major sources for food, medicines, fodder, gums, fiber, cosmetic and cultural products. The NWFPs can broadly be classified as:-

- Extractive products e.g. plant gums, resins, essential oils, dyes and tannins
- Edible products e.g. indigenous fruits
- Medicinal and pharmaceutical plant products e.g. Aloes
- Animal products e.g. bee products
- Fibers
- Eco-tourism

The Non Wood Forest Products received notable attention, by being recognized as a source of environmentally sound and sustainable development at the United Nations Conference on Environment and Development (UNCED) in 1992. Currently, there is high and increasing global demand for bio-products and nutraceuticals derived from NWFPs. The market for bio-prospecting is about USD 800 billion worldwide (http://eastafricabusiness.blogspot.co.ke/2010/10/strategy-for-bioprospecting-in-kenya.html). Global market for medicinal plants, for instance, is estimated at over USD 14 billion/yr (Mafimisebi *et al*., 2013)

In the last few decades, the role of NWFPs in the Kenyan economy has been minor compared to the supply of timber and wood products (Muniu and Kahuki 1998). Recent studies however, show heightened interests in NWFPs identification research and development (Kimondo *et al*., 2016; Jama *et al*., 2008; Chikamai *et al*., 2004 ;). Importance of NWFPs for rural households, particularly in times of adversity, is well documented (ICRAF 2004; Shackleton and Shackleton 2004; Arnold 2001; Falconer 1997; Falconer and Arnold 1992). In Kenya, the level of utilization of NWFPs varies from one region or community to another, and in line with the ecological zones differentiation. Utilization is more in the drylands than high rainfall areas where modern agricultural crop production dominates land use decisions. The Government has made commitment to address Arid and Semi-Arid Lands (ASALS) challenges as highlighted in various policy documents including: the National Policy for the Sustainable Development of the Arid and Semi-Arid Lands; Agricultural Sector Development Strategy (2010); Kenya Vision 2030 and Draft National Forest Policy 2016.This commitment is important in boosting the promotion of NWFPs.

KEFRI has recognised the potential for commercialization of NWFP. The institute at its National Forest Products Research Programme (NFPRP) prioritised research on generating technologies

to; ensure sustainable production, management, utilization, and commercialisation of non-wood forest products. The Programme has developed technologies for production of a range of products from NWFP resources. The various NWFP technologies have potential for bio enterprise development that will improve livelihoods of communities as well as for use by industries. The NFPRP has packaged the technologies and information for dissemination to relevant users. The major avenue for dissemination of the technologies is through trainings. This curriculum has therefore been developed to guide the trainings on production, processing and marketing of various NWFPs. The curriculum will be useful to trainers involved in promotion of NWFPs.

2.2 Purpose of the Non Wood Forest Products Training Curriculum

The purpose of the NWFPs training curriculum is to guide trainers on the scope; duration of the training; course content; necessary materials and assessment tools,

2.3 Beneficiaries of Trainings on Non Wood Forest Products

- Community groups
- Cottage industries
- Relevant technical staff
- Students
- Relevant extension service providers
- Relevant community resource persons

2.4 Training Strategy

The training approach will vary depending on the target group, duration of the training and budget. The various categories include: Training of Trainers (TOT); training of enterprise groups; and exchange visits to relevant areas.

2.5 Curriculum packaging

The Training Curriculum (TC) on Non Wood Forest Products is competency based and packaged into modules as follows:

TC Module Code 001-I - Aloe Production, Processing and Marketing
TC Module Code 001-II – Gums and Resins Production, Processing and Marketing
TC Module Code 001-III- Dyes and Tannins Production, Processing and Marketing
TC Module Code 001-IV- Indigenous Fruits Production, Processing and Marketing
TC Module Code 001-V - Prosopis pods Collection, Processing and Marketing

2.6 TC Module 001-I - Aloe Production, Processing and Marketing

2.6.1 Introduction

The genus Aloe contains over 400 different species. In Kenya, there are about 60 indigenous species of Aloes occurring in the wild in arid and semi-arid lands. The key uses of aloe include; production of cosmetics and medicines. Aloe products that have been linked to aloe community groups in Kenya include: soap, cream, lotion, shampoo and detergents.

2.6.2 Purpose

This module outlines relevant knowledge and skills on propagation, management, harvesting of Aloe and processing of its products.

2.6.3 Training outcomes

After implementation of the training curriculum, the participants should be able to:

- Demonstrate an understanding of the different types of Aloes in Kenya
- Have skills on: Aloe propagation, management, harvesting; and processing of Aloe products
- Practice safe farming of Aloes
- Undertake commercial production and marketing of Aloe products
- Have an awareness of the policy frameworks and legal requirements relating to Aloes
- Cope with emerging issues relevant to Aloes

2.6.4 Target group for the training

- Community groups
- Cottage industries
- Youth and women groups
- Community resource persons
- Extension service providers
- Students

2.6.5 Training approach

- Lectures
- Practical
- Field visits

2.6.6 Teaching and learning resources

Aloe plants, Photos, training manual, relevant literature and Extension materials, Processing equipment, Aloe raw materials and sample products

2.6.7 Course duration

This course will require 60 contact hours (Table 2.1)

Table 2.1 Content for Training Module on Aloe Production, Processing and Marketing

Topic	Content	Delivery Methods	Duration (Hours)		Responsible Institution
			Instruction time	Field work/ Demonstrations	
Types of Aloes in Kenya	• Introduction • Types of Aloes ✓Exotic ✓Indigenous • Ecological requirements and effects of climate change	• Lectures • Demonstrations • Discussions • Illustrations	2	5	• KEFRI • KWS, • MUSEUMS • NGOs
Aloe propagation	• Propagation methods ✓ Seeds ✓ Suckers ✓ Cuttings ✓ Tissue culture ✓ Nursery practices • Transplanting to the field	• Lectures • Field Demonstrations • Discussions • Illustrations	2	6	KEFRI, KWS, MUSEUMS, NGOs
Tending and field management of Aloe	• Good agricultural practices (GAP)	• Lectures • Field Demonstrations • Discussions • Illustrations	2	6	KEFRI, KWS, NMK, , NGOs
Harvesting and post-harvest handling of Aloes	• Harvesting • Post-harvest handling ✓ Sorting ✓ Boiling ✓ Storage	• Lectures • Field Demonstrations • Discussions • Illustrations	3	8	KEFRI, KWS, NMK, , NGOs

Topic	Content	Delivery Methods	Duration (Hours)		Responsible Institution
			Instruction time	Field work/ Demonstrations	
Processing and value addition of Aloes	• Processing ✓ Soap ✓ Lotion ✓ Cream	• Lectures • Field Demonstrations • Discussions • Illustrations	2	18	KEFRI, KWS, NMK, , NGOs
Branding and marketing of Aloe products	• Packaging • Branding • Certification and registration • Market awareness • Advertising	• Lectures • Demonstrations • Illustrations	1		KEFRI, KWS, NMK, NGOs
Formation and strengthening common interest groups	• Purpose and type of member-based producer organisations • Legal requirements, elements and steps for formation of a marketing association • Group dynamics and leadership • Gender and resource management	• Lectures • Group work • Discussions • Demonstrations • Field executions	2	2	KEFRI/ Min of Cooperatives
Legal and policy requirements for Aloe production	• International Convention on Trade in Endangered Species (CITES) • Wildlife Conservation and Management Act	• Lectures	1		KWS, NEMA, NMK, KEFRI, KFS

Topic	Content	Delivery Methods	Duration (Hours)		Responsible Institution
			Instruction time	Field work/ Demonstrations	
	2013 • Environmental Management and Coordination Act (EMCA) 2015 • Kenya Vision 2030 • Sustainable Development Goals (SDGs) • Constitution of Kenya 2010				

2.6.8 Training assessment

- Practical assignments
- Action plans
- Course evaluation feedback
- Field and excursion reports

2.7 TC Module 001-II: Gums and Resins Production, Processing and Marketing

2.7.1 Introduction

Gums and resins are important commodities from the drylands with high potential for spurring economic development within communities in the regions. Plant gums and resins include gum arabic and commercial gum resins such as; myrrh, hagar and frankincense.

