KENYA COFFEE SUSTAINABILITY MANUAL

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Preamble

The Kenya Coffee Platform (KCP) is a multi-stakeholder sustainable coffee platform that brings together stakeholders in a non-competitive approach working towards a thriving, sustainable sector. Its constituency includes farmers and farmer organizations, County and National Governments, trade, service providers, standard owners, NGOs, individuals, and development partners.

The Kenya Coffee Platform (KCP) also known in Swahili as "Sauti ya Kahawa" is aligned to the Global Coffee Platform. The Global Coffee Platform (GCP) which is the Apex body facilitates the global agenda made through the public-private partnership initiative, to ultimately improve the livelihoods of coffee farming communities and the natural environment of coffee production areas through global alignment. The goal of KCP is to create an inclusive and participatory County and National level coffee forum that brings together all coffee stakeholders to discuss critical issues affecting the sector resulting to an increase in coffee production and quality in the Country and a conducive business environment.

The KCP identified the need to harmonise the various manuals being used by various stakeholders in Kenya to train farmers. It has developed a standard training material geared towards improving farmers' knowledge with view to increasing coffee production and improve quality - the Kenya Coffee Sustainability Manual (KCSM). This manual was developed in collaboration with public and private coffee stakeholders and covers key issues on sustainable coffee production. The manual targets trainers of trainers.

KCSM is organised into different modules as prioritized by the coffee stakeholders. The modules include but not limited to best agricultural and processing practices, climate smart strategies, gender and youth, sustainable coffee farming and market access.

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german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

List Of Acronyms

AFA - Agricultural Food Authority

AFCA - Africa Fine Coffees Association

CIAT - International Centre for Tropical Agriculture

CMS - Coffee Management Services

CRI - Coffee Research Institute

EMO - Effective micro organisms

FTOK - Fair Trade Association of Kenya

GCP - Global coffee platform

KCPA - Kenya Coffee Producers Association

KCSM - Kenya Coffee Sustainability Manual

NCP - National Coffee platform

NOAA - Natural Oceanic Atmosphere Administration

SECAEC - Solidaridad East and Central Africa Expertise Centre

SMS - Sustainable Management Services

Introduction

The history of coffee - The ancient coffee myth

The discovery of coffee is shrouded in myth and mystery. Coffee as a beverage was first discovered in the highlands of Eastern Africa, where it still grows wild. The legend has it that Kaldi, a goats' herdsman, who had come to Africa from Yemen to work at a Monastery around the year 850 AD (Anno Domino) made the discovery. He noticed his goats becoming playful and behaving in a rather strange manner. The goats became extremely lively - leaping and dancing about, probably due to something they might have just eaten. He suspected that the bright red berries on the nearby bushes may have been the cause. He plucked a few and took them to the Monastery and gave them to the Abbot, the Monastery head.

The myth continues that the Abbot threw some of the berries in the fire and they were immediately mesmerised by an extremely pleasant aroma, coming from the roasting cherries. He quickly recovered a few of the freshly roasted beans and put them into some boiling water. He tasted the "brew" and was astounded to find that he immediately gained new strength and energy. The Abbot was so impressed with the concoction that from that day on, he served it to his monks to keep them awake during the midnight prayers. The monks called the black drink "kahveh" which in the African language can probably be translated to mean "stimulating and invigorating".

This threatened the market for the "forbidden – wine" (alcohol), not only at the African Monastery but far beyond into Arabia, later into Turkey and to the rest of the coffee world.

Introduction of coffee to Kenya

Coffee was introduced to Kenya by the French Missionaries towards the end of 19th century. The first plantations were established at Bura in the Coast region at around 1893 but later relocated to Kibwezi and Kikuyu in search of more favourable growing conditions. The first variety to be introduced was the French Mission variety, a derivative of the Bourbon type of Arabica coffee. This variety was characterized by high yield and better quality than the typical-derivatives. The French Mission variety is the base population from which most Kenyan Commercial cultivars were selected. During this period, all the coffee was grown in large estates.

Smallholder coffee growing in Kenya started in 1935 in Meru and Kisii regions following the recommendations of the Devonshire White Paper report of 1923. This was a policy paper issued by the Protectorate colonial secretary who indicated that African interests in the colony had to be paramount. This gave rise to the emergence of the smallholder sub sector operating under the auspices of marketing co-operative societies. Coffee is now produced under two distinct production systems, namely the

small scale holdings and plantations estimated at 700,000 and 4,000 respectively. The small scale growers are organised into over 500 coffee co-operatives. The sector employs approximately 30% of the total labour force in Agriculture.

Module 1: Principles and Methods of Training

Objective

To enable the trainers understand the basic components of effective communication, the necessary preparations, implementation, monitoring and evaluation of training programmes.

Content

i) Introduction.
ii) Communication process - Transmitter, medium and receiver.
iii) The 7Cs of Communication - clear, concise, concrete, correct, coherent complete and courteous
iv) Barriers to Communication - inaudible, voice monotony, unfamiliar audience, wrong pitch, unreceptive audience, mixed messages and overloading.
v) How to avoid communication barriers.
vi) Methods of training - lectures, discussions, skill and practical/lessons and demonstrations.
vii) Organising and managing a training course - organization checklist and management checklist.
viii) Training evaluation and monitoring – definitions, methods of carrying out evaluation / monitoring.

Methodology

i) Lectures sessions on effective communication and training organization.
ii) Exercises on 7Cs of communication and barriers to communication. Trainees should exercise on public speaking.
iii) Demonstrations several gestures and body language.
iv) Illustrations of writing skills - How to write on flip charts.
v) Discussion on training evaluation questionnaires.

Teaching Aids

i) Projector-LCD/Lap top.
ii) Flip chart/ white board and marker pens.
iii) Hand-outs.
iv) Audio-visuals.

1.1 Introduction

Training aims at imparting skills and knowledge to the trainees. To achieve this, the trainer should be a good communicator, knowledgeable, creative and open minded. The training should ensure that the learners are able to apply the skills and knowledge acquired in their working places. Training should result to a positive behavioural change which should substantially contribute to the success of businesses.

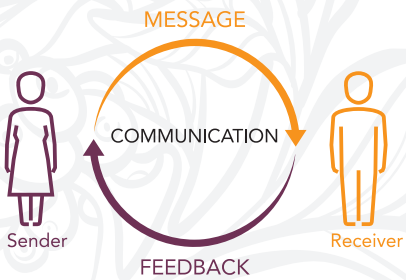
1.2 Communication process

Communication is the process through which information is transmitted from a source to the receiver for the purpose of effecting a desired change. The communication process has three important basic components:-

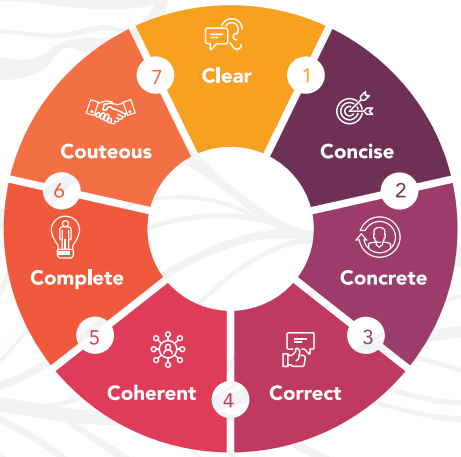
- Transmitter (Message source)
- Medium (communication channel)
- Receiver (decoder)

Information is transmitted through the following communication channels:-

- Spoken language (oral communication – adverts, announcements)
- Written (letters, notes, books, emails, wattsup, instagram)
- Body language (Gestures, Facial expressions)



Communication process



7Cs of communication

1.3 The 7Cs of Communication

Trainers need to develop effective communication skills in order to ensure the message gets across since communication is the instrument through which desired change may be induced. They should avoid "Just telling them".

Successful communication only takes place when the message is transmitted and received in an intact form by the receiver who must also interpret it to have the same meaning as when it was transmitted. It must be:-

Clear	Perfect, pure, clear as a bell
Concise	Brief, short, terse, summarizing
Concrete	Real, existing, you can feel it
Correct	Accurate, true
Coherent	Logical, rational
Complete	Whole, thorough, detailed
Courteous	Well mannered, polite, civil

1.4 Barriers to Communication

There many barriers to communication that exist, but some are more persistent and common than others. They may occur due to:-

- Inaudible voice (speaking too softly).
- Monotonous voice without variation (flat voice).
- Use of words, expressions and terms unfamiliar to the audience.
- Pitching message at wrong level (beyond the experience and understanding capacity of the audience.
- Unreceptive receiver (fatigued, sleepy, disinterested).
- Overloading (too much information at once).
- Mixing the messages.
- Distractions from outside and within the room.
-

1.5 How to avoid communication barriers

There are many ways of avoiding communication breakdown which could occur as result of various communication barriers that exist. These barriers can be avoided through:-

- Understanding the subject matter well.
- Preparing well before the presentation.
- Using an audible voice.

- Using language that is understood by receiver.
- Capturing the attention of the receiver through gestures, variation of voice and random questions.
- Avoiding distractive mannerisms such as picking the nose and inappropriate dressing.
- Logically arranging the message to enhance flow.
- Making the message simple and very clear.

The ability to get the message across is a learned skill developed through planning and practice. Trainers are expected to have effective communication skills and be competent in presenting ideas, giving directions and explaining procedures. The way they present all ideas makes the difference between whether the audience listens and influences their attitudes. To be an effective oral communicator the trainer should:-

- Know the subject well.
- Understand the audience.
- Prepare before the presentation.
- Choose words and language carefully.
- Use voice effectively.
- Arrange points logically.
- Show interest and enthusiasm.
- Use body language- maintains eye contact, visual expressions, gestures, etc.
- Use illustration to enhance transmission.
- Avoid destructive mannerisms.
- Keep explanations short and avoid boring people (summarise your points).
- Evaluate the audience for impact.

1.6 Methods of training

A number of methods are available to the trainer to effectively carry out the training. These include:-

- Lectures / skills lessons.
- Discussions / sharing of experiences on communication.
- Demonstrations on how to communicate effectively.
- Group practical on effective communication.
- Role play.

Trainers are encouraged to use combinations of methods for the best results. Use of teaching aids is greatly encouraged but these should be simple, legible, organised, clear and concise. The choice of a particular method will depend on:-

- Group (audience) characteristics- educational level, experience, knowledge, age etc.
- Time available for the training.
- Size of the group.
- Types of facilities and teaching aids available.
- The objective of training.
- Experience and knowledge of the trainer.

1.7 Organising and managing a training course

There is need for the trainer to be well informed about the training organization and management checklists. It is important for a trainer to go through the training organization and management check lists item by item.

1.7.1 Training organization checklist

- Establish whether the course is part time or full time.
- Establish duration.
- Establish content.
- Plan syllabus and time table.
- Identify and engage appropriate instructors.
- Secure suitable training venue - well lit, well ventilated room.
- Select and notify trainees through appropriate channels - dates, time and place.
- Select and brief session leaders.
- Select and review preliminary reading materials.
- Prepare course documentation.
- Arrange training equipment- projector, microphone, chalkboard, writing materials, visual aids etc.
- Arrange training room, seating arrangements, name cards, position of chalkboard screen etc.

1.7.2 Training management checklist

- Remind session leaders.
- Arrange facilitation for external facilitators/trainers.
- Introduce and thank sessions leaders.

1.8 Training evaluation and monitoring (M&E)

Monitoring and Evaluation (M&E) is a process that helps improve performance and achieve desired results. Its goal is to improve current and future management of outputs, outcomes and impact.

The training evaluation examines whether the training programme achieved the desired effect. This ensures the learners are able to apply the skills and knowledge acquired in their work. Commonly used methods include observations, questionnaires and interviews.

Evaluation aims at determining the relevance, effectiveness and impact of activities in light of the objectives. It is a self-assessment of knowledge or skills gained. It also gauges the participants' application of learning and enables the identification of changes in future trainings.

Monitoring involves regular observation and recording of activities taking place in a project or programme. It is a process of routinely gathering information on all aspects of a programme to check on whether activities are being efficiently implemented, reaching the intended target groups and achieving the intended objectives.

1.8.1 Methods of carrying out evaluation

Training evaluation includes trainer evaluation, course evaluation and follow-up or physical progress monitoring to check if trainees are implementing the skills and knowledge learnt. This assessment is done by collecting data on whether the participants were satisfied with the deliverables of the training program, whether they learned from the training and are able to apply the skills learnt.

Satisfaction and Participant

Satisfaction evaluation is the most basic measure for assessing the success rate of any training. The trainer, usually, hands out a survey at the end of the course to test the reaction of the participants. It covers common questions like whether the participants enjoyed the training, did they like the trainer. Moreover, would they want him or her back. It answers to the expectations of the trainees.

Knowledge Acquisition

Knowledge acquisition evaluation checks how much the participants have learnt from the training course. They are required to demonstrate the concepts that they have learned during the training. Participants are supposed to take the exam, after the training and evaluation done to determine if the participant has understood and learned the concept or not.

Behavioural Application

This method of evaluation deals with the behavioral application of their newly acquired skills. It also involves monitoring the changing behaviors as the skills and knowledge are applied to the tasks.