Gum arabic is used for industrial applications as an emulsifier in soft drinks, and stabilizer in alcoholic and pharmaceuticals industries; antioxidant in lithographic printing plates; emulsifier and thickener in confectionary and milk products and as an ingredient in health foods and artificial blood serum. Resins particularly frankincense are used in unprocessed form for both fragrance and flavor purposes, though there some essential oils and extracts that are distilled from resins

2.7.2 Purpose

This module outlines relevant knowledge and skills on production, harvesting, processing and marketing of gums and resins products

2.7.3 Training outcomes

After implementation of the training curriculum, the participants should be able to:

- Demonstrate an understanding of the different types of gums and resins producing species in Kenya
- Have skills on harvesting, processing and marketing of gums and resins
- Undertake commercial production and marketing of gums and resins products
- Have an awareness of the policy frameworks and legal requirements relating to gums and resins
- Cope with emerging issues relevant to gums and resins

2.7.4 Target group for the training

- Community groups
- Cottage industries
- Youth and women groups
- Community resource persons

- Extension service providers
- Students

2.7.5 Training approach

- Lectures
- Practical
- Field visits

2.7.6 Teaching and learning resources

Training manual, photos, relevant literature and extension material, processing equipment, product samples, live trees

2.7.7 Course duration

This course will require 37contact hours (Table 2.2)

2.7.8 Training assessment

- Practical assignments
- Action plans
- Course evaluation feedback
- Field and excursion reports

Table 2.2 Content for Training Module on Gums and Resins Production, Processing and Marketing

Topic	Content	Delivery Methods	Duration (Hours)		Responsible Institution
			Instruction Time	Field work/ Demonstrations	
Taxonomy/ ecology of gums and resins producing species	• Introduction • Main gum arabic and gum resins producing species: taxonomy and ecology. • Effect of climate change • Other gums and gum resins producing species • Sources of adulteration	• Interactive lectures • Group discussions • Field excursions	3½	5	KEFRI, KFS
Description and uses of gums and gum resins in Kenya	• Definition and description of gums and resins • Local and commercial uses • Opportunities for value adding, processing and marketing	• Interactive lectures • Group discussions • Illustrations • Demonstrations	3		KEFRI GARA
Harvesting of gums and resins	• Tapping and collection ✓ Optimum tree age and size ✓ Tapping season ✓ Tapping tools ✓ Procedures for tapping for optimum yield and sustainability	• Interactive lectures • Group discussions • Illustrations • Field Demonstrations	5	6	KEFRI GARA
Post-harvest handling of gums and resins	• Drying and storage • Cleaning, sorting and grading • Packaging and certification	• Interactive lectures • Group discussions • Demonstrations	3	2	KEFRI GARA

Topic	Content	Delivery Methods	Duration (Hours)		Responsible Institution
			Instruction Time	Field work/ Demonstrations	
Processing of gums and resins	• Gum Arabic: Grinding, spray drying and kibbling • Production of essential oils from resins	• Interactive lectures • Group discussions • Illustrations • Field Demonstrations	1½		KEFRI KIRDI
Marketing of gums and resins products	• Overview of the market situation ✓ Factors affecting market supply ✓ Collection patterns by different communities ✓ Prices ✓ Players in market chain • Market outlets for gum arabic and resins • Challenges in marketing of gums and resins • Opportunities for streamlining the trade chain	• Interactive lectures • Group discussions • Demonstrations	3	-	KEFRI GARA
Formation and strengthening common interest groups	• Purpose and type of member-based producer organizations • Legal requirements, elements and steps for formation of a marketing association • Group dynamics and leadership • Gender and resource management	• Lectures • Group work • Discussions • Demonstrations • Field executions	2	2	KEFRI, GARA, Ministry of Cooperatives

Topic	Content	Delivery Methods	Duration (Hours)		Responsible Institution
			Instruction Time	Field work/ Demonstrations	
Legal and policy requirements for gums and resins	• Draft gums and resins regulations 2018 • The Natural Resources (Benefit Sharing) Bill, 2014 • Wildlife Conservation and Management Act 2013 • Environmental Management and Coordination Act (EMCA) 2015 • Kenya Vision 2030 • Sustainable Development Goals (SDGs) • Constitution of Kenya 2010	• Lectures	1		KWS, NEMA, NMK, KEFRI, KFS

2.8 Module 001-III: Dyes and Tannin Production, Processing and Marketing

2.8.1 Introduction

Natural dyes are derived from plant sources such as roots leaves, bark, berries, wood and other organic sources such as fungi and lichens. The draft Kenyan Forest Policy recognizes non- wood forest products such as dye sand tannins to have critical importance to the livelihoods of rural communities and have significant contribution to the household incomes. / Rural economies. Promoting sustainable use of dyes and tannins and intensifying training on such is important.

2.8.2 Purpose

This module outlines relevant knowledge and skills on propagation, management, harvesting, of plant sources for dyes as well as processing and marketing of dye and tannins products in Kenya.

2.8.3 Training outcomes

After implementation of the training curriculum, the participants should be able to:

- demonstrate an understanding of the key natural dyes and tannin producing species in Kenya
- have awareness of the main characteristics and applications of dyes and tannins in the cottage industry
- have the ability to propagate, establish and manage dye and tannin plants using appropriate techniques
- have the ability to collect /harvest and extract dye and tannin products using appropriate techniques
- undertake sustainable production and value addition of dyes and tannins
- have awareness of commercial potential of natural dyes and tannins
- have the ability to brand, package, and market dye and tannin products
- have an awareness of the policy framework and legal requirements relating to exploitation and conservation of natural dyes and tannins plants

2.8.4 Target group for the trainings

- Community groups
- County environmental officers
- Extension service providers (Agriculture and Forestry)
- Students
- Cottage industries
- Youth and women groups
- Community resource persons,

2.8.5 Training approach

- Classroom/Instructor–led instructions
- Plenary /group discussions
- Practical
- Field excursions

2.8.6 Teaching and learning resources

- Relevant publications
- Plant samples / photos
- Processing equipment
- Product samples/ Photos
- Training manual
- Materials/equipment for demonstrations

2.8.7 Course duration

This course will require 30 contact hours (Table 2.3)

2.8.8 Training assessment

- Practical assignments
- Field and excursion reports
- Action plans
- Course evaluation feedback

Table 2.3 Content for Training Module on Dye and Tannins Production, Processing and Marketing