1.8.2 Performance Monitoring

A continuing function that uses systematic collection of data on specified indicators to provide indications of the extent to which outputs and short and mediumterm results are being achieved. (Adapted from OECD Glossary, 2002).
Monitoring is carried out through probing the objectives, logframes and performance indicators which must be established during the training needs analysis or when the program that identified training as a way of bringing out change was established. i.e before the monitoring exercise.

i) Performance indicators . These measure inputs, processes, outputs, outcomes and impacts of development interventions. They are used for setting targets and measuring progress towards them. Eg I ton of seed produced by year 2.
ii) The logical framework (Logframe). This identifies objectives and expected causal links and risks along the results chain. It has a narrative on what is to be done (e.g establish coffee nurseries), Objectively Verifiable Indicators, means of verification, assumptions and risks.
iii) Formal surveys. These are used to collect standardised information from a sample of people or households. They are useful for understanding actual conditions and changes over time.
iv) Rapid appraisal methods. These are quick, cheap ways of providing decision-makers with views and feedback from beneficiaries and stakeholders. They include interviewing, focus groups and field observation.

Achieving Desired change in coffee

Behavioural change is required to ensure farmers farm coffee sustainably and are able to optimise their yield as well as minimise their negative social and environmental impact. This change occurs at 2 levels, the first being the adoption of practices learned to improve their sustainable coffee production, while the second is the actual change on the farmers livelihood and surrounding environment.

Impact and outcome level change.

To measure the actual change at the farmer livelihood and longer term outcome level, the larger global coffee stakeholder community has initiated 15 indicators at the Economic , Social and Environmental dimension to showcase change to a better coffee world. These are also in line with SDG 2.4 on sustainable agriculture.

Consultations are ongoing at a global level to ensure this are the highest priority issues to measure to ensure a sustainable coffee world. A data standard is available to help stakeholders improve their technical systems to collect data on this indicators.

The indicators developed are below

Dimension	Indicator Topics	Description (Metrology)
General	Farm and Farmer Characteristics	Unique Farmer ID
		First and Last name
		Year of birth
		Gender
		Total farm size & Total Area planted in Coffee
		Location of the farm
		GPS Coordinates
Economic (Prosperity)	Coffee Profit	Total revenue from coffee sales minus total costs for coffee production (Reported in USD/ha of coffee productive area.)
	Yield / Productivity	kgs of GBE (harvested)/ha of coffee productive area
	Cost of Production	Costs incurred to produce the coffee during the last production year (calculated per kg of GBE)
	Price - Chain efficiency & returns distribution	Average Price received per kg of coffee (GBE) by farmer as a percentage of the FOB price , For Kenya NCE price
	Sustainable purchases	Volume of sustainable purchases by buyer and as a proportion of total, and change year to year.
Social (improved wellbeing / livelihoods)	Poverty Level	Comparison of total household revenue to International (World Bank) Poverty Line (total divided by # adult individuals in hh)
	Wages	Daily average earnings for farm labor compared to (rural) minimum wage

	Child labour	% of school-age household members, under age 18, who have completed appropriate grade level for their age Option: Prohibition of children in hazardous working conditions
	Hunger	Whether the household was food secure during the last production year (report 0 days of food insecurity--i.e., not skipping meals or significantly reducing food intake because food was not available)
	Labor Practices	% of good labor practices adopted (of those listed)
Environmental (Conserve Nature)	Forest and Ecosystem Protection	Land area (in ha) and proportion of the farm that was converted from natural land (e.g., forest, savanna) to land used for coffee production in the last 5 years. % of forest and ecosystem protection practices used on the farm
	Fertilizer use	Whether a professional assessment or advice was used to determine fertilizer needs on the farm Name and Amount of fertilizer used compared to yeild
	Water Conservation & Contamination Prevention	% of applicable water conservation practices used on the farm (of those listed) % of water contamination prevention practices used on the farm (of those listed) Amount of water used per KG Coffee
	Pest control/ hazards	% of IPM practices employed on the farm Use of banned or hazardous pesticides on the farm Pesticides used and their amount
	Soil Conservation	% of applicable soil conservation practices used on the farm (of those listed)

SDG indicator 2.4.1 Proportion Of Agricultural Area Under Productive And Sustainable Agriculture

list of themes and sub-indicators (see definitions in Annex and supporting documents)

No.	Theme	Sub-indicators
1	Land productivity	Farm output value per hectare
2	Profitability	Net farm income
3	Resilience	Risk mitigation mechanisms
4	Soil health	Prevalence of soil degradation
5	Water use	Variation in water availability

No.	Theme	Sub-indicators
6	Fertilizer pollution risk	Management of fertilizers
7	Pesticide risk	Management of pesticides
8	Biodiversity	Use of agro-biodiversity-supportive practices
9	Decent employment	Wage rate in agriculture
10	Food security	Food insecurity experience scale (FIES)
11	Land tenure	Secure tenure rights to land

Module 2: Coffee Nursery Management

Objective

To enable trainees understand all aspects of coffee nursery management in order to raise quality planting materials for enhanced productivity.

Content

i) Introduction.
ii) Nursery licensing – terms and conditions, types of licensing, licensing authority.
iii) Selection of a nursery site - slope, accessibility, security, water supply.
iv) Coffee varieties – Arabica: SL 28, SL 34, K7, Ruiru 11 Batian, Blue mountain and Robusta
v) Construction of a nursery structure – Orientation,sand beds, propagators and shade.
vi) Methods of coffee propagation - seed, Cuttings, Grafting and tissue culture.
vii) Potting media and transplanting - materials and ratios, specification of potting materials; transplanting - age of pre-germs.
viii) Maintenance of seedlings - watering, weeding, insect pest and disease management.
ix) Hardening of seedlings - hardening procedure.
x) Nursery diversification – fruit trees, agroforestry trees.

Methodology

i) Lectures - Licensing, site selection, varieties, nursery structure construction, propagation, seedling maintenance.
ii) Demonstrations - nursery structure construction, seed de-husking, sowing, potting, transplanting, grafting and cuttings.
iii) Field visits to a coffee nursery and clonal gardens.
iv) Group discussions on alternative materials for nursery construction.

Teaching aids

i) Slides and diagrams.
ii) Design plans.
iii) Charts.
iv) Coffee nursery.
v) Samples - seeds, suckers, potting materials, manure/compost, top soil, UV treated polythene sheets, disinfectant.
vi) Tools - secateurs, grafting.

2.1 Introduction

Proper nursery management is key to raising quality planting materials to ensure optimum number of seedlings are obtained.

2.2 Nursery licensing

For quality control purposes, all coffee nurseries must be licenced by the relevant licensing authority. To ensure traceability, nursery operators shall maintain proper records in regard to source and amount of seed, number of seedlings realized and to whom the seedlings are sold to.

2.3 Selection of a nursery site

Characteristics of an ideal nursery site:-

- Level or gently sloping land to avoid depressions where cold air settles at night.
- Avoid areas that are prone to flooding.
- Easily accessible and properly secured.
- Sheltered from wind.
- Permanent supply of uncontaminated water.

2.4 Coffee varieties

The existing Arabica commercial coffee varieties are SL 28, SL 34, K7, Kenya Blue Mountain, Ruiru 11 and Batian. Ruiru 11 and Batian are resistant to CBD and CLR and are adaptable to most coffee growing areas of Kenya. Robusta coffee is also grown in Lake Basin region and is also suitable for the coastal strip.

2.5 Maintenance of seedlings

- Water seedlings regularly depending on prevailing weather conditions. Avoid overwatering which predisposes seedlings to damping-off. Other factors that may cause damping off includes; poor potting mixture, over shading and acidic soils.
- Regularly uproot any emerging young weeds.
- Apply foliar feed as recommended after 4 months following transplanting.
- Control diseases such as damping-off and Brown eye spot by using 0.5% copper solution.
- Control the common insect pests like green scales, giant looper and leaf miners as they occur.

Damping off

Brown eye-spot

2.6 Construction of nursery structures

2.6.1 Construction of a propagator for seed and cuttings

- Constructed on East to West direction in order to have shade all the time.
- The propagators are constructed at 1.5m width and a maximum of 10m length.
- To achieve good drainage, scoop the soil out to a depth of 37.5cm (1.5ft). Thereafter, fill with gravel to a depth of 15cm (0.5ft) and then add 7.5cm layer of sand.
- A 15cm layer of rooting media is put on top of the sand.
- For seeds, the recommended seeding media is pure clean river sand.
- For cuttings, the recommended rooting media are either sawdust from cypress trees, pure river sand or red subsoil.
- Construct a wall of 22.5cm above the ground to avoid crumbling of media, surface run-off and assist in holding the polythene sheet cover in place.
- 1.2m high Posts are erected at 3m intervals on either side of the bed.
- To maintain ideal relative humidity and temperatures the propagators are covered with a 1000 gauge UV treated translucent polythene sheet.

Conventional propagator

Improvised propagator

2.6.2 Construction of a nursery shade

- Shield the seedlings from direct sunlight by erecting a shade at 2m high using posts spaced at 3m apart.
- Thick galvanized wire of gauge four is strained on the posts to hold the shade material in place.
- Use appropriate shading material like Shade net(50%) , split bamboo, banana leaves, maize Stover, grass or sisal poles.
- 75-80% and 50% shade nets are ideal for propagators and hardening shade respectively.

A conventional nursery

2.7 Methods of coffee propagation

The main methods of coffee propagation are:

- Seeds
- Cuttings
- Grafting
- Tissue culture

2.7.1 Propagation by seed

- Coffee seeds are acquired from Coffee Research Institute.
- With proper management, 1kg of coffee seed produces between 3000-4,000 seedlings.
- To ensure high germination rate, seeds should be sown immediately after collection. If not sown, the seeds should be kept in cool dry place and not for more than one day.
- Use 5-7cm (2-2.75 inches) deep pure clean river sand (without soil) as propagation media.
- To reduce germination period, de-husk the seed by use of hands just before sowing.
- Sow the seeds at a spacing of 2.5cm by 2.5cm (1inch X 1inch) and a depth of 1cm. The centre cut should face up.
- The seeds are then thinly covered with sand and moistened with water using a watering can.
- Cover the propagator with a 1000 gauge translucent UV treated polythene sheet to maintain ideal temperature and humidity. Ensure the propagators are shaded.

- Apply adequate clean water regularly (ensure adequate moisture by using a finger to check for wetness)
- Regularly uproot any emerging young weeds
- The pre-germs usually emerge after 6 – 8 weeks
- Pre-germs are ready for potting when they have a pair of cotyledons leaves This takes about 2 -2 ½ months


Sowing-centre cut up


Seed thinly covered


Germination & emergence


Pre-germs

2.7.2 Vegetative propagation

Vegetative propagation is a method of producing planting materials using plant vegetative parts instead of seeds. The materials produced vegetatively are genetically identical to the mother plant. This is done predominantly on the disease resistant hybrid cultivar Ruiru 11.

2.7.2.1 Clonal mother plants

- These trees are derived from seedlings which have undergone a pre-selection test for Coffee Berry Disease (CBD) and Coffee Leaf Rust (CLR) resistance.
- The selected mother trees are established in the field at a spacing of 1m by 1m.
- After 12-18 months, the primary branches are removed and the stems bent and pegged down in a horizontal position to encourage growth of orthotropic (vertical) shoots.
- Suckers grow from the dormant buds at each node, and are ready for harvesting after six months.


Clonal garden - young suckers


Clonal garden – Suckers ready for harvesting

2.7.2.2 Propagation by cuttings

- Harvesting of suckers should be done early in the morning when the atmospheric relative humidity is relatively high.
- Single node cuttings are prepared by making a cut at an angle below the node but retaining the pair of leaves.
- The cuttings are planted in the propagators at a depth of 2 to 4 centimetres and at a spacing of 4cm by 4cm.
- Callus formation begins 3 weeks after planting and is complete in 5-6 weeks.
- Root development follows after 8-10 weeks.

2.7.2.3 Propagation by grafting

- This is the successful healing of the union between the scion and root-stock.
- Grafting requires 10-12 months old seedlings (or pencil thick) to be used as root-stock.
- Root-stocks of other commercially existing Arabica coffee varieties are compatible with Ruiru 11.
- The graft union is tied with a polythene tape and the entire seedling is placed in a propagator to heal.

Grafting process

2.7.2.4 Propagation by Tissue culture

- This is the generation of plantlets using plant parts such as leaves by use of growth hormones.
- The method is limited to highly specialized facilities/ laboratories and therefore cannot be adopted at the farm level.

2.8 Potting media and transplanting

- The recommended potting mixture consists of three parts top soil, two parts sand and one part manure (top soil: sand: manure=3:2:1). For example, to fill 125 polybags of 5 by 9 inches, use 3 debes of sieved top soil, 2 debes of sand, one debe of well decomposed manure, 25gms TSP or 50gms SSP.
- Put the mixture in National Environment Management Authority (NEMA) compliant potting materials, place them in rows in the shaded beds and water thoroughly.
- Make a hole in the centre of the pot using a pointed stick and insert the pre- germ to the level of the stem crown. For pre-germs, transplanting is done after the two cotyledons unfold, which is about 8 weeks after sowing. Weak pre- germs or those with twisted roots are discarded.
- For cuttings, transplanting is after 8-10 weeks.
- Carefully firm the mixture around the stem.

Poly bags with potting mixture

Pre-germs transplanted

2.9 Hardening of seedlings

- Gradually reduce shade and the watering frequency to harden the seedlings at 7-8 months after potting.
- Completely remove the shade one month before planting.
- Ideally, seedlings are ready for transplanting when they have 1-2 pairs of primary branches. This is around 8-10 months after potting.

Module 3: Coffee Establishment, Rehabilitation and Renovation

Objectives

- To enable growers understand coffee planting practices that ensures optimum plant population, production, productivity and quality.
- To bring back into production coffee farms that have been neglected, devastated by pests or adverse weather conditions

Content

i) Introduction.
ii) Ecological requirements - altitude, temperature, rainfall and soils.
iii) Coffee varieties - improved, traditional, suitable area, spacing and attributes.
iv) Land preparation - timing, procedure, soil analysis and conservation.
v) Layout and preparation of planting holes - procedure, hole size, timing, media preparation and back filling.
vi) Field planting - source of seedlings, age, timing and procedure.
vii) Field maintenance of young coffee - mulching, irrigation, weeding, nutrition and intercropping.
viii) Coffee rehabilitation and renovation - definitions, importance quality improvement, pest and disease incidence, increase national production, profitability.
ix) Considerations for renovation and rehabilitation - extent of pest and disease attack, climate change, poor agricultural practices, age, succession management.
x) Rehabilitation and renovation process - timing and procedure.
xi) Steps of rehabilitation and renovation - assessment, program structure, partners, funding, implementation, monitoring and evaluation.
xii) Barriers towards renovation and rehabilitation - costly, reduced incomes, knowledge, competition from other enterprises, risk involved.

Methodology

i) Lectures - land preparation, filed maintenance, mulching, irrigation, weeding, nutrition and intercropping.
ii) Demonstration - layout and preparation of planting, field planting.
iii) Observation - morphological difference of coffee varieties.
iv) Field visit to a recently established farm.
v) Field visits and observations on neglected and rehabilitated farms.
vi) Case studies on rehabilitated / renovated coffee farms.

Teaching aids/materials

i) Trainers Manual.
ii) Flip chart, marker pens.
iii) Illustrations on proper establishment, deep and shallow planting.
iv) Mature seedlings.
v) Fertilizer samples –TSP/SSP fertilize manure, lime.
vi) Tools - Pegs, planting line, hoes, spade, tape measure and sisal twine.

3.1 Introduction

Coffee is a perennial crop with a long lifespan. Proper establishment is necessary to enhance root development for anchorage, nutrient and water uptake. This will lead to a sustained high yield and quality.

3.2 Ecological requirements of coffee

3.2.1 Arabica Coffee

- Altitude: from 1,200 to 2,100 m above sea level.
- Optimal temperature range: 15 °C -27°C.
- Maximum day temperature: not more than 30°C.
- Minimum night temperature not below 15°C.
- Diurnal Temperature range not more than 19°C.

Above19°C diurnal temperature range results in distortion, yellowing and cracking of leaves and tips, a condition known as "hot and cold" or crinkle leaf.

- Well distributed rainfall of not less than 1000mm per year for East of Rift Valley and 1145mm for West of Rift Valley. Coffee requires a stress period of 1-2 months before the rains to stimulate flowerings.
- Soils: free draining up to a depth of 1.5m to 3m in drier areas, fertile and slightly acidic (pH range 4.4-5.4 calcium chloride method).
- Avoid planting coffee on black cotton soils.

3.2.2 Robusta Coffee

Robusta coffee is a high yielding species well adapted to warm and humid equatorial climates. It requires more hot and humid environment.

- **Altitude:** from 500-1432m.
- **Temperature:** Optimal range of 18°C to 36°C, minimum not below 10°C.
- **Rainfall:** The ideal amount of rainfall lies between 900 and 2000mm that is well-distributed.
- **Soils:** free draining up to a depth of at least 1.5m and 3m in drier areas, fertile and slightly acidic (pH range 4.4-5.4).

3.3 Coffee varieties

The commercial Arabica varieties in Kenya are SL28, SL34, K7, Kenya Blue Mountain, Ruiru 11 and Batian. Ruiru 11 and Batian are resistant to CBD and CLR.

The areas grown, spacing, tree population and the specific varietal attributes are given in Table 1.

Table 1: Commercial coffee varieties

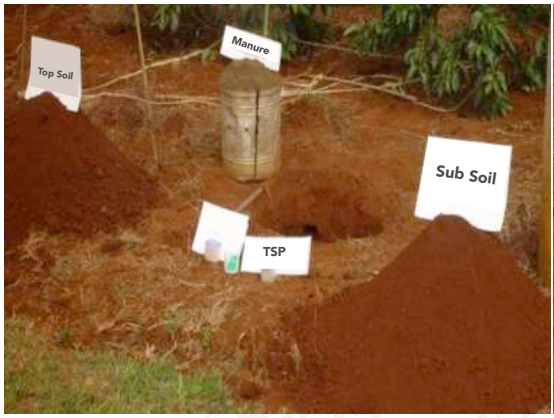
Variety	Areas Grown	Spacing and population density	Attributes
Batian	All coffee growing areas	2.1 x 2.4 m (7 x 8ft) 1905 trees/ha	• Resistant to CBD and CLR • Early maturing (18 months) • Cost effective - reduces costs by 30% • High yielding, high quality
Ruiru 11	All coffee growing areas	2 x 2 m(6.6 x 6.6ft) 2500 trees/ha	• Resistant to CBD and CLR • Early maturing (18 months) • Cost effective - reduces costs by 30% • Compact growth amenable to high density planting • High yielding, high quality
SL 34	High altitude with good rainfall	2.74 x 2.74 m (9 x 9 ft) 1330 trees/ha	• High yielding, high quality • Susceptible to Coffee Leaf Rust and Coffee Berry Disease
SL 28	Medium to high altitude coffee zones less prone to Leaf Rust	2.74 x 2.74 m (9 x 9 ft) 1330 trees/ha	• High yielding, high quality • Susceptible to Coffee Leaf Rust and Coffee Berry Disease
K7	Low altitude	2.74 x 2.74 m (9 x 9 ft) 1330 trees/ha	• Tolerant to Coffee Leaf Rust • Tolerant to drought • High yielding, high quality

3.4 Land preparation

- Prepare the land well in advance, digging out all tree stumps, roots, bushes and grasses. Land cleared of trees within 6 months should not be used for coffee planting because of the risk of Armillaria, a fungal disease which causes root rot.
- Ensure soil analysis is done to determine the inherent soil condition.
- Make terraces or other soil conservation structures where the land has steep slopes.
- Protect bench terraces by planting grasses e.g. Blue grass (Paspulum notatum) on the bench faces.

3.5 Layout and preparation of planting holes

- Layout and peg the planting points along the contours at the appropriate spacing
- Space holes at 2.74m x 2.74m (9ft × 9ft) for SL 34, SL 28 and K7; 2m × 2m (6.6 ft x 6.6 ft) for Ruiru 11 and 2.1m x2.5m (7ft x 8 ft) for Batian variety.
- Dig the planting holes during the dry season, at least three months before planting/ onset of rains.
- Planting holes should measure 60cm x 60cm x 60cm (2ft × 2ft × 2ft).
- Place top-soil (first 15cm or 6 inches) and sub-soil (15cm-60cm or 6”-24”) separately.
- 1 month before planting fill the holes with the top soil mixed with a minimum of 1 “debe” (20 litre bucket) of well decomposed manure or well-rotten coffee pulp, 100g TSP or 200g SSP If the soil pH is below 4.4, add 100g of lime to the mixture, otherwise add as per soil test results.
- Slightly mound the mixture in the holes to allow for settling.
- Place pegs at the centre of the holes and align appropriately.



Planting media

Back filled holes with pegs replaced

3.6 Field planting

- Obtain coffee seedlings from KALRO - CRI or any licensed coffee nursery.
- Select seedlings that are about 30 - 40 cm tall, with 1 - 2 pairs of primary branches and that should have undergone sufficient hardening.
- Plant the seedlings at the start of the main rain season after the soil has become wet up to about 60cm (2ft) deep.
- Remove the pot carefully to avoid disturbing the root system.
- Open the soil mound sufficiently at the top centre to accommodate the tap root and other roots and plant the seedling without burying the stem crown.
- Fill in the soil and press firmly without compacting and avoid stepping on it.
- Avoid deep planting as this usually interferes with nutrient uptake leading to stunted growth.

Deep planting

Correct planting

3.7 Field maintenance of young coffee

3.7.1 Mulching

- Young coffee requires mulching in order to conserve moisture, suppress weeds and moderate soil temperatures.
- Apply the mulch around the stem and ensure that it does not come into contact with it to avoid incidences of insect pest attack.

Mulching of young coffee

3.7.2 Watering

- During dry spells, water the seedlings at least two times a week until they are well established.
- Avoid over-watering to encourage proper root development.

3.7.3 Weed Management

- Undertake hand weeding around the young trees. Use implements like the half-moon jembe to weed in between the rows.
- In the event that there are stubborn weeds like couch grass, cover the seedlings (with a bucket or bag) before spraying the weeds with a suitable herbicide.

3.7.4 Nutrition

- Apply 50g of CAN per seedling six months after planting.
- After one year, apply 80g of NPK e.g. 17:17:17 per tree.
- one and half year apply 100g of CAN.
- At two years, apply NPK at 125g per tree. Subsequent applications should be as per the recommendations - based on soil analysis.

3.7.5 Intercropping

- Intercropping can be undertaken within the first two years after establishment. Suitable intercrops include short leguminous crops such as field beans, tomatoes and irish potatoes.
- Plant the intercrops using a recommended fertilizer preferably NPK fertilizer such as 17:17:17.
- Plant the intercrop at the middle of the inter rows at least 2 feet away from the coffee rows/stem.

Young coffee intercropped with beans

3.8 Coffee rehabilitation and renovation

Rehabilitation is the stumping or pruning of coffee trees to rejuvenate diseased, aging or otherwise underproductive trees. Renovation is the entire replacement of diseased, aging or otherwise unproductive trees with new plants. It also entails infilling dead spots in existing farms and planting more coffee in top-worked fields to attain optimal plant density.

Neglected coffee farm

Well tended coffee

3.8.1 Importance of renovation and rehabilitation

- Brings back into production coffee trees that have been neglected and improves quality.
- Reduces incidences of pests and disease attack on the well managed coffee farms as neglected farms act as breeding grounds.
- Rehabilitation of neglected farms help to increase National production.
- Renovation helps to bring back farms into profitability.

3.8.2 Factors to consider in renovation and rehabilitation

- **Extent of diseases and insect pest attack:** some pest and disease damage can be overcome without replanting but severe outbreaks can necessitate replanting.
- **Climate change:** increasing temperatures and moisture stress can demand replanting with drought – tolerant varieties, or varieties that are particularly suited to yield in certain climatic condition.
- **Agricultural practices:** poor agricultural practices can lead to the deterioration of trees to the point where they require R&R. It is important that R&R is always accompanied by GAPs to prevent the same decline from happening again.
- **Age:** coffee production, quality and resistance to diseases may deteriorate with age that may necessitate renovation.
- **Succession management:** lack of proper succession management within coffee farming business leads to negligence of the farms upon the demise/incapacitation of the owner/ investor.

3.9 Rehabilitation and renovation process

- Rehabilitation is normally conducted after the peak productive period and may entail pruning or change of cycle.
- It starts by clean stumping, then raising of suckers and finally selecting two or three to become the new heads.
- It is critical to complement R&R with GAP to avoid trees deteriorating again.
- Replanting starts with uprooting the old trees, preparing the holes and then planting new coffee seedlings. That kind of renovation can ensure higher yields in future but the farmer has to endure a longer period without income thus risking implementation program.
- The best alternative is top-working if the stump is not diseased, followed by infilling to increase the plant population in case of varietal conversion to Ruiru 11.

Rehabilitation process

3.10 Steps in undertaking rehabilitation and renovation

- Assess short and long term viability of R&R based on cost, capacity and farmer willingness to invest.
- Design a program and focus on farmer need analysis.
- Identify and partner with suitable support organizations.
- Source for funding by either own savings or grant/loan.
- Implement the components of the program.
- Follow up to monitor efforts and evaluate results.

3.11 Barriers towards rehabilitation and renovation in the smallholder sub- sector

- High cost of R&R and lack of access to finance.
- Lack of knowledge to implement R&R.
- Farmers have to endure a period of about two years with reduced or no income. To overcome this, farmers are advised to undertake the processes in blocks.
- Competition from other crops or preferable income activities.
- The risk of price fluctuation may demotivate farmers from undertaking R&R.

Module 4: Coffee Nutrition

Objectives

To impart knowledge on nutritional requirements of coffee for sustained soil fertility, coffee quality and yields.