Topic	Content	Delivery methods	Duration (hours)		Responsible institution
			Instruction time	Field work/ Practical's	
Dye and tannin producing plants in Kenya	• Introduction to Key dye and tannin producing plants in Kenyan • Commercial potential of dye and tannin producing plants • Effect of climate change	• Lectures • Discussions • Illustrations	2	-	KEFRI, KFS, NMK, NGOs, Community resource persons
Management and Exploitation of Dye/ Tannin Producing Plants	• Sustainable management and exploitation of natural dye and tannin producing plants	• Lectures • Field excursions • Demonstration • Discussions • Illustrations	2	-	KEFRI, KFS, NMK, NGOs, Community resource persons
Propagation & Management of Natural dye and tannin producing plants	• Propagation methods • Seeds collection and handling • Vegetative propagation • Nursery practices • Field preparation and establishment	• Lectures • Field excursions • Demonstration • Discussions • Illustrations	2	5	KEFRI, KFS, NMK, NGOs, Community resource persons
Harvesting and extraction of dye and tannin products	• Harvesting and extraction of dye tannin products.	• Lectures • Field excursions • Demonstration • Discussions • Illustrations	Theory 2	5	KEFRI, KFS, NMK, NGOs, Community resource persons

Topic	Content	Delivery methods	Duration (hours)		Responsible institution
			Instruction time	Field work/ Practical's	
Processing and value addition of dye and tannin products	• Processing • Dyes • Tannins • Dyed materials	• Lectures • Field excursions • Demonstration • Discussions • Illustrations	2	5	KEFRI, KFS, NMK, NGOs, Community resource persons
Branding and marketing of dye and tannin products	• Overview of the market situation (factors affecting market demand and supply of natural dye and tannin products) • Market awareness • Certification ,registration • Branding and Packaging • Advertising	• Lectures • Demonstration • Illustrations	2	1	KEFRI, KFS, NMK, NGOs, Community resource persons
Challenges in domestication/conservation of dyes and tannins.	Challenges in:- • marketing of natural dye and tannin products • Propagation and establishment of natural dye and tannins plants • Sustainable extraction, Processing and utilization of natural dye and tannin plants • Conservation of natural dye and tannin producing plants	• Lectures • Discussions • Illustrations	2		KEFRI, KFS, NMK, NGOs, Community resource persons

2.9 TC Module 001-IV: Indigenous Fruits Production, Processing and Marketing

2.9.1 Introduction

Indigenous fruits (IFTs) are recognized as a significant source of essential nutrients as well as a source of income. There are 400 species of fruit plants from 57 families in Kenya. The key uses of indigenous fruits include; food, medicine and supplements among others.

2.9.2 Purpose

This module outlines relevant knowledge and skills on propagation, management, harvesting of indigenous fruits and processing of their products.

2.9.3 Training outcome

After implementation of the training curriculum, the participants should be able to:

- demonstrate an understanding of the different types of indigenous fruits in Kenya
- have skills on: propagation, management, harvesting of indigenous fruits; and processing of their products
- practice safe farming of indigenous fruits
- undertake sustainable commercial production and marketing of indigenous fruit products
- have awareness of policy frameworks and legal requirements relating to indigenous fruits
- cope with emerging issues relevant to indigenous fruits

2.9.4 Target group for the training

- Community groups,
- Cottage industries
- Youth and women groups
- Community resource persons,
- Extension service providers ,
- Students

2.9.5 Training approach

- Lectures
- Practical
- Field visits

2.9.6 Teaching and learning resources

Indigenous fruit trees, Photos, relevant literature and Extension materials, Processing equipment, indigenous fruits raw materials and sample products

2.9.7 Course duration

The course duration will require 36 contact hours (Table 2.4)

2.9.8 Training Assessment

- Practical assignments
- Action plans
- Course evaluation feedback
- Field and excursion reports

Table 2.4 Content for Training Module on Indigenous Fruit Trees Production, Processing and Marketing

Topic	Content	Delivery methods	Course duration (Hours)		Responsible Institution
			Instruction time	Fieldwork/ demonstration	
IFTs in Kenya	• Introduction - Key IFTs in Kenya	• Lectures • Field • Discussions	3	2	KEFRI
IFTs propagation	• Propagation methods ✓ Seeds ✓ Cuttings ✓ Nursery practices • Transplanting to the field	• Lectures • Field • Demonstrations • Discussion • Illustrations	8	-	KEFRI
Harvesting and postharvest handling of Indigenous fruits	• Harvesting • Postharvest handling of fruits ✓ sorting ✓ de-pulping ✓ storage	• Lectures • Field • Demonstrations • Discussions • Illustrations	3	6	KEFRI
Processing and value addition of fruits	• Processing ✓ Jam ✓ Juice ✓ wine	• Lectures • Field • Demonstrations	5	6	KEFRI

Topic	Content	Delivery methods	Course duration (Hours)		Responsible Institution
			Instruction time	Fieldwork/ demonstration	
		• Discussions • Illustrations			
Branding and marketing of fruit products	• Packaging • Branding • Certification and registration • Market awareness • Advertising	• Lectures • Demonstrations • Illustrations	3		KEFRI

2.10 Module 001-V: Prosopis Pods Collection, Processing and Marketing

2.10.1 Introduction

Prosopis tree species are some of the many exotic trees that have been introduced in Kenya and its pods are a valuable source of carbohydrates, sugars and proteins.

2.10.2 Purpose

This module outlines relevant knowledge and skills on management, collection of Prosopis pods and processing of its products.

2.10.3 Training outcomes

After implementation of the training curriculum, the participants should be able to:

- understand the spread of prosopis in Kenya
- have skills in: Prosopis, management, harvesting; and processing of its products
- undertake commercial production and marketing of Prosopis products
- have awareness on policy frameworks and legal requirements relating to Prosopis
- cope with emerging issues relevant to Prosopis

2.10.4 Target group for the training

- Community groups
- Cottage industries
- Youth and women groups
- Community resource persons
- Extension service providers
- Students

2.10.5 Training approach

- Classroom/Instructor –led
- Participatory group discussions
- Practical
- Field visits

2.10.6 Teaching and learning resources

Prosopis plants, Photos, relevant literature and Extension materials, Processing equipment, Prosopis pods and sample products.