Content

i) Introduction.
ii) Essential nutrients in coffee – Nitrogen, Phosphorus, Potassium, calcium, sulphur, magnesium, iron, zinc, manganese, copper, boron and molybdenum.
iii) Role of macro and micronutrients and deficiency symptoms – chlorotic/necrotic leaves, shortened internodes, reduced leaf size, overbearing dieback.
iv) Sources of macro and micronutrients - Inorganic fertilizers and their application schedules/rates, Foliar feeds, manures, mulches, compost and nutrient content.
v) Composting procedure – materials for use, use of EM, setting up the heap, monitoring the decomposition and renewing the mixture for regular supply of compost.
vi) Soil/leaf sampling and analysis - materials required, how to sample, when to sample and sample treatment before analysis.
vii) Liming – use of analysis report, nominal/minimal application rate and how to apply.
viii) Crop estimation – Importance of crop estimation, Timing, Methods used in crop estimation.

Methodology

i) Class lecture/field trainings sessions.
ii) Demonstrations of fertilizers/manure application, soil sampling and composting, foliar spray and liming.
iii) Group work/ practical sessions by participants.

Teaching aids/materials

i) Samples of various fertilizers, agricultural and dolomitic lime, soil auger and soil collection containers.
ii) Calibrated fertilizer applicator for large estates and cups for smallholder/lime measures
iii) Samples of decomposable and non - decomposable materials.
iv) Tools - jembes, shovels and pangas.
v) Illustrations of well - nourished coffee plants.
vi) Illustrations of deficiency symptoms on coffee plants.
vii) Cherry from well and poorly nourished coffee plants viii)pH meter, biological indicator of soil acidification (fern).
ix) Thermocouple for checking temperature of compost.

4.1 Introduction

For high yields and quality, there is need for adequate and timely supply of both macro and micro nutrients. The nutrients can be supplied from various sources such as fertilizers, manures or compost. Fertilizer programs are based on established inherent soil fertility characteristics and expected production level.

4.2 Essential nutrients in coffee

- Macronutrients – elements required in large quantities. They consist of the primary macronutrients required in relatively higher quantities such as Nitrogen (N), Phosphorous (P) and Potassium (K) and the secondary macronutrients required in moderately high quantities such as Calcium (Ca), Magnesium (Mg), and Sulphur (S).
- Micronutrients - elements required in very small quantities but are essential for plant growth. They include Zinc (Zn), Copper (Cu), Boron (B), Iron (Fe), Manganese (Mn), Molybdenum (Mo), Chlorine (Cl).

4.3 Role of macro and micronutrients and deficiency symptoms

4.3.1 Importance of macronutrients

Nitrogen (N)

- Essential for vegetative growth.
- Increases tree bearing capacity.
- Enhances bean size.

Phosphorus (P)

- Essential for roots and bearing wood development.
- Promotes early berry maturity.
- Increases bean density.

Potassium (K)

- Crucial in glucose transportation from the chlorophyll to storage tissues – roots, stems and branches.
- Promotes healing of injured plant tissue especially after picking, pruning and hail storm damage.
- Essential for berry development – enhances bean size (berry length) hence raises the proportion AA and AB grades.
- Regulates evapotranspiration pull i.e. the opening and closing of stomata thus the loss of water through the stomata and the uptake from the soil.
- Enhances mucilage formation and ripening.

Magnesium (Mg)

- A major constituent of chlorophyll which facilitates the making of plant glucose which in turn makes all the biochemical constituent of the plant – starch, amino acids, vitamins and the plant tissues.
- Enhances bean colour (Bluish-Green colour).
- Initiates root formation.

Calcium (Ca)

- Facilitates growth of apical and root terminal points – intensifies flowering density.
- Essential for vegetal and floral bud formation – it's a constituent.
- Manages the lyophilic series - directs the overall ratios of nutrients uptake.
- Plays a key role in bark formation – its constituent of the bark tissue.

Deficiency symptoms

Nitrogen deficiency (yellowing of young leaves) overbearing die-back due to of N deficency.

Phosporous deficiency (yellowing of older leaves).

Phosporous deficiency (yellowing of older leaves).

4.3.2 Importance of micronutrients Zinc (Zn)

It is the only known metallic plant hormone which:

- Boosts flower initiation and formation.
- Enhances fruit set and leaf size.
- Sets the inter-nodal spacing on the branch and the stem.
- Enhances phosphorus uptake and utilization.
- Determines the leaf symmetry.

Boron (B)

- Enables flower fertilization by facilitating pollen germination through the stigma to the ovary. Consequently, optimal flowering and fruit set are realized i.e. it minimizes flower abortion.
- Manages the utilization of water in the plant together with potassium. Consequently, it regulates the uptake of water from the soil together with potassium.
- Promotes shoot and root growth.
- Facilitates protein and sugar synthesis from glucose.

Iron (Fe) and Sulphur (S)

- Helps in the production of chlorophyll which is required in glucose formation.
- Promotes bean colour (lack of iron leads to amber beans).
- Together with copper, iron facilitates energy transfer processes during photosynthesis.

Molybdenum (Mo)

- Facilitates translation of pinheads to expanding berries without abscission i.e. abnormal drop of the pinheads

Deficiency symptoms

Zinc deficiency

Boron deficiency

Iron deficiency

4.4 Sources of macro and micronutrients

4.4.1 Inorganic Compound Fertilizers (NPK)

- These are granular, mechanically mixed homogeneous fertilizers with multiple nutrients. Examples of compound fertilizers are 17:17:17 and 20:10:10.
- If two or more nutrients are limiting in the soil, it's economical to apply a compound fertilizer. One of the annual N-fertilizer applications should be replaced with a compound fertilizer at a rate sufficient to supply the same quantity of Nitrogen.

Nitrogenous Fertilizers

- Sources include Ammonium Sulphate (AS), Calcium Ammonium Nitrate (CAN) and Urea.
- The choice of Nitrogen fertilizer depends on the soil reaction (pH).

Phosphate Fertilizers

- Common sources include Single Super Phosphate (SSP), Di-Ammonium Phosphate (DAP), Triple Super Phosphate (TSP) and Phosphoric/phosphorous acid.
- The choice of a Phosphatic fertilizer depends on the soil reaction (pH).
- DAP contains both Phosphorous and Nitrogen but has an acidifying effect. It is only recommended for use in soils with high pH and high levels of potassium. Continuous use of DAP without soil analysis can lead to big cherries without beans. Avoid using DAP unless recommended after soil analysis.

Potassium Fertilizers

- Sources include Muriate of Potash, Sulphate of Potash and organic manure (coffee pulp, napier grass and cattle manure).

Foliar Fertilizers

- These are formulations of soluble fertilizers usually applied on the foliage of the coffee tree to supplement soil applied fertilizers with the aim of:

  - Correcting nutrient deficiency.
  - Supplementing nutrient availability where soil nutrient uptake is impeded during dry weather or cold spells.
  - Apply when evaporation is low, preferably mornings or evenings, when it is not hot.

4.4.2 Organic fertilizers

Consist of manures, mulches and composts

- Boma manures are livestock organic waste made from accumulated dung from cattle pens and bomas.
- Farmyard manure (FYM) is made from a mixture of farm plant residues and daily accumulation of dung. Periodic turning of the boma and FYM leads to a fine livestock manure. The latter is often richer in potassium.
- Compost is made from decomposed organic materials derived from plant residue.

- Mulches are plant materials applied directly on the soil surface.

The benefits of all these include:

  - » Improvement of soil structure.
  - » Improvement of soil porosity/aeration - ability of the soil to hold optimal water and air.
  - » Lowered soil bulk density hence improved uptake.
  - » Moderation of top soil temperatures.
  - » Minimization of top soil moisture loss.
  - » Increment of microbial activity.
  - » Suppression of weed/insect pests.
  - » Soil erosion control.

- To avoid inducing nutrient imbalances, the mulching material to be used should be guided by the soil nutrient status. Examples of manures and the nutrients they supply:

  - » Cattle manure - rich in Nitrogen and Potassium.
  - » Poultry manure - rich in Phosphorus and Nitrogen.
  - » Coffee pulp - rich in Potassium and Nitrogen.
  - » Sisal waste - rich in Calcium.

- The amount of nutrients released to crops depends on:

  - » Nature and origin of materials.
  - » Level of decomposition.
  - » Weather conditions.
  - » Storage condition - exposing the manure to direct sun or rain leads to loss of Nitrogen.

4.4.3 Fertilizer Application

Appropriate fertilizer types and rates depend on overall fertility status of the soil and can be determined by undertaking soil analysis.

N.P.K application

- Apply 6 months before the main flowering (April for October/November flowering and October for March/April flowering) at the rate of 250g/tree to allow the plant to absorb adequate amount of P. P absorption is a slow process for dicots.
- Apply 2 weeks after the onset of rains to allow the feeder roots to develop.
- Apply on at most 20cm wide ring along the drip line and incorporate shallowly in the soil. Alternatively, scoop some soil, apply then cover shallowly (1 – 2 inches) with soil. The latter is more efficient.

Boron/Zinc application

- Apply a foliar mixture of Zinc and Boron at the rate of 2 - 3kg of each per Ha (40 - 60 g of each/20 litres of water) 2 – 3 months before the main flowering.

Nitrogen application

- Apply Nitrogen fertilizer (e.g. CAN/AS) after the main flowering, two weeks after the onset of rains at the rate of 300g/tree per year.
- For East of Rift Valley, apply in 2 equal splits at 3 - 4 weeks interval (150g per application).
- In West of Rift Valley, apply in 3 equal splits at 3 - 4 weeks interval (100g per application).
- Apply the fertilizer in at least a 30cm wide ring starting from the drip line towards the stem.
- If trees are carrying a heavy crop, apply a foliar fertilizer rich in Nitrogen during the dry or cold spell. For example, apply Urea 46% N at the rate of 10kgs/ha (10kgs in 1000 lts of water or 200g per 20lts of water) or other foliar formulations rich in Nitrogen. A better practice will be to use a foliar rich in NPK.
- Additional application of Nitrogen should be based on expected production. Trees carrying a heavy crop should be supplied with adequate nitrogen.

The table below gives a guideline on the amount of nitrogenous fertilizer to be applied for various levels of production.

Fertilizer application rates based on production per unit.

Amount of crop estimated in the current season	Kg N/ha per year	Grams of fertilizer/ tree		Kg of fertilizer/ha	
		21% N	26% N	21% N	26% N
Less than 1000 kg clean coffee per hectare (5 kg of cherry per tree)	80	330	260	390	310
1000-1500 kg clean coffee per hectare (5 – 7 kg of cherry/tree)	100	358	290	476	385
1500–2000 kg clean coffee per	100 – 150	358 - 538	290- 434	476 -	385- 577
hectare (7– 10 kg of cherry/tree)				715	
Over 2000 kg clean coffee per hectare (over 10 kg of cherry /tree	Up to 200	716	578	952	769

Note: Nutrition rates are dependent on prevailing crop. To determine the amount of N per hectare for Ruiru 11 and Batian, a multiplication factor can be used bearing in mind the table above is based on SL variety at 1330 trees / hac.

Fertilizer application schedule for late main crop areas

OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
					Main flowering		Initial expansion		Final expansion/ maturation		
Final expansion/ maturation					CAN						
			Zinc sulphate								
			Solubor								
			Lime							Lime	
			Manure							Manure	

The key areas for the late main crop are – Central region, Upper Embu and West of Rift.

Note: NPK application in West of Rift valley should be done in August or September depending on the start of rains.

Fertilizer application schedule for early main crop areas

OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Main flowering		Initial Crop Expansion			Final expansion/ maturation						
	CAN				NPK						
								Zinc sulphate			
								Solubor			
			Lime							Lime	
			Manure							Manure	

The key areas for the early main crop are – Meru, Machakos, Taita, and Oloitoktok regions.

4.4.4 Manure application

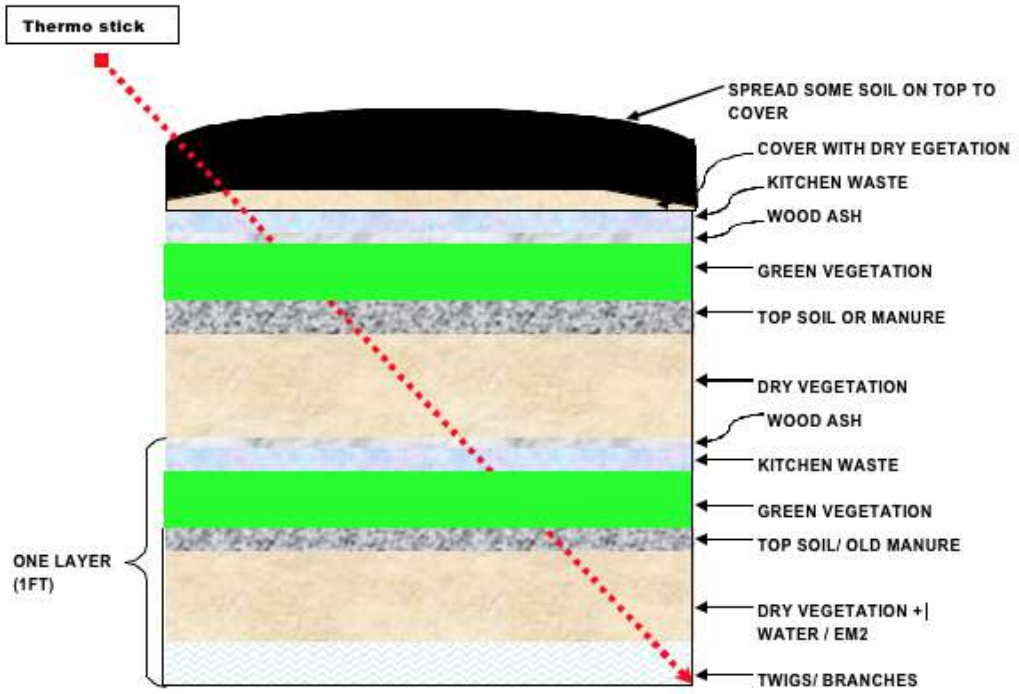
- Apply 1 - 2 debes of well decomposed manure/coffee pulp once a year during the dry weather, a month before the rains.
- Dig a shallow furrow ring (4 – 6" deep), 30cm wide, starting from the drip line towards the stem. Apply the manure and mix with soil.
- Manure may also be applied in the water basins - 45 cm deep. Leave a depression not exceeding 4" from the ground and cover with a thin layer of soil. However, this is not be the best practice.

4.5 Composting procedure

Compost is made from on-farm plant residues such as postharvest remains, weeds, tree litter fall, fodder/forage crops, coffee pulp, kitchen waste and other biodegradable materials. To assist in composting, EM (Effective Micro-organisms) can be used. This is a culture of micro-organisms that aids rapid breakdown of organic materials to release nutrients. The stock culture is termed as EM1 and is used to generate the working culture - EM2 as follows:

- Mix 1 litre of EM1 with 1 litre of Molasses and 20 litres of water. Let the mixture ferment for 7 days.
- 2 litres of EM2 can be mixed with 100 litres of water for use in compost making.
- For large scale compost, prepare ground of 100ft by 4ft wide. This should be done in areas free from flooding and run-offs.
- Line the composting depression with a strong polythene sheeting
- Stack the materials into 2ft thick layers.
- Apply the diluted EM2 solution and repeat the layering until approx. 4ft high.
- Wet each layer with adequate amount of water.
- Compress the layers and cover with polythene sheet and apply a thin layer of soil on top.
- Incubate for 3 weeks. After 3 weeks, start and continue turning and rewetting biweekly to aerate the mixture evenly.
- Poke in a thermocouple regularly to monitor the compost temperatures or use a stick to feel the temperatures.
- The decomposition process is complete when the mixture no longer feels hot.
- The compost will be fluffy and dark in colour when fully decomposed. This takes approximately two months.
- The end point is determined by a 66% reduction from the original volume.
- Apply 5 -10kg of the compost per tree depending on the canopy size.
- For small scale compost, make a hole 5ft by 5ft but the horizontal length depends on the availability of the composting materials and undertake the process above.
- Apply the compost from the first hole after two months and restart filling all over gain
- To ensure a continuous supply, undertake the procedure repeatedly.
- EM is readily available at Agrochemical shops.

Compost



NB. All the above steps must be carried out within 24 hours.

Well decomposed manure.

4.6 Soil and leaf sampling for analysis

4.6.1 Soil sampling

Soil sampling entails collecting representative samples (random sampling) from the whole farm for the purpose of analysis. It should be done during the dry season

- When sampling, ensure you have two containers, a fork jembe or a panga and packaging bags (for the sample).
- Take samples from the various parts of the farm. Collect samples outside the tree canopy between 4 trees.
- At the sampled point, dig out and place the top soil (first 6") separately from the sub soil (6 - 18"). Mix the top soil and the sub soil separately and take 1 or 2 handfuls from each and put in separate containers. Repeat this at the other sampled points.
- Thoroughly mix the soil in each of the containers and take a sample of about 1kg of top soil and 1kg of subsoil.
- Put the topsoil and subsoil in separate packages and label appropriately giving your name, location and address (Postal and email). Send the samples to CRI.
- At least 5 sampling holes (cores) should be dug for a small farm of 1 acre and below. For larger farms add 2 - 3 cores per every additional acre.
- Undertake soil analysis every 2 - 3 years in order to determine the type and quantities of fertilizers to apply.

Soil sampling tools and process.

4.6.2 Leaf sampling

Soil sampling tools and process.

- A sample should represent not more than 8 hectares. However, irrespective of plot size, samples may be taken to diagnose problems in specific areas.
- Use the fourth leaf pair counting from the first fully open leaf at the tip of a primary branch from the mid canopy of the cropping region of the tree. Where the fourth leaf pair is not available, sample the third pair.
- Take a sample from at least 25 trees selected randomly from the plot. The selected trees should be representative of the field.
- Pick four leaves from the four compass points of a tree. A single leaf from the fourth leaf pair should be picked.
- A complete sample should therefore consist of four leaves from each of the 25 trees thus making a total of 100 leaves per sample.
- Sample either from the uniform - cropping or non - cropping branches but not from both
- Sample before the onset of rains.
- Pack the 100 leaves in a khaki paper bag and put a label. The label should indicate the name of the farmer, block number/size and the date of sampling.
- Submit to CRI within 48 hours of sampling.
- Soil sampling should be done every two to three years.

4.7 Liming

- Apply lime as advised in the soil analysis report.
- Where soil analysis has not been done and there is an indication of high acidity (e.g. presence of fern and poverty grass), apply lime at 250g/tree each year in order to attain a suitable soil pH (4.4 - 5.4).
- Broadcast the lime along the rows during the dry weather.

Lime application

4.8 Crop estimation

- Crop estimation is the approximation/determination of the expected yield. It is expressed as the number of Kg of cherry per unit area (acre/ha/tree).

Importance of crop estimation

- Activity planning - It helps in planning for inputs purchase (particularly N), coffee picking and processing i.e. fermentation, drying and storage area.
- Budgeting and sourcing of financing required for critical farm operations like additional fertilizers and picking/processing expenses.
- Can be used to calculate the expected incomes.

Timing

- The best time is during the rapid expansion stage which is 7 – 17 weeks after flowering.
- At this stage, there are minimal chances of physical damage since the berries fairly developed. The timing also helps in giving the farmer adequate time to meet additional nutrient requirements based on production in addition to preparing for processing budgetary requirements.

Crop in rapid expansion stage.

4.6.2 Crop Estimation Process

Methods used in crop estimation

- Visual observation method
  - » Visual assessment of the bearing canopy at every stage of crop growth.
  - » Used in conjunction with past record/production trends.
  - » Requires on farm experience to achieve significant level of reliability and is less costly/tedious.

- Actual count method which is a reliable but costly exercise and involves the following steps;
  - » Randomly select a sample area of about 10% of total production unit.
  - » On the selected tree samples, count and record the number of bearing branches (at lower/middle/high canopy levels).
  - » Select randomly from the sampled tree (s) 2 or more bearing branches - should be representative of the rest of the branches.
  - » Count and record the berries on each selected branch for every tree sample (in the sample unit area).
  - » Sum up the total number of berries on the sampled branches, record and then take the mean (average).
  - » Multiply the mean number of berries by the number of bearing branches on the sampled tree(s).
  - » Sum up the total number of berries for all trees in the sample unit.
  - » Calculate the mean (average) number of berries in the sample unit.
  - » Multiply the mean (average) from sample unit by total number of trees in the production unit.
  - » Convert the number of berries to kg of cherry/Clean coffee; assumptions – 500 to 600 berries (good coffee) is equivalent to 1Kg Cherry. 6 to 7kg of cherry is equivalent 1Kg of clean coffee.

Module 5: Irrigation In Coffee

Objective

To enable trainers/farmers understand when and how to irrigate coffee in order to produce high yields and quality.

Content

i) Introduction.
ii) Benefits of irrigation - production, bean size, flower induction, ground fertilizer application.
iii) Coffee water stress testing.
iv) Types of irrigation - bottle, overhead, basin, under tree and drip.
v) Critical periods to irrigate - moisture content is inadequate, pinheads.
vi) Breaking dormancy, when trees are under stress.
vii) Important aspects of irrigation - weed, calibration, repair of leaks, well serviced system.

Methodology

i) Lectures.
ii) Discussions on irrigation methods and timings.
iii) Demonstrations on various irrigation methods and use of cobalt chloride kits.
iv) Group work practicals on setting up the moisture monitoring kit.
v) Visits to farms under irrigation.

Teaching aids/materials

i) Trainers Manual.
ii) Flip chart/ white board and marker pens.
iii) Cobalt Chloride kit.
iv) Drip Irrigation pipes, small sprinklers for under tree irrigation.
v) Illustrations on overhead sprinklers.

5.1 Introduction

Irrigation is the artificial application of controlled amounts of water to the soil at predetermined intervals. It may be done to make up for inadequate or break dormancy rainfall for the purpose of increasing the cropping level. It can also be done to supplement rainfall especially when the tree is carrying a heavy crop. Irrigation may be done through drip, overhead, basin, under tree or bottle.

5.2 Benefits of irrigation

- Increases production by up to 50% especially when rains are below normal.
- Increases the bean sizes hence the proportion of premium grades and thus enhances quality.
- It can be used to induce flowering.
- It protects the tree from damage arising from overbearing when there is drought.
- It allows ground fertilizer application in case of rain failure.

5.3 Coffee water stress testing

The moisture deficit testing kit (cobalt chloride disc method) is used to determine whether to irrigate or not. On average, if time taken by the disc to change from blue to pink is 5 minutes or more, there is need for irrigation. Other appropriate methods include use of electronic devices such as infra-red monitoring tool and farmers experience by visual observation.

Cobalt chloride kit

Moisture stress on young coffee plant

5.4 Types of irrigation

- **Drip irrigation** – this is the most preferred type of irrigation since it is economical in water usage. Water is delivered through laid out drip lines that have equally spaced openings.
- **Overhead irrigation** – the use of sprinklers to apply water above the coffee bushes. It is the most uneconomical in water usage and predisposes the coffee trees to disease attacks. It is also expensive to run.
- **Basin irrigation** – holes are dug between the coffee trees and water is applied into holes.
- **Under tree irrigation** – This is preferred where CBD is severe to avoid wetting the canopy. It involves use of small sprinklers to apply water under the trees.
- **Bottle irrigation** – This is ideal for small scale farmers and involves the use of bottles to apply water under the tree canopy.

Drip irrigation coffee

Over-head irrigation

Basin irrigation

Bottle irrigation

5.5 Critical periods to irrigate

Coffee needs to be irrigated when:

- Moisture content is inadequate for the young coffee
- Flower buds are fully formed but there are no rains to induce blossoming
- Pinheads are breaking dormancy (7th week from fruit set) but there is moisture deficit
- Rains fails during the ripening stage – This is a critical stage in the coffee production cycle and every effort to irrigate should be made if rain fails
- Coffee trees are under stress due to drought

5.6 Important aspects of irrigation

- Irrigate weed free coffee fields
- Determine the amount of water being applied - collect water from the discharge point for a given period of time. This will tell how long to irrigate
- Repair leaking pipes and joints – to minimise water wastage
- Ensure the pump and the whole irrigation system is working properly – check the foot valves, sluice valves and the return valves
- Sources of water may be – rivers, lakes, boreholes, shallow wells and reservoirs
- Ensure the water is tested on suitability for coffee farming
- For sustainability in water sources, harvest water from buildings and run off from farms into dams and reservoirs
- For sustainable water use, irrigate in the early morning and at night
- Bottle irrigation can be done for young seedlings

Module 6: Coffee Canopy Management

Objective

To enable growers understand practices of managing the coffee tree canopy for optimal production and regular annual cropping

Content

i) **Introduction** – definitions, forms of canopy management
ii) **Benefits of canopy management** - crop leaf ratio, flowering stimulation, growth of new stems, pest and disease, overbearing ,biennial cropping and tree rejuvenation
iii) **Coffee tree training systems** – single and multiple stem systems, capped and uncapped
iv) **Main pruning** – definitions, when, how to prune capped and uncapped, benefits and limitations of capped and uncapped system
v) **Handling and de-suckering** – definitions, timing and procedure
vi) **Change of cycle** –definitions, procedure for capped and uncapped system
vii) **Top- working** – definition, methods used, how to top-work and procedure

Methodology

i) Lectures on benefit of canopy management, training system, handling and de- suckering
ii) Demonstrations on capping, pruning, handling and de-suckering, change of cycle and top-working
iii) Discussions on benefits and limitations of capped and uncapped systems
iv) Practical on pruning, handling, de-suckering, change of cycle and top-working

Teaching aids / materials

i) Trainers Manual/ brochures/ fliers
ii) Flip chart
iii) Pruning saw
iv) Secateurs
v) A primary branch with secondary branches
vi) Coffee suckers
vii) Mature plant for top-working viii)Grafting knife
ix) Grafting bags
x) Tubing
xi) Protective gear
xii) Disinfectant

6.1 Introduction

Canopy management is the overall process of ensuring optimal production of the bearing wood in order to maximize annual regular cropping. It includes pruning, tree training, handling, de-suckering and change of cycle.

6.2 Benefits of Canopy Management

- Maintains a suitable crop: leaf ratio
- Opens the tree to sunlight which stimulates flowering
- Encourages growth of new stems and crop producing branches
- Reduces pests and disease susceptibility
- Helps to reduce over-bearing and dieback
- Reduces biennial cropping
- Maintains an appropriate tree shape
- Rejuvenates the coffee tree

6.3 Coffee Tree Training Systems

6.3.1. Single and multiple stem training

In a single stem system, the coffee tree has only one bearing head while in multiple stem system, the tree has two or more heads. In preparing trees for multiple stem system, cut the shoot above the first pair of primaries, approximately 1foot from the ground and this will encourage growth of several suckers. Select and leave the desired number of suckers.