2.10.7 Course duration

This course will require 36 contact hours (Table 2.5)

2.10.8 Training Assessment

- Practical assignments
- Action plans
- Course evaluation feedback
- Field and excursion reports

Table 2.5 Content for Training Module on Prosopis Pods Collection, Processing and Marketing

Topic	Content	Delivery methods	Course duration (Hours)		Responsible institution
			Instruction time	Field work demonstrations	
Extent of spread of Prosopis in Kenya	• General overview of invasive species • Introduction and ecology of prosopis in Kenya • potential for commercial exploitation of prosopis	• Interactive Lectures • Group discussions • Field demonstrations • Illustrations • Small-scale pod processors for animal feeds	3	3	KEFRI , KFS and university of Nairobi (animal production, Kabete campus)
Management of Prosopis	Managing the spread of prosopis by utilization. i.e. wood utilization as :direct fuel, charcoal and timber; pod utilization as :animal feed, human food; *Prosopis* flowers as source of bee forage for honey and beeswax		2	3	KEFRI
Utilization of prosopis pods	• Pods collection , grading and packing • Processing for human food and livestock feeds • Making of human food (jam and "chapatti") from pods		6	14	

Topic	Content	Delivery methods	Course duration (Hours)		Responsible institution
			Instruction time	Field work demonstrations	
	• Bee forage for honey production				
Marketing of Prosopis products	Analyzing and evaluating marketing opportunities		1	1	

CHAPTER 3: BIOMASS ENERGY PRODUCTION AND UTILIZATION

Course Code 002

3.1 Introduction

Biomass energy is the main source of energy for majority of Kenyan households and rural based small and medium enterprises (Githiomi, 2010; IIED, 1997,). Biomass energy contributes over 80% of Kenya's national energy needs, a scenario that is expected to continue into the foreseeable future. Biomass energy is mainly from firewood and charcoal. Other forms of biomass energy include agricultural waste and briquettes. The future of biomass energy is bleak without adapting modern technologies as the rate of wood harvesting currently exceeds the annual growth.

KEFRI through National Forest Products Research Programme plays a role in development and promotion of technologies for efficient charcoal production and utilization. The programme promotes appropriate technologies in utilization to reduce wastage of biomass. These include briquette making using charcoal dust (previously considered a waste), and micro-gasifiers that utilize small sized pieces of wood in cooking and heating.

The Programme has been undertaking building capacity of stakeholders in efficient charcoal production and use of appropriate technology to reduce wastage of biomass. This curriculum has been developed to guide trainings on improved charcoal production technology, briquetting technology and promotion of improved cook stoves for energy saving.

3.2 Purpose of the Biomass Energy Training Curriculum

The purpose of the biomass energy training curriculum is to guide trainers on the scope; duration of the training; course content; necessary materials and assessment tools.

3.3 Beneficiaries of the Trainings on Biomass Energy

- Charcoal Producer Associations /groups (CPAs/CPGs)
- Local communities
- Cottage industries
- Relevant technical staff
- Students
- Relevant extension service providers
- Relevant community resource persons
- Learning institutions

3.4 Training Strategy

The training approach will vary depending on the target group, duration of the training and budget. The various categories include: Training of Trainers (TOT); training of enterprise groups; and exchange visits to relevant areas.

3.5 Curriculum Packaging

The Training Curriculum (TC) on Biomass Energy is competency based and packaged into modules as follows:

TC Module 002-I: Sustainable Charcoal Production
TC Module 002-II**:** Briquetting Technology
TC Module 002-III: Improved Cook Stoves for Efficient Utilization of Biomass Energy

3.6 TC Module 002-I: Sustainable Charcoal Production

3.6.1 Introduction

Charcoal provides 82% of urban and 34% of rural household energy needs. The charcoal value chain employs over 700,000 people who support over two million dependents (ESDA, 2005). Charcoal is a preferred household energy source due to its affordability, its friendliness to use indoor compared to fuel wood and it's easy to transport. It is estimated that the national demand of charcoal in Kenya is over 16 million m^3 while supply is estimated at about 13.5 million m^3. Since charcoal production depends on woody biomass harvested from trees growing mostly in woodlands and farmlands. Continued unsustainable charcoal production is resulting in extensive environmental degradation

Low recovery rates in charcoal production due to use of inefficient charcoaling technologies is a major challenge facing the charcoal industry. This calls for development of efficient charcoal production technologies to curb deforestation. Various technologies to improve on conversion efficiencies and utilization have been developed, however, according to several studies; uptake of these improved technologies has been low among charcoal producers and consumers.

3.6.2 Purpose

This module is intended to equip the participant with the necessary knowledge and skills, on sustainable charcoal production, marketing and utilization.

3.6.3 Training outcomes

By the end of the module unit, the participant should be able to:

- have knowledge of the key tree species used for production of quality charcoal
- apply appropriate methods of establishment and management of tree resources for charcoal production
- produce quality charcoal products using appropriate sustainable and innovative methods i.e. the different types of improved kilns

- observe legal requirements affecting charcoal production and marketing e.g. charcoal rules and regulations
- explore economic opportunities and challenges in charcoal production
- apply safety procedures while producing and harvesting charcoal

3.6.4 Target group for the training

- Charcoal Producer Association /groups (CPAs/CPGs)
- Extension service providers (CBOs/ NGOs/ Forest /Agricultural extension officers)
- Environmental County officers
- Community leaders
- Relevant community resource persons

3.6.5 Training approach

- Lectures
- Practical
- Field excursions

3.6.6 Teaching and learning resources

Fuelwood samples, Charcoal samples, Data bases on tree resources (KEFRI, KFS, ICRAF), Relevant publications (Research notes, Technical; report, guideline etc),Training manuals on Charcoal production, Relevant policy & legislative documents e.g. Charcoal rules , 2009; Forest Conservation and Management Act 2016), Videos, Photos, Extension materials, Tree nursery

3.6.7 Course duration

The training will require 34 contact hours (Table 3.1)
Note: construction of kiln and carbonization of charcoal takes 6 days and can run parallel to the rest of the course

3.6.8 Training assessment

- Practical based on set targets for community group
- Field / excursion report)/
- Action plans at end of training
- Course evaluation feedback

Table 3.1 Content for Training Module on Sustainable Charcoal Production

Topic	Course Content	Delivery methods	Duration (hours)		Responsible organization
			Instruction time	Field work (Demos)	
Introduction to sustainable charcoal production in Kenya	• Introduction to biomass energy use in Kenya • Charcoal production in Kenya • Key tree species used for charcoal production • Available tree resources for charcoal production • Quality of charcoal from various tree species • Methods of establishment and management of tree resource for charcoal production • Impact of charcoal production on tree species diversity and the environment	• Interactive Lectures • Group trainings • Workshops • Discussions/presentations • Demonstrations • Illustrations	6	4	KEFRI KFS Community resource persons
Charcoal production Methods	• Introduction to methods of charcoal production in Kenya • Types of Production Kilns -Traditional earth, Improved kilns and their uses (Improved earth kilns, Casamance Kilns, Potable Metal Kilns, drum kiln and brick kilns) • Charcoal production process • Wood preparation • Suitability of wood sizes for charcoal for different kilns • Arrangement/stacking of wood in kilns • Covering kilns and lighting • Monitoring of charcoaling process • Cooling the kilns • Harvesting of charcoal • Safety procedures while harvesting charcoal	• Interactive Lectures • Community group trainings • Workshops • Discussions/presentation • Demonstrations • Illustrations • Field excursion	2	4	KEFRI KFS JUA KALI SECTOR