6.3.2 Capped and uncapped system

- The capped system involves cutting the heads at a height not exceeding 6 feet from the ground while in the uncapped system, the apical stem growth is maintained
- The free growth is appropriate for smallholder, small estates and medium estate farmers while the capped system is appropriate for the mechanized plantations

Capped system

Free growth system

6.4.1.1 Benefits of uncapped tree system

- It is cheap, simple and quick to manage.
- Good for crop control and prevention of over-bearing.
- Stems replacement and change of cycle is easy.
- It bears crops mostly on primaries which give bigger beans of higher quality.

6.4.1.2 Limitations of uncapped tree system

- Tree breakages are common especially with delayed change of cycle.
- Picking and spraying is difficult on tall trees.
- Irregular growth of trees in a field.
- Rotting of stumps with age.

6.4.2.1 Benefits of capped tree system

- Easy picking and spraying at convenient uniform height.

6.4.2.2 Limitations of capped tree system

- Pruning is complicated, slow and requires skilled labour.
- Top branches liable to scorching without shade

6.4 Pruning

Pruning is a process through which undesired branches are removed in order to concentrate growth on the wanted branches and it is normally carried out after the main harvesting. Unhealthy trees due to die-back should be pruned only after new vegetative growth.

Un-pruned coffee tree

Pruned coffee tree

6.4.1 How to prune coffee under the uncapped system (free growth)

- Remove all primary branches touching the ground
- Open the centre by removing all the secondary branches within 9 inches (22.8cm) for traditional and Batian varieties and 6 inches (15cm) for Ruiru 11 from the main stem.
- Remove all the interlocking primaries
- After the third main harvest, maintain a bearing height: 5.5 feet for coffee in the coffee-tea zones, 5 feet for main coffee zones and 4.5 feet for marginal coffee zones.
- Remove the old primaries below the above recommended bearing height
- Allow 4 non-cropping secondary branches per primary and 2 more bearing ones
- Remove the interlocking primaries spirally, one from each alternate head especially for Ruiru 11
- Remove all the dry branches
- Remove all secondary branches growing upwards, inwards and downwards
- Cut back primaries to ensure they do not grow beyond 3 feet
- Maintain 2 or 3 bearing heads per stem

Too many heads

Correct number of heads

Well pruned primary branch

6.4.2 How to prune coffee under the capped system

- Has a fixed bearing head, hence the crop is mostly borne on the secondary branches and tertiaries.
- Capping is done at 1.83 metres (6ft) from soil level.
- Cut back primaries to maintain a length of 2.5 feet. Primaries carrying a crop should not be more than one metre long.
- Cut off secondary branches, tertiaries and laterals which have carried two crops to encourage new laterals.
- Leave 4 bearing secondary branches and 2 non-bearing ones on one Primary.
- If possible leave only one secondary on each node on alternate sides of primary.
- Remove secondary branches and laterals growing upright or within 15cm (6 in) towards the main stem
- Always remove suckers unless wanted for change of cycle.
- For capped multiple stem remove all inside primaries.

6.5 Handling and de-suckering

- Handling involves thinning out of the young shoots that develop after rains or irrigation
- De-suckering is the removal of suckers on main stems and at the base of the trunk
- Handling can be done at any time but mainly at the end of the rain season
- De-suckering can be done at any time but at least every 3-4 months for the uncapped system and every 2 months for the capped system
- Replace the non-bearing secondary branches which have matured with young shoots. Do not remove those carrying a crop
- Do not allow suckers to grow unless they are for change of cycle or replacement of broken bearing head(s)

6.6 Change of cycle

A process of rejuvenation (renewal) of the old bearing heads with new ones. This can be done through gradual replacement or clean stumping. This should be preferably done after every 5 major main crops

6.6.1 Uncapped (free growth)

- Start preparing for change of cycle 18 to 24 months before heads are to be cut off.
- Cut off the inside primaries leaving those within 1.5-2.5 feet from the top. This will make the heads to bend outwards as illustrated below
- Allow suckers to grow in the main stem at about 12 to 18 inches from the ground
- When suckers are about 18 inches high, select 4 strong, health and well- spaced suckers and cut off the rest.
- Just before the long rains, cut off 1 sucker leaving 3 to develop into new heads
- One year before cutting the old stems, prune off all the primaries inside the main stems
- Remove one head each year starting with the one on the sunrise side. Cut off at an angle of 450 slanting outwards
- Change of cycle can be done by clean stumping where all stems are cut to allow for regeneration of new suckers. The suckers are progressively selected to allow for development of up to 3 bearing heads

Change of cycle process for uncapped

6.6.2 Change of cycle in a capped system

- Change of cycle is done after 5 cropping years
- In case there are 3 heads per stem start the process by removing the head facing the sunrise side
- Side prune the remaining heads on the sunrise side to allow adequate light at the base of the stem
- Allow suckers to grow in the main stem at about 12-18 inches from the ground
- The rest of the procedure is as for the uncapped
- Undertake stem surgery whenever necessary to remove the dead wood and create space for sucker expansion

Change of cycle for capped system

6.7 Top-working

Top-working is varietal conversion that involves converting disease susceptible mature trees of Arabica coffee into Ruiru 11/Batian without uprooting and replanting.

6.7.1 Methods used in top-working

- Side wedge grafting that leaves the upper portion of the root stock as a breather -gives rise to weak stems
- Whip and tongue grafting-done on pencil thick suckers and is the most common method
- Bark grafting -done on the side of the main stem and gives rise to weak stems which can easily break off

Top-work during cool and wet weather to achieve best results

6.7.2 How to top-work

Top working procedure:

- Induce sucker growth on the trees to be converted by side pruning in September to October or January to February
- When the suckers are six months old, they will be approximately pencil thick, hardened and suitable for grafting
- Select 3 to 4 healthy suckers per stem originating from as near the ground as possible (4-6 inches) and graft with single node scions of Ruiru 11 or Batian bearing a pair of leaves
- Tie the graft union with a tape to keep the scion in place and to prevent fungal infections
- Lower a milky tube to enclose the grafted sucker and tie the lower open end tightly just below the graft union
- Pour a little water (approximately 50ml) carefully into the polythene bag maintaining its level below the graft union. The water helps to maintain a high relative humidity for enhanced healing
- Remove the bag when the graft union is completely healed (after about 6 months)
- Remove the tape tying the graft union
- Remove the old stems when the grafted suckers start bearing
- Infill with the selected variety to achieve the recommended plant population for the new variety

Steps in top working

6.7.3 Benefits of top-working

Steps in top working

- There is no interference with normal cropping pattern
- The farmer saves on the cost of uprooting old bushes and establishment
- The well-established root system of old stumps prevents lodging which may occur when young trees carry a heavy crop
- Gets into production faster than through -uprooting and replanting
- Increased plant population per unit area especially where compact varieties are used
- It leads to high returns as a result of foregone fungicide costs

Module 7: Management Of Weeds In Coffee

Objective

To enable trainees identify the various types of weeds and understand their economic importance and management strategies

Content

i) Introduction
ii) Economic importance of weeds – effects on yields and quality
iii) Classification of common weeds - annual and perennial
iv) Timeliness in weeding – timing, age of weeds, height
v) Methods of weed control – mechanical, cultural, chemical, integrated
vi) Spray equipment, appropriate nozzles

Methodology

i) Lectures
ii) Discussions on why weed and best time of weeding
iii) Demonstrations on types of weeds, methods of weed control
iv) Display of spray equipment, nozzles and herbicides

Teaching aids / materials

i) Projector, LCD/Lap top
ii) Flip chart/ white board and marker pens
iii) Weed specimens
iv) Weeding tools
v) Herbicide samples
vi) Spray equipment and nozzles

7.1 Introduction

Weeds compete with coffee for nutrients, light and moisture. This leads to production of less yields and low quality coffee grades like C, T, TT and defects like lagged beans and pods. Weeds also act as alternate host to some coffee pests making their management difficult in un-weeded fields.

There are two types of weeds, annual and perennial. Their management includes mechanical, cultural, chemical and integrated weed management strategies.

7.2 Economic importance of weeds

A weed is plant that grows where it is not wanted. weeds have the following effects on coffee:-

- Competition for moisture, nutrients and light
- Lowers quality and quantity
- Serves as alternate host for coffee pests
- Interferes with field operations

7.3 Classification of common weeds

Weeds are classified either as annual or perennial weeds.

7.3.1 Annual weeds

These are weeds that complete their vegetative cycle within one year and are easy to control e.g. gallant soldier, black jack and Mexican marigold

7.3.2 Perennial weeds

These are weeds that persist over seasons and are difficult to control e.g. Kikuyu grass, nut grass, wandering jew, oxalis and couch grass

Well weeded coffee field

Un-weeded coffee field

7.4 Timeliness in weeding

Effective weed control depends on timely application of the control methods that should be done before:-

- Weeds get too big and the root system makes them difficult to pull out
- Weeds can seed adding to the weed problem (fourth leaf stage)
- Fertilizer is applied which would otherwise be taken up by weeds
- Mulching is done

7.5 Methods of weed control

Weed management in coffee can be achieved through mechanical, cultural, chemical or a combination of any two or more strategies hereby referred to as Integrated Weed Management (IWM).

7.5.1 Mechanical

This involves:-

- **Hand hoeing** - done shallowly to avoid damaging root hairs by using a hoe (jembe) or a panga.
- **Forking** - should be done every 2 – 3 years mainly to break hardpans and enhance soil aeration. This is best done during the dry season to aid in management of difficult weeds
- **Slashing** - appropriate when the soils are too wet and the use of a hoe is difficult. Care must be taken not to injure the trees as this would predispose them to Fusarium infection.
- **Tractor drawn mower** – this is economical on large scale operations

7.5.2 Cultural

This involves use of traditional practices such as mulching, close spacing and cover crops.

7.5.3 Chemical

This entails use of PCPB registered herbicides which are either systemic or contact in their mode of action.

- Systemic herbicides control both annual and perennial weeds
- Contact herbicides control the annual weeds
- Chemical control should be applied only as the last option

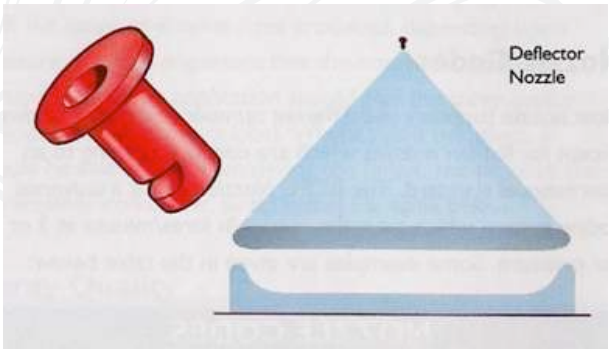
7.5.4 Integrated Weed management

This is a combination of any two or more of the methods mentioned above. It is most effective, cost friendly and efficient as it is directed by the weed spectrum present in a particular coffee farm.

7.5.5 Spray equipment and appropriate nozzles

For effective chemical control, it is important to use recommended spray equipment - motorised sprayers or knapsack sprayers and most importantly the selection of nozzles. The nozzles should be wedge shaped as opposed to cone shape. These will cover large swathes as well as ensuring chemical does not drift to coffee plant. Sometimes it is important to use a shield to avoid any chemical drift.

Knapsack sprayer



Wedge nozzle for spraying weeds

Module 8: Management Of Coffee Diseases

Objective

To enable trainees understand the various types of coffee diseases, economic importance and the management strategies.

Content

i) Introduction
ii) Economic importance of coffee diseases – effects on yields and quality, losses due to diseases
iii) Classification of coffee diseases in Kenya – Major and minor diseases
iv) Management of major Coffee diseases - Coffee Berry Disease (CBD), Coffee Leaf Rust (CLR), Bacterial Blight of Coffee (BBC). Fusarium bark disease (FBD), Fusarium root disease(FRD),
v) Management of minor coffee diseases - Armillaria root rot, Botrytis Warty disease, Root rot, Brown eye spot, Leaf blight and stem die back
vi) Appropriate spray equipment, nozzles and protective clothing

Methodology

i) Lectures
ii) Discussions on loses due to various diseases
iii) Illustrations of various diseases and their impacts
iv) Practicals on identification of diseases disease symptoms
v) Display of spray equipment, nozzles, resistant varieties
vi) Visit to coffee farm

Teaching aids / materials

i) Trainers Manual and slides
ii) Flip chart/ white board and marker pens
iii) Disease specimens
iv) Spray equipment nozzles, resistant varieties
v) Fungicide/bactericide samples

8.1 Introduction

There are four major coffee diseases in Kenya namely; Coffee Berry Disease (CBD), Coffee Leaf Rust (CLR), Bacterial Blight of Coffee (BBC) and Fusarium Disease (Fusarium Bark and Fusarium root disease). Minor diseases include, Armillaria root rot, Botrytis Warty disease, Root rot, Brown eye spot, Leaf blight and stem die back.