Topic	Course Content	Delivery methods	Duration (hours)		Responsible organization
			Instruction time	Field work (Demos)	
	• Practical: Construction of Kilns/ stacking / lighting/ carbonization to cooling and harvesting for a stack of $2m^3$) for Improved earth and casemance kilns)	• Demonstrations • Illustrations • Field excursion	1	6 days	FPD (KEFRI)
Challenges and opportunities in charcoal production in Kenya	• Highlight key challenges • Determine the effects of over exploitation of tree resources for charcoal production • Identify the inefficient conversion methods that may lead to low rates of recovery and environmental degradation • Key challenges and barriers in production and movement of charcoal products • Negative perception & over exploitation of tree resources	• Theory • Interactive Lectures • Workshops • Discussions/presentations • Demonstrations • Illustrations • Field excursion	2	2	FPD (KEFRI) KFS , NGOs
Policies and regulations on Charcoal production and trade	• Highlight relevant legislations (Forest Conservation and Management Act 2016; Energy Act, EMCA, 2015; Forests (Charcoal)Regulations, 2009) • Discuss charcoal production rules according the required standards • Obtain feedback & emerging issues on domestication of charcoal rules	• Interactive Lectures • Community group trainings • Workshops • Discussions/presentations • Demonstrations • Illustrations	2		FPD (KEFRI) KFS /NGOs
Trade and marketing issues in charcoal business	• Identify opportunities available for commercial charcoal production • Identify existing marketing channels • Branding and packaging of sustainably produced charcoal • Demand & supply • Markets (Sales/ Pricing)	• Interactive Lectures • Workshops • Discussions/presentations • Illustrations	3		FPD (KEFRI) , KFS / Ministry of trade /

Topic	Course Content	Delivery methods	Duration (hours)		Responsible organization
			Instruction time	Field work (Demos)	
Formation and strengthening of user groups	• Group dynamic • Leadership and Governance • Team building • Book keeping • Financial management • Gender and resource management	• Interactive Lectures • Workshops • Discussions/presentations • Illustrations	6	2	KEFRI,KFS, Ministry of social services

3.7 TC Module 002-II: Briquetting Technology

3.7.1 Introduction

Currently demand for firewood/fuelwood and charcoal is 18,702,748 m^3 and 16,325,810 m^3 respectively whilst the supply stands at 13,654,022m^3, and 7,358,717m^3 respectively (MEW&NR, 2013). There is therefore a huge deficit to be met through improving efficiency of utilization and use of alternative sources of energy such as charcoal briquettes.

A briquette is a block of compressed organic material that is used as fuel instead of charcoal, firewood or mineral coal. Use of briquettes reduces on cutting of trees for wood fuel. Briquettes are healthier than firewood and charcoal as they smoke less if carbonized material are used. They also have an economic advantage of using materials that would otherwise be discarded as agricultural or forest waste

3.7.2 Purpose

This module outlines relevant knowledge and skills on briquetting including suitable materials and equipment, production, trade and marketing and relevant policies and regulations.

3.7.3 Training outcomes

After implementation of the training curriculum, the participants should be able to:

- appreciate briquetting technology as an alternative source of biomass energy and social development
- Appreciate the importance of agricultural, agro-industrial and forest wastes as an alternative and suitable material for briquetting.
- apply efficient carbonizing methods for various briquetting materials
- produce briquettes using various agricultural/forest waste and appropriate briquetting equipment
- undertake commercial production and marketing of briquettes
- have an awareness of the policy frameworks and legal requirements relating biomass energy
- Cope with emerging issues relevant briquettes

3.7.4 Target group for the training

- Charcoal Producer Associations /groups (CPAs/CPGs)
- Service providers (CBOs/ NGOs/ Forest /Agricultural extension officers)
- Environmental County officers
- Local communities
- Cottage industries
- Agro industries/Agro ventures
- Relevant technical staff
- Students

- Relevant community resource persons

3.7.5 Training approach

- Lectures
- Practical
- Field visits

3.7.6 Teaching and learning resources

Training manuals on briquette production, relevant literature and Extension materials Briquetting raw materials, Briquetting machines, Charcoal briquette samples, video, photos

3.7.7 Course duration

This course will require 25 contact hours (Table 3.2)

3.7.8 Training assessment

- Practical assignments
- Action plans
- Course evaluation feedback
- Field and excursion reports

Table 3.2 Content for Training Module on Briquetting Technology

Topic	Course Content	Delivery methods	Duration (Hours)		Responsible organization
			Instruction time	Field work/ Demonstrations	
Briquetting technology as an alternative source of biomass energy.	• Introduction to biomass energy use in Kenya • Climate change and resources for biomass energy production • Introduction to briquetting technology • Identification and acquisition of suitable raw materials and equipment • Identification and acquisition of suitable binding materials • Preparation of binder • Carbonization of raw materials • Briquette production • Briquette drying	• Interactive Lectures • Demonstrations • Group discussions • Illustrations	7	10	• FPRC (KEFRI) • KFS • KIRDI • "Jua Kali" Sector
Policies and regulations on biomass production and trade	• Highlight relevant legislations (Forest Act 2005, Energy Act, EMCA) • The Charcoal Rules 2009	• Interactive Lectures • Group discussions	2		• FPP(KEFRI) • KFS
Trade and marketing of briquettes	• Identification of marketing channels • Branding and packaging • Markets • Demand & supply • Pricing • Access to finances	• Interactive Lectures • Demonstrations • Group discussions • Illustrations	2		• FPP(KEFRI) • KFS
Formation and strengthening common interest groups	• Purpose and type of member-based producer organizations • Legal requirements, elements and steps for formation of a marketing association • Group dynamics and leadership • Gender and resource management	• Lectures • Group work • Discussions • Demonstrations • Field executions	2	2	• KEFRI/ Min of Cooperatives

3.8 TC Module 002-III: Improved Cook Stoves for Efficient Utilization of Biomass Energy

3.8.1 Introduction

Currently, in Kenya the cook stove sector is growing rapidly and various designs of cook stoves are available in the market. The demand of improved cook stoves has led to flooding of the market with stoves which are costly, of various qualities some of which do not meet the required standards which includes; efficiency in fuel use, low emission of greenhouse gases, low emissions and safety.

3.8.2 Purpose

This module outlines relevant knowledge and skills on design, fabrication, use and marketing of cook stoves for efficient biomass utilization.

3.8.3 Training outcomes

After implementation of the training curriculum, the participants should be able to:

- Understand various designs of biomass cook stoves
- Have skills in design and fabrication of biomass cook stoves
- Understand the social and environmental benefits of use of improved cook stoves
- Promote use of biomass cook stove
- Undertake commercial production and marketing of biomass cook stoves.
- Cope with emerging issues relevant to biomass cook stoves

3.8.4 Target group for the training

- Community groups
- Cottage industries
- Schools
- Hotels and Restaurants
- Youth and women groups
- Community resource persons
- Extension service providers
- Students

3.8.5 Training approach

- Classroom/Instructor –led
- Participatory group discussions
- Practical

3.8.6 Teaching and learning resources

Prototype stoves, Photos, relevant literature and Extension materials, fabrication equipment, fabrication supplies for making cook stoves and fabricated stoves

3.8.7 Course duration

This course will require 29 contact hours (Table 3.3)

3.8.8 Training assessment

- Practical assignments
- Course evaluation feedback

Table 3.3 Content for Training Module on Improved Cook Stoves for Efficient Utilization of Biomass Energy

Topic	Content	Delivery methods	Duration (Hours)		Responsible organization
			Instruction time	Field work/ Demonstrations	
Improved cook stoves for efficient use of wood fuel	• Introduction to energy saving stoves in Kenya • Designs of cook stoves including micro-gasifiers in Kenya • Advantages and disadvantages of improved cook stoves over traditional cook stoves	• Interactive Lectures and Demonstrations • Discussions • Illustrations • Workshops	4	3	KEFRI KFS MOA JUA KALI SECTOR
Improved cook stoves efficiencies , production and sales	• Efficiencies of cook stoves in comparison to existing traditional stoves • Production /fabrication of improved cook stoves • Demand and supply levels of improved cook and factors influencing their demand • Potential markets for improved cook stoves • Pricing/Sales	• Interactive Lectures and Demonstrations • Discussions • Illustrations •	4		
	• Fabrication of improved cook stoves	• Demos/ Practical's	2	16	

CHAPTER 4: BAMBOO PROPAGATION, MANAGEMENT AND UTILIZATION

Course code: 003

4.1 Introduction

Bamboo is a fastest growing plant that generates substantial amounts of biomass within a short period of time. It is a versatile species with multiple economic and ecological benefits which have not been fully exploited in Kenya. The characteristics of bamboo make it one of the most important non-timber forest resources which can play an important role in the reduction of timber consumption, environmental and forest protection, poverty alleviation and sustainable development of rural economies. Kenya currently has about 150,000 ha predominantly of indigenous Y*ushania alpina* species. It grows well in the dry and medium potential areas providing a potential for alternative viable use of land in over two thirds of the country. Bamboo is however an untapped major resource with unutilized ecological and economic potentials that needs to be developed and promoted for sustainable development.

KEFRI has done extensive research on bamboo and has developed germplasm plots in its eco-region research programmes and sub-programmes. Over 20 species from Asia and East Africa have been introduced and tested in the field. A total of fifteen species are doing very well in the various eco-regions of the country In addition, the Institute through the National Forest Products Research Programme (NFPRP) has continued to conduct capacity building, in design and production of bamboo products at Karura. The NFPRP has also undertaken the capacity building activities in other regions across Kenya. However, to date, the capacity building activities are still in high demand across the county

4.2 Training Strategy

The training approach will vary depending on the target group, duration of the training and budget. The various categories include: Training of Trainers (TOT); training of enterprise groups; and exchange visits to relevant areas.

4.3 Curriculum Packaging

The Training Curriculum (TC) on Bamboo Propagation, Management and Utilization is competency based and packaged into one (1) module:

4.4 Purpose

This training module is designed to equip the learner/participant with the knowledge and skills pertaining bamboo conservation, growing and utilization in Kenya.

4.5 Training Outcomes

At the end of implementation of the training curriculum, the participant should be able to:

- have knowledge of various types of bamboo
- undertake bamboo propagation and nursery management
- undertake bamboo plantation establishment and management
- undertake sustainable harvesting of bamboo
- have skills on bamboo processing into various products.
- comprehend product grading, value addition and marketing
- recognize potential sources of conflict in community leadership

4.6 Target Group for the Training

- Community Based Organizations (CBOs)
- Learning Institutions e.g. TVET
- Entrepreneurs
- Practicing Artisans
- Cottage Industry
- Youth and women groups
- Community resource persons,
- Extension service providers

4.7 Training Approach

- Lectures
- Demonstrations
- Illustrations
- Practical

4.8 Teaching and Learning Resources

- Relevant publications
    - ✓ KEFRI- Guideline for growing bamboo 2007
    - ✓ KEFRI- Bamboo harvesting and preservation manual 2011
    - ✓ KEFRI- Bamboo products design manual 2011
    - ✓ INBAR- Bamboo Processing furniture manual
    - ✓ KEFRI- Bamboo finishing manual 2011
    - ✓ Safety and workshop management manual
    - ✓ Leadership and group dynamics manual
    - ✓ Marketing and entrepreneurship guideline manuals

- Bamboo culms
- Tools
- Chemicals (preservatives)
- First Aid kit

4.9 Course Duration

The training will require 102 contact hours (Table 4.1)
Note: the practical session on bamboo processing requires 5 days i.e. 40 hours

4.10 Training Assessment

- Practical assignments
- Attendance of the learning sessions (10%)
- Course evaluation feedback
- Action plans
- Field and excursion reports

Table 4.1 Content for Training Module on Bamboo Propagation, Management and Utilization

Topic	content	Delivery methods	Duration(hours)		Responsible Institution
			Instruction time	Field work/Demonstration	
Bamboo propagation	Use one node cutting Use of double node Use of multiple nodes (layering	Interactive Lectures Group work Discussions Demonstrations Field executions	4	4	CHERP
	Bamboo wildings Use of bamboo wildings as planting materials	Demonstrations Field executions		4	CHERP
	Bamboo offset Use of bamboo offset as planting material	Demonstrations Field executions		4	CHERP
	Bamboo seeds Use of bamboo seeds			4	CHERP
	Bamboo Nursery management Watering methods weeding Hardening	Interactive Lectures Group work Discussions Demonstrations	4	4	CHERP
Bamboo field Establishment And Management	Spacing Weeding Thinning "Trenching" Effect of climate change	Interactive Lectures Discussions Illustrations	1		CHERP
WORKSHOP Management and safety precaution	Introduction to safety rules Functions of the first aid	Lectures Discussions Demonstrations	1		FPRC
Bamboo harvesting	Criteria for selection Cutting procedures Cutting tools and extraction Hauling from Stump site Removal of branches	Interactive Lectures Discussions Demonstrations Field executions	4	4	FPRC
Bamboo	preservation and using boric	Interactive	4	4	FPRC

preservation	acid and Borax (practical) The other potential methods: Steeping or sap displacement Horizontal dip diffusion method The open-tank treatment Butt treatment Bamboo Clump curing: Smoking White-washing Plastering Soaking in water Leaching in water Pressure Treatment	Lectures Group work Discussions Demonstrations			
Bamboo Processing	Types of processing tools Usage and handling of tools and Maintenance of tools Splitting methods Bending Weaving techniques Bamboo structural uses	Interactive Lectures Group work Discussions Demonstrations	5days (40)		FPRC
Marketing	Market identification and access Product grading and value addition Common interest marketing	Interactive Lectures Group work Discussions Demonstrations Field executions	4		FPRC
Group dynamics and leadership	Group membership and tittles Roles of group members Decision making and participation Common group pitfalls Conflict resolution Action planning	Interactive Lectures Group work Discussions Demonstrations Field executions	8		FPRC
Assessment and closing event	Written assessment Closing speeches Issuance of certificates	Individual work Closing remarks	4		

Chapter 5: TRAINING CURRICULUM ON TIMBER PROCESSING AND UTILIZATION

5.1 Introduction

Timber and their related products are important and constitute a major portion of the bill of quantities in the construction industry. Processing, handling and trade in timber and its products provide direct and in direct employment opportunities to many Kenyans. Due to high the high demand of timber and timber products against a low supply, sustainable utilization is necessary. This therefore requires efficiency in the entire value chain; from felling, logging and sawing, post-processing handling and use. The efficiency is influenced by processing technologies and skills.

KEFRI has developed various technologies and operating skills aimed at improving timber processing and utilization. However, uptake of these technologies and skills has been low among various stakeholders in the industry. This curriculum outlines skill improvement in timber value chain, to supplement the on-the-job training in timber processing. The modules have been structured to address practical challenges in each stage of timber processing, handling and utilization, while contributing to other requirements for sustainable development goals and mitigation to climate change.

5.2 Purpose of the Timber Training Curriculum

The purpose of this timber training curriculum is to guide trainers on the scope; duration of the training; course content; necessary materials and assessment tools for processing and utilization of timber.