8.2 Economic importance of coffee diseases

Coffee production is constrained by two fungal diseases namely Coffee Berry Disease (CBD) and Coffee Leaf Rust (CLR). Their management accounts for up to 30% of production costs. Coffee Berry Disease may lead to total crop loss while Coffee Leaf Rust causes indirect loss through leaf fall. Therefore, there is need to apply effective, timely and sustainable control strategies

8.3 Classification of coffee diseases in Kenya

Some diseases are major while others are minor The major coffee diseases in Kenya include

- Coffee Berry Disease (CBD)
- Coffee Leaf Rust (CLR)
- Bacterial Blight of Coffee (BBC)
- Fusarium bark disease (FBD)
- Fusarium root disease (FRD) Minor diseases are:
- Armillaria root rot
- Botrytis Warty disease
- Root rot,
- Brown eye spot,
- Leaf blight and stem die back.

8.4 Management of major Coffee diseases

8.4.1 Coffee Berry Disease (Colletotrichum kahawae)

Symptoms

- **On flowers:** dark brown blotches/streaks on the petals. Flowers may be destroyed but loses from flower infection are generally not serious
- **On green berries:** small dark sunken patches/lesions which spread rapidly and may cover the whole berry. Infected berries may be shed or remain on the trees in a black shrivelled condition
- **On ripe berries:** dark sunken lesions with black dots spreading rapidly on the ripe berries (late Blight)
- **On leaves:** brown marginal spots. However, leaf infection is not common
- Severe infections may cause the die-back of twigs and branches

CBD infected berries

Late-blight

Conditions favouring high disease incidences

- Cool temperatures – 18-200 C
- High humidity - encourages spores production
- Rainfall – rain droplets disperse the spores to the rest of the tree. After the dispersal, at least 5 hours of wetness on the berries are required for the spores to germinate. Rainfall occurring in the late afternoon is therefore likely to provide suitable conditions for infection

Management of CBD

- **Cultural control** – proper and timely pruning, handling and de-suckering, and regular change of cycle. This reduces the initial disease inoculum.
- **Chemical control** – correct and timely use of PCPB registered fungicides for coffee. It is advisable to complete the CRI recommended CBD control program for it to be effective and to avoid development of resistance by the pathogen. Farmers should start spraying before the rains and continue until the rains and the cold spells are over
- **Resistant varieties** – new planting of disease resistant varieties or conversion of susceptible varieties to resistant ones through top working (grafting)

8.4.2 Coffee Leaf Rust (Hemileia vastatrix) Symptoms

- Pale yellow spots appear on the underside of the leaves at the onset of infection
- The spots later change to yellow/orange powdery masses
- Affected leaves fall off prematurely in case of severe infection. This condition may cause dieback if not controlled

Coffee leaf rust

Conditions favouring high disease incidences

- Warm and wet conditions
- Wind and or rain – disperses the spores
- After the dispersal of spores, at least 3 hours of wetness on the leaves are required for them to germinate. Only germinating spores on the lower surface of a leaf can penetrate and cause infection

Management of Leaf Rust

- **Cultural control** - proper and timely pruning and regular change of cycle
- **Chemical control** - this entails the use of PCPB registered Copper-based fungicides. Timing is critical for the control of leaf rust and the sprays should be applied before the commencement and during the early period of the rainy season. For effective management:
  - » Start the 1st round of sprays just before the short rains and repeat 3 weeks later
  - » Start the 2nd round of sprays before the onset of long rains and do 2 more at 3 weeks interval
  - » In case the infection is severe (20% of leaves have rust), it is necessary to use a systemic PCPB registered coffee fungicide. Do not spray more than 2 times a year as it affects production of plant hormones leading to hormonal imbalance such as the balance between floral and vegetal inducing hormones. This may affect flowering and thus production
  - » Adhere to the CRI recommended spray programme. Improper use of fungicides may lead to development of resistance by the pathogen

- **Resistant varieties** - planting of disease resistant varieties or conversion of susceptible varieties to resistant ones through top-working (grafting)

8.4.3 Bacterial Blight of coffee (Pseudomonas syringae pv. garcae)

Symptoms

- **On leaves:** black soaked lesions. Leaves eventually dry out, roll inwards and turn brown but do not shed
- **On twigs and shoot tips:** die back syndrome as infection extends downwards from the terminal bud
- **On flowers and pin head stage:** if attacked, pin heads appear water soaked. Both the flowers and pin heads shrivel, turn black and the entire crop may be lost
- **On internodes of young branches:** dying of branches above the area of infection. Infection may start at the internodes of young succulent branches or green stems as a result of hail damage or through wounds caused by sucking insects

Bacterial Blight of Coffee

Conditions favouring high disease incidences

- Cool and wet weather
- Injuries as a result of hailstorms and insect attack

Management of BBC

- **Cultural control** - proper pruning, minimising use of high N foliar feed formulations, splitting ground N application, sterilising pruning tools (e.g. with Kerol 1% or Lysol 3% or methylated spirit), cutting off and burning infected twigs and branches, frequent de-suckering and avoiding transportation of seedlings from BBC prone areas
- **Chemical control** - use of PCPB registered bactericides (Copper based products are most effective). For example, during the wet weather, use Kasumin Bordeaux (Copper Sulphate plus Lime at 1:1 ratio). A single spray after hailstorm to protect fresh wounds from infections is necessary
- Use the CRI recommended programme to manage the BBC

8.4.4 Fusarium Bark Disease (Fusarium stilboides)

There are 3 distinct forms namely Storeys bark disease, Collar rot and Scaly bark.
Symptoms

- Yellowing and wilting of leaves and eventual death of the tree
- For Storeys bark - suckers are attacked at the base forming lesions that girdle the stem forming a bottle neck at the base
- For Collar rot - a cankerous lesion develops causing a constriction at the base near the ground level
- For Scaly bark – rising up and flaking of the bark on mature stem especially at the point where a primary has been cut off. On old trees, this may be difficult to recognize. However, when seen on young wood or associated with cankerous regions around the base of branches or suckers, it is most likely fusarium. Unless cankerous areas develop or dieback begins, affected stems and branches may survive

Storeys bark

Collar rot

Scaly bark

Conditions favouring high disease incidences

- Poor nutrient status of soil
- Weak trees as a result of poor establishment, drought or scorch
- Scars on trees due to pruning, careless slashing of weeds and herbicide damage on green suckers
- Excessive weed growth and mulching too close to the stem causing a warm moist micro climate around the base
- Failure to destroy affected trees

Management of Fusarium Bark Disease

Cultural control

- Avoid deep planting
- Keep soil pH at optimum (4.4-5.4)
- Proper application of mulch (6" from the stump) to avoid Collar rot
- Sterilising of pruning tools with methylated spirit
- Eliminate wood boring insect pests e.g. yellow headed borer. This can be done by maintaining soil potash at optimal level as per soil analysis recommendations
- Uproot and burn all infected trees having die bark from Collar rot

Chemical Control

- In case of storey bark disease cut off and burn affected suckers or heads. Paint the scars with a PCPB registered fungicide. Make a fungicidal paint such as Captan (1 teaspoonful of Captan plus 150ml vegetable oil)
- In disease prone areas, spray suckers raised for conversion fortnightly with PCPB registered fungicide for coffee such as Captan at 40gm in 10 litres of water from emergence until wood bark matures to about 30 cm (1 foot) from the base
- For scaly bark, no action need to be taken as long as no further signs of disease develop

8.4.5 Fusarium Root Disease (Fusarium solani)

Symptoms

- Sudden wilting of leaves and death of the tree
- Infected trees may remain alive for several years but disease symptom appears once the tree is subjected to water stress. At this stage a cross- section of the stem near the soil level reveals a pink-purplish colouration, sometimes with dry rot at the centre depending on severity of infection on the tree.

Conditions favouring disease incidences

- Injury at the time of planting
- High acidity in soils
- Chemical or mechanical injury to the roots
- Water logging

Management of FSD

- **Cultural control**
  - » Uproot and burn infected trees. Leave the hole exposed for at least six months before replanting
  - » Avoid damaging the roots of seedlings during planting

- **Chemical control**
  - Sterilise the planting holes with a PCPB registered soil fumigant such as Basamid at a rate of 150gm per hole

8.5 Minor Coffee Diseases

8.5.1 Armillaria root rot (Armillaria heimii)

This is a fungal disease commonly associated with new establishments where trees have been uprooted leaving residual lateral roots. The residual roots contain food substrates for Armillaria fungi to multiply. These fungi eventually infect the developing coffee roots.

Symptoms

- Wilting and death of the leaves
- Death of the verticals (shoots, suckers and the stem)
- Subsequent death of affected trees
- In advanced stage of the disease, the wood of the affected tree is decomposed into a white wet mass with characteristic black zone lines running through the wood tissue

Conditions favouring high disease incidences

- Clearing of forest without first ring barking the trees

Management of Amillaria

- Where coffee has to be planted in newly cleared forest land, it is recommended that ring-barking of the forest trees be done 2 to 3 years earlier
- Removal of forest tree stumps and roots
- The infected tree(s) should be uprooted and replanting delayed for 2 years

8.5.2 Other minor coffee diseases

Other minor coffee diseases include Botrytis Warty disease, Root rot, Brown eye spot, Leaf blight and stem die back. However, these are not of major economic importance.

8.6 Appropriate spray equipment, nozzles and protective clothing

For effective chemical control, it is important to use recommended spray equipment - motorised sprayers or knapsack sprayers. The spray equipment should be functioning properly, well calibrated and with appropriate nozzles - Hollow Cone Nozzle. Appropriate personal protective clothing should be used.

For further information on coffee diseases please refer the coffee atlas by Coffee Research Institute

Module 9: Management of Coffee Insect Pests and Responsible use of Pesticides

Objective

i) To enable trainees identify the various insect pests of coffee and understand their economic importance, symptoms of damage and management strategies
ii) To enable the trainees understand the responsible use of pests control products

Content

i) Introduction
ii) Economic importance of coffee pests – effects on yields and quality
iii) Classification of insect pests - major and minor insect pests
iv) Pests Scouting and IPM
v) Management of prevalent insect pests - symptoms of damage and management strategies
vi) Responsible use of pesticides – pesticides classification, chemical poisoning and first aid measures, precautions for purchase, transportation and storage of pesticides and disposal of pesticides

Methodology

i) Lectures sessions on coffee insect pests
ii) Discussions on classification of insect pests, their feeding habits and damage symptoms
iii) Illustrations of various insect pests
iv) Field/laboratory practicals on identification of insect pests and damage symptoms
v) Demonstration on scouting, stripping, de-suckering, use of a spoke

Teaching aids / materials

i) Trainers Manual, slides
ii) Flip chart/ white board and marker pens
iii) Insect pest specimens and damaged stems
iv) Dummies of various insecticides
v) Spraying equipment, protective clothing

9.1 Introduction

Globally, about 1000 insect pest species infest coffee of which 35 are known to attack coffee in Kenya. Of these, some are major while others are minor.

9.2 Economic importance of Insect pests

Insect pests infest coffee flowers, berries, leaves, branches, stems and roots. This leads to reduction of yield and quality. For instance, yield losses as high as 96% have been reported in Africa as a result of Coffee berry borer infestation while a crop loss of 15-27% in total bean weight has been associated with an infestation of 2 - 4 Antestia bugs per tree.

9.3 Classification of Insect pests

9.3.1 Major insect pests

The major coffee insect pests are Antestia Bug, Coffee Berry Borer (CBB), Thrips, Coffee Scales (Green scales, Mealy bugs), Stem Borers (White Stem Borer, Yellow headed Borer), Berry moth, Leaf miner, Root mealybug, and Giant Loopers.

9.2.2 Minor insect pests

Minor insect pests include Capsid bugs, Systates weevil, White Waxy scales, Brown scales, Mites and Cottony scales among others

9.4 Pests Scouting and IPM

- Pest scouting refers to random survey of pest presence and population level and is critical in pest management
- For effective pest management, it is important to take into consideration the economic threshold levels (ETL) i.e. the pest population level beyond which if not controlled is likely to cause crop loss which exceeds the cost of control with an insecticide
- To manage the pests, it is recommended that an integrated pest management (IPM) approach be practiced
- IPM entails combining several pest control methods such as biological (use of biological control agents), cultural and chemical (use of insecticides and bio-pesticides))

It is important to avoid unnecessary insecticide sprays in order to conserve the beneficial insects or natural enemies

9.5 Management of prevalent insect pests

9.5.1. Antestia Bug

It is a broad insect, up to 6mm long (¼ inch long), dark brown in colour with orange and white markings

Symptoms and damage

- Buds leading to abortion
- Rotting of beans within the berries
- Fan branching and short internodes on terminal growth
- Characteristic zebra pattern on beans that grow to maturity causing the beans to be of low quality

Antestia bugs

Good coffee parchment

Antestia damaged beans

Management

Cultural control

- Timely pruning, handling and de-suckering

Chemical control

- Spray when the pest population reaches 2 bugs per tree for East of Rift Valley and 1 bug per tree for West of Rift Valley using any of the PCPB registered insecticides

9.5.2 Coffee Berry Borer (CBB) Symptoms and damage

- One or two small round holes appear near the apex of mature green or ripe berries.
- Adult females and the larvae cause damage by feeding inside the mature berries causing the inside of the fruit to rot
- Damaged beans has distinctive blue-green stains and may contain up to 20 larvae of different sizes

Berry borers

Berry Borer damage

Management

Cultural

- Regular Pruning
- Practice field hygiene by collecting infested fallen berries to avoid the berries becoming breeding reservoir for CBB
- Strip all the remaining berries at the end of the harvest season. If infested, bury or burn them
- Avoid over-shading (self-shading or bushiness) in order to enhance searching capacity of natural enemies on CBB

Chemical

Ensure timely spraying twice at 3 weeks interval (15th and 18th week from the main flowering (blossoming) using any of the PCPB registered insecticides. This to apply where infestation was severe (above 5%) in the previous season

Integrated method

Use of pheromone traps (Brocap traps) – The traps contain ethanol- methanol (50:50)+ acid fuchsine +Britex 80ppm mixture that attract the CBB

Brocap trap

9.5.3 Thrips

Brocap trap

Symptoms and damage

- White silvery patches with minute black spots on leaves, berries and green shoots
- Heavy infestation cause death of leaves or total leaf fall


Thrips damage

Management

Cultural control

- Mulching, shading and irrigation
- Use of sticky traps

Chemical control

- Spray using a PCPB registered insecticide at ETL of 1-2 per leaf when there is drought and 2-3 when there are rains.