5.3 Beneficiaries of the Trainings on Timber Processing and Utilization

- Machine operators in tree felling, logging and sawing
- Civil and Structural engineers in the building sector
- Furniture manufacturers
- Relevant technical staff
- Students

5.4 Training Strategy

The training approach will vary depending on the target group, duration of the training and budget. The various categories include: Training of Trainers (TOT); training of enterprise groups; and exchange visits to relevant areas.

5.5 Curriculum Packaging

The Training Curriculum (TC) on Timber Processing and Utilization is competency based and packaged into modules as follows:

TC Module 004-I: Logging and Chainsaw Operation
TC Module 004-II: Saw milling

TC Module 004-III: Soft Wood Timber Grading
TC Module 004-IV: Wood seasoning

5.6 TC Module 004-I: Logging and Chainsaw Operation

5.6.1 Introduction

Chain saw operation, tree felling and logging are important but high risk activities that require skill and experience to minimize accidents during operations. The operations also require efficiency in delivering raw materials to the required processing facilities. It is therefore important to train the relevant staff and equip them with skills for efficient logging operations.

5.6.2 Purpose

This module outlines relevant knowledge and skills on tree harvesting and logging

5.6.3 Training outcomes

After implementation of the training curriculum, the participants should be able to:

- understand various tree harvesting and logging methods
- have skills in tree harvesting and logging
- promote use of safe tree harvesting and logging methods
- cope with emerging issues relevant to tree harvesting and logging

5.6.4 Target group for the training

- Chainsaw operators and logging personnel from wood industry
- Logging supervisors and managers

5.6.5 Training approach

- Classroom/Instructor –led
- Participatory group discussions
- Practical

5.6.6 Teaching and learning resources

Forest inventory equipment, Chain saws, Skidding equipment, Photos, relevant literature, Log transportation trucks

5.6.7 Course duration

This course will require 50 contact hours (Table 5.1)

5.6.8 Training assessment

- Written assignments
- Practical assignments
- Course evaluation feedback

Table 5.1 Content for Training Module on Logging and Chainsaw Operation

Topic	Content	Delivery Method	Duration (Hours)		Proposed Resource Institution
			Theory	Practical	
Introduction to Chain saws and Maintenance	• Important parts of a chain saw • Opening, servicing and maintenance requirements for a chain saw • Chain sharpening techniques • Fuel mixing for chain saws • Safe carrying of a chain saw – with engine on and off	Theory Practical	2	4	-KEFRI-Forest Products -Kenya Forestry College (KFC) -Universities
Safety measures in Chain saw operation	Adequate chain saw maintenance as a safety measure • Fuel requirements and mixing • Opening up of the machine and cleaning • Changing and fitting the chain • Maintenance of the dumpers and chain breaks • Sharpening of the chain Personal protection requirements when operating a chain saw	Theory Practical	2	4	
Running a chain saw, techniques and safety	• Safe starting the chain saw • Acceleration and safety devices; chain breaks • Safe handling of a working chain saw • Cutting parts of a chain saw and safety measures; the kick back zones	Theory Practical	2	4	

Topic	Content	Delivery Method	Duration (Hours)		Proposed Resource Institution
			Theory	Practical	
	• Possible ways of minimizing accidents while operating a chain saw				
Tree felling, techniques and safety	• Designing a safe tree felling plan • Selective harvesting of trees; safety and environmental requirements • Escape route planning and preparation • Team building in tree felling • Directional felling techniques; various cuts and their purposes • Slow fall out of a tree; the hinge	Theory Practical	2	6	
Log de-branching and cross-cutting for various uses	• Clean and safe de-branching • Safe handling of chain saw while removing branches • Forward and reverse cutting • Cross cutting wood for different uses	Theory Practical	2	6	
Log skidding	• Log skidding equipment • Effect of skidding on log quality • Skidding distance and route optimization • Economics of skidding operations	Theory Practical	2	6	
Log transportation to the mill	• Log loading methods and equipment • Optimization of log loading practices • Logging distance and choice of	Theory Practical	2	6	

Topic	Content	Delivery Method	Duration (Hours)		Proposed Resource Institution
			Theory	Practical	
	transportation method/equipment				

5.2 TC Module 004-II: Saw Milling

5.2.1 Introduction

Kenya is a low forest cover country and this requires conservation of wood resources, which can be achieved through efficient saw milling processes. Although the sawing technologies differ from one saw mill to another, sawing skills have a major effect on timber recovery and quality. This module therefore is aimed at equipping the trainee with the necessary skills in saw mill operations for eco-efficient timber sawing.

5.2.2 Purpose

This module outlines relevant knowledge and skills in saw milling

5.2.3 Training outcome

After implementation of the training curriculum, the participants should be able to:

- Acquire knowledge in saw mill machine operation and maintenance
- Have skills in skills for efficient timber sawing
- Promote use of safe timber sawing
- Cope with emerging issues relevant to timber sawing

5.2.4 Target group for the training

- Saw mill machine operators
- Saw mill supervisors

5.2.5 Training approach

- Classroom/Instructor –led
- Participatory group discussions
- Practical

5.2.6 Teaching and learning resources

Personal Protective Equipment, Logs, Standard saw mill, relevant literature

5.2.7 Course duration

This course will require 70 contact hours (Table 5.2)

5.2.8 Training assessment

- Written assignments
- Practical assignments
- Course evaluation feedback

Table 5.2 Content for Training Module on Logging and Timber Sawing

Topic	Content	Delivery Method	Duration (Hours)		Proposed Resource Institution
			Theory	Practical	
Introduction to saw mill operations, maintenance practices and safety	Introduction to sawmill tools and equipment • Parts of a sawmill • Alignment, leveling and sawmill gauges in saw mill machines • Lubrication of sawmill parts • Changing of saws	Theory Practical	2	4	-KEFRI-Forest Products -Kenya Forestry College (KFC) -Universities
	Safety requirements in saw mill operations • The factory act • Personal Protective Equipment (PPE) in saw milling • First Aid practices	Theory	2		KEFRI-Forest Products -Kenya Forestry College (KFC) -Universities
Introduction to saw milling	Saw milling process/techniques and timber quality control	Theory	2		KEFRI-Forest Products -Kenya Forestry College (KFC) -Universities
Log Yard Organization	• Log yard organization • Log measurements and volume calculations	Theory Practical	2	4	KEFRI-Forest Products -Kenya Forestry College (KFC) -Universities

Topic	Content	Delivery Method	Duration (Hours)		Proposed Resource Institution
			Theory	Practical	
Log breakdown	• Primary log opening for high timber recovery • Log sawing plan • Aligning and directing logs into the saw • Use of different sawing methods	Theory Practical	2	4	KEFRI-Forest Products -Kenya Forestry College (KFC) -Universities
Timber Re-sawing, trimming and sorting	• Re-sawing and timber trimming for high recovery • Timber sorting and storage	Theory Practical	2	4	KEFRI-Forest Products -Kenya Forestry College (KFC) -Universities
Saw doctoring	Circular Saw blade maintenance • Leveling and tensioning • Repairs on cracks Band saw blade maintenance • Leveling and tensioning • Repairs on cracks Sharpening of saw blade • Teeth geometry setting • Filling of saw blade cutters • Set saw blade cutters	Theory Practical	6	36	KEFRI-Forest Products -Kenya Forestry College (KFC) -Universities

5.3 Module 004-III: Soft Wood Timber Grading 5.3.1 Introduction

Application and utilization of sawn timber in construction and other engineering applications has been a challenge in Kenya. Some of the challenges are as a result of the properties of wood while others are due to inappropriate appreciation of strength of timber for the intended uses. Timber grading is a method in which timber is inspected to remove the defects that reduce the potential of timber in a given desired application. Since soft woods constitute the highest proportion of timber used in construction industry, it was necessary to develop a procedure to grade timber to the required standards for various applications.

5.3.2 Purpose

This module outlines relevant knowledge and skills on grading soft wood timber in accordance to the Kenyan standards KS02-771.

5.3.3 Training outcomes

After implementation of the training curriculum, the participants should be able to:

- Acquire knowledge on soft wood timber and its application in structural uses
- Have skills in timber grading
- Cope with emerging issues relevant to timber grading and utilization

5.3.4 Target group for the training

- Architects
- Quantity surveyors
- Structural and Civil engineers in the building sector
- Timber merchants

5.3.5 Training approach

- Classroom/Instructor –led
- Participatory group discussions
- Practical

5.3.6 Teaching and learning resources

- Timber hand samples
- Full length timber samples
- Timber act and standards
- Writing and tracing Materials/equipment
- Large room for full size timber grading practical

5.3.7 Course duration

This course will require 82 contact hours (Table 5.3)

Table 5.3 Content for Training Module on Timber Grading

Topic	Content	Delivery Method	Duration (Hours)		Proposed Resource Institution
			Theory	Practical	
Introduction	• Introduction to soft wood timber species and grading; ✓ Softwood timber species ✓ Define Timber grading	Theory	4		✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS ✓ Private Sector (HTes)
	• Definitions and terms used in timber industry; ✓ Terms used in timber grading ✓ Importance of timber grading ✓ Timber grades	Theory	1		✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS ✓ Private Sector (HTes)
	• Introduction to saw milling; ✓ Saw milling process/techniques ✓ Effect of saw milling process on timber grades	Theory	1		✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS ✓ Private Sector (HTes)
Timber seasoning and preservation	• Timber seasoning ✓ Air seasoning ✓ Kiln seasoning • Timber preservation ✓ Preservation methods ✓ Preservatives	Theory	2		✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS Private Sector (HTes)
Introduction to Timber strength	Important timber characteristics ✓ Density	Theory	2		

Topic	Content	Delivery Method	Duration (Hours)		Proposed Resource Institution
			Theory	Practical	
	✓ Timber structure ✓ Moisture content				
Timber strength reducing characteristics	• Timber defects ✓ Knots ✓ Slope of grain ✓ Fissures ✓ Wane ✓ Sap-stains ✓ Seasoning defects; spring, warp, twist, cup, ✓ Dimensions and mechanical damages	Theory	2		✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS Private Sector (HTes)
Demonstration on assessment of defects other than knots	• Sawing defects ✓ Dimensions and mechanical damages ✓ Wane ✓ Sap-stains	Practical demonstrations		4	✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS Private Sector (HTes)
	• Seasoning defects ✓ Seasoning defects; spring, warp, twist, cup, ✓ Fissures	Practical Demonstrations		2	✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS Private Sector (HTes)

Topic	Content	Delivery Method	Duration (Hours)		Proposed Resource Institution
			Theory	Practical	
Knot-area-ratio (KAR) system	• Introduction to Knot area measurement ✓ Definition of; margin knot area (MKAR) ✓ Total knot (TKAR) ✓ Methods of assessment	Theory	8		✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS Private Sector (HTes)
	• Practical demonstrations ✓ Practical with hand samples ✓ Practicals with full size samples	Practicals		8	✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS Private Sector (HTes)
Grading rules for softwood timber	• Grading rules for GS grade ✓ Defect limits for GS grade • Grading rules for SS grade ✓ Defect limits for SS grade	Theory	6		✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS Private Sector (HTes)
The timber Act and KS02-771 standard	• Basis for timber standard ✓ Introduction to the timber act ✓ Introduction to KS02-771 standard	Theory	8		✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS Private Sector (HTes)

Topic	Content	Delivery Method	Duration (Hours)		Proposed Resource Institution
			Theory	Practical	
Grading for General structural (GS) grade	• Methods of grading for GS grade ✓ Grading by knot area ratio ✓ Grading by other defects	Practical		12	✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS Private Sector (HTes)
	• Practical in grading for GS (Hand samples) ✓ Practicals with hand sample ✓ Practicals with full size samples	Practical		16	✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS Private Sector (HTes)
Grading for Special structural (SS) grade	• Methods of grading for SS grade ✓ Introduction to Grading for Special structural (SS) grade ✓ Practical grading for SS with hand samples ✓ Practical grading for SS with full size samples	Practical		16	✓ KEFRI-Forest Products ✓ MoHUD ✓ KEBS Private Sector (HTes)

5.3.8 Training assessment

- Written assignments
- Practical assignments
- Course evaluation feedback

5.4 TC Module 004-IV: Wood Seasoning5.4.1 Introduction

Trees contain considerable amount of moisture, which begins to be lost when a tree is cut down and processed into various products including sawn timber. The process of losing moisture from green timber can be very unpredictable due to variations in air temperature and humidity. Low temperature and high humidity slows the process while high temperature and low humidity hastens it. When drying timber is exposed to a combination of the two conditions, the result is usually defects within the timber. A skilled timber user can control the drying process to minimize such defects and enhance timber quality, a process referred to as seasoning. Seasoning aims to dry timber uniformly with minimum deformation in the shortest possible time to a moisture level similar to the surrounding air.

5.4.2 Purpose

This module outlines the relevant knowledge and skills on timber seasoning.

5.4.3 Training outcomes

After implementation of the training curriculum, the participants should be able to:

- acquire knowledge in timber seasoning methods
- have skills in timber seasoning processes
- cope with emerging issues relevant to timber seasoning

5.4.4 Target group for the training

- Timber merchants.
- Timber artisans
- Students

5.4.5 Training approach

- Classroom/Instructor –led
- Participatory group discussions
- Practicals

5.4.6 Teaching and learning resources

Kiln operation manual, Kiln facilities, Timber yard and facilities, Sawn timber

5.4.7 Course duration

This course will require 30 contact hours (Table 5.4)

5.4.8 Training assessment

- Written assignments
- Practical assignments
- Course evaluation feedback

Table 5.4 Content for Training Module on Timber Grading

Topic	content	Delivery methods	Duration (Hours)		Responsible Institution
			Instruction time	Practical	
Seasoning methods	Natural seasoning • air drying	Interactive Lectures Group work Discussions	4		KEFRI
	Artificial seasoning • Kiln dying	Interactive Lectures Group work Discussions	4	4	KEFRI
	Kiln operating practice • Charging kiln • Sample boards • Kiln operation • Kiln records • Drying schedules	Interactive Lectures Group work Discussions	3	8	KEFRI
	Defects of seasoning • splitting • warping • cuppin • bowing • casehardening	Interactive Lectures Group work Discussions	3	4	KEFRI-FPRC