9.5.4 Green scales, Mealy bugs and other scales

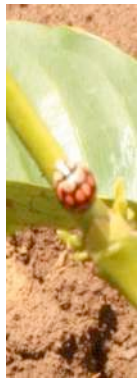
Scales and Mealy bugs suck plant sap causing reduction in coffee production and quality. The management of Green scales, Brown scales, White waxy scales and the

Kenya mealy bugs is similar. Lady birds commonly predate the scales and mealy bugs

Symptoms and damage

- Rows of flat oval Green scales along main leaf veins and near tips of green shoots
- Mealy white masses of insects (Mealy bugs) between clusters of berries and/or flower buds
- Sticky honey dew and sooty mould growing on leaves
- Presence of attendant ants climbing on infested coffee trees


Green scales infestation




Lady bugs


Kenya mealy bugs infestation

Management

Cultural control

- De-suckering and removal of branches touching the ground
- Proper weeding to avoid weeds becoming bridges for the ants

Biological control

- Natural enemies such as parasitoids, parasites, predators and fungal pathogens attack the Scales thus reducing their infestation

Chemical control

- Under severe infestation, spray the infested trees (spot spraying) with a PCPB registered insecticide such as mineral oil e.g. white oil or DC- Tron plus (100ml in 20 litres of water) or any other PCPB registered product for this pest
- Under severe infestation, spray the infested trees (spot spraying) with mineral oil e.g. white oil or DC-Tron plus (100ml in 20 litres of water)

Integrated method

- Combines the cultural, biological and chemical methods. Coffee trees infested by scales are banded (Chemical control) 6 inch at the base of the trunk with a PCPB registered insecticide. Followed by removal of any branches (cultural control) touching the ground that act as the bridges for attendant ants. This creates favourable conditions for natural enemies (Biological control) to attack the scales.

9.5.5 White Stem Borer Symptoms and damage

- Wood shavings extruded by larvae burrowing in the stem
- Ring barking at the base of the trunk
- Oblong holes visible on the trunks left by larvae after entering the trunk
- Visible round holes on trunks left by emerging adults
- Yellowing of foliage and eventual death of trees

White borer damage and frass

White borer adult and larvae

Management

Mechanical control

- Kill the larva(e) that is already in the stem by inserting a wire/spoke into the tunnel
- Physically collect and kill the beetle at the onset of rains

Chemical control

- Paint or spray a 90 cm band above the ground on coffee trunk with a PCPB registered insecticide. Repeat after one year and every second year.
- Insert a cotton ball soaked in an insecticide through the tunnel in incidences where the larva has entered into the stem.

9.5.6 Yellow headed borer Symptoms and damage

- Wilted tips of primary branches
- Ejected frass (Sawdust like) visible on the ground
- Series of holes on the underside of primary branches and on the main stem
- Breaking of branches especially when trees carries a heavy crop

Yellow headed borer adult

Larva

damage

Management

Cultural control

- Cut off infested primaries and burn them
- Kill the larva(e) already in the stem by inserting a wire/spoke at the last hole downwards
- Remove and burn the heavily infested heads

Chemical control

- Enlarge the lowest hole and use a pen filler or an oil can to squirt in any PCPB registered insecticide

9.5.7 Berry moth

The larva is a reddish caterpillar 12mm (1/2 inch) long when fully grown.

Symptoms and damage
Webbed berry clusters with one or more berries being brownish black, dry and hollow

Berry moth adults

larva

Berry moth damage

Management

Cultural control
- Remove infested berries. Destroy them by burning or deep burying

Chemical control
- Spray with a PCPB registered insecticide and repeat 5-6 weeks later if buds or young berries are being infested. Scout for the pest soon after main flowering.

9.5.8 Leaf Miner

The pest is most common in the East of the Rift Valley.

Symptoms and damage
Irregular brown blotches on the upper side of the leaves, covering white caterpillars of size 12 mm (½ in) long within the "mine".

Leaf Miner damage

Management

Chemical control

- Use recommended systemic insecticides that are ground/soil applied
- Foliar spray biological PCPB registered insecticides (Insect Growth Regulators - IGR's)

9.5.9 Root Mealybug Symptoms and damage

- Wilted and yellowish Leaves
- Stunted Roots that are encased in clusters of greenish and white fungal tissue
- White mealy bugs visible after peeling off the fungus.

Management

Cultural control

- Uproot infested trees, leave the holes open for 3 months and replant as recommended under coffee establishment

Chemical control

- Apply the PCPB registered insecticide during establishment and/or infilling
- Ground application along the drip line of infested coffee trees with PCPB registered insecticides. This to be applied when soils are wet

9.5.10 Capsid Bug

This is a common coffee pest in all coffee growing regions

Symptoms and damage

- Blackening of flower buds due to death of stamens and petals
- Club shaped elongated style with pale green shaft and black head

Management

Chemical control

- Use any PCPB registered insecticides

Biological control

- The nymphal stages are attacked by endo-parasites
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9.5.11 Giant Looper

Giant Looper is a widely distributed pest. It is associated with heavy use of Organo-phosphates. The caterpillars are Pale grey to dark brown in colour and they resemble the twigs. They measure 5 cm (2 in) when fully grown. They move with looping motion

Symptoms and damage

- Young caterpillars perforate pits on the leaf surface usually on the upper side.
- Jagged edge leaf margins eaten by older caterpillars.
- Caterpillars prefer young leaves but they also feed on berries and large flower buds.

Management

Chemical control

- Spray the infested coffee trees with PCPB registered bio- pesticides

Mechanical/Physical control

- Manually, collect and kill the caterpillars

Biological control

- The caterpillars are attacked by various predators and parasitic wasps

9.5.12 Other coffee insect pests

Other coffee insect pests that are not of much economic importance include, Jelly grub, Green Loopers, Dusty Brown Beeetle, Fruit fly, Yellow, Green and Red Tortrix, Black Borer, Fried Egg scales, White Waxy scales, Mites, Lacebug, Tip borer, Black borer, Leaf Skelotonizer, Systates weevil, Tailed caterpillar, Stinging caterpillar, Berry butterfly and Cottony scales. These pests occur sporadically and are associated with indiscriminate use of insecticides which leads to elimination of natural enemies such as Ladybird beetles. Consequently, the pest population increases to a level warranting chemical control.

9.6 Responsible use of pesticides

This is the use of pesticides in a way that will not be detrimental to human beings, animals and the environment e.g. water bodies (streams and lakes), soils and beneficial organisms.

Pesticide classification

Class	Description	Label Signal words	Pesticide colour code
Ia	Extremely hazardous	DANGER, POISON, PLUS SKULL AND CROSS BONES SYMBOL	
Ib	Highly hazardous		
II	Moderately hazardous	WARNING/HARMFUL	
III	Slightly hazardous	USE WITH CARE	
IV	Unlikely to present acute hazard in normal use	CAUTION	

Source: World Health Organization (WHO)

9.6.1 Chemical poisoning and First Aid measures

- Chemicals can poison both animals and human beings and may enter into the body system through:
  - **Inhalation** – through the nose
  - **Dermal** – through the skin
  - **Ingestion** – through the mouth
  - **Inoculation** – through wounds and rashes
- Symptoms of chemical poisoning include abdominal pains, dizziness, difficulty in breathing, skin rash, nausea and vomiting
- If the poison was inhaled, move the person so that they can inhale fresh air, but be careful not to expose yourself to the chemical fumes while doing so. If the person is not breathing, call emergency services and start mouth to mouth resuscitation
- In case of ingestion, administer a poison absorbent e.g. activated charcoal mixed with water to absorb the chemical and induce vomiting
- If the poison came into contact with the person's eye, flush the eye with running water for 15 minutes and call for emergency services
- If the poison came into contact with the person's skin, remove any contaminated clothing taking care not to touch the poison. Flood the skin with running water and wash gently with soap
- Seek medical advice and carry the label/container with you

9.6.2 Precautions for purchase, transportation and storage of pesticides

- Purchase reputable products which are labelled in Kiswahili and English. The labels should have the following information:
  - Name of the pesticide
  - Chemical formulation e.g. EC, WP, G
  - Manufacturing/expiry dates
  - Instructions - rate and method of application, precautions, target pest, timing and frequency of application
  - Hazard classification
  - PCPB registration number
  - AAK logo
- Do not purchase chemicals in damaged packages
- Do not carry pesticides in a vehicle that is also used to transport food
- Store pesticides in a place that can be locked and is not accessible to unauthorised people or children
- Pesticides should always be kept in their original containers in a place where they cannot be confused for food or drink

9.6.3 Effective and safe use of chemicals

- Read the label carefully and strictly follow the instructions
- Do not purchase any chemicals without labels
- Always use protective clothing while handling chemicals. This includes overall/ apron, rubber boots, rubber gloves, goggles, respirators/ facemask, hat and a face shield
- Spray towards the wind direction
- Use red flags as labels to indicate where chemicals have been sprayed
- Do not smoke while spraying or handling pesticides
- Wash your body thoroughly after using chemicals
- Do not eat before washing your hands
- Dig a disposal hole at least 100 meters away from streams, wells and houses. In a hilly area, the hole should be on the lower side of the homestead or wells
- Left-over pesticide suspension and hand/sprayer washings should be disposed off safely by pouring into the hole
- Place a cover on the hole
- Card board, paper and cleaned plastic containers can be burned far away from houses and sources of drinking water
- Empty containers should be triple rinsed into the spray tank, punctured and buried or burnt
- Never re-use pesticide containers
- Never discard pesticide containers in the homestead disposal pit

Appropriate protective clothing

Correct and incorrect way of mixing chemicals

9.6.4 Proper disposal of obsolete pesticides

- Obsolete pesticides are those that have expired or have been banned
- Dispose obsolete pesticides in a hole away from water bodies or take them back to distributor/manufacturer
- Empty pesticide bottles should be triple rinsed, punched and buried or collected for disposal

9.6.5 Highlights on responsible and effective use of pesticides

- Breast-feeding and expectant mothers should not handle chemicals
- Chemicals pause a serious health hazard to both the humans and the environment and therefore should be used only if necessary and also in the appropriate minimum amount
- Avoid contamination of any natural resources e.g. streams, ponds and wetlands
- Keep the chemical spray equipment clean after use but ensure the waste water does not contaminate water sources e.g. river, springs
- Have a separate store for chemical storage alone. The store should be well lit, ventilated, rain proofed and well labelled
- Store chemicals in the light order and in a manner not likely to cause spillages
- Keep the stores under lock and key and only allow authorized personnel
- Have a display of procedures for emergency handling and first aid
- People handling glyphosates should undergo health check-ups yearly

Module 10: Primary Coffee Processing

Objective

To enable learners understand all aspects of primary processing of coffee in order to maintain the quality of harvested cherries throughout the process

Content

i) Cherry harvesting - Selective picking, cleanliness of harvesting containers, protection from the direct sun light and cherry transportation
ii) Cherry sorting - avoiding contamination, what to sort, weighing and what to do with the sorted beans
iii) Pulping and pre-grading - definition, machine cleanliness, when to pulp, pre- grading and water re-circulation
iv) Fermentation and intermediate washing - why ferment, shading fermentation tanks, fermentation period, intermediate washing, grittiness as an indication complete fermentation and maintenance of fermentation tanks
v) Final washing and grading of parchment - Use of paddles, grading by parchment density, parchment soaking
vi) Parchment drying - skin drying, white stage, soft black stage, medium black stage, hard black stage and conditioning
vii) The semi-washed processing method - eco-pulper as a water saving technology and the process
viii) Processing at small and medium estate farms - Use of hand/motorized pulpers, fermentation containers, grading and soaking
ix) Storage of parchment - ventilated bins, avoiding moisture reabsorption, insulation from heat, sorting of defects and storage duration
x) Factory hygiene and maintenance - repairs, painting, cleanliness and general hygiene
xi) Coffee waste management - use of seepage tanks, minimizing water usage, maintenance of seepage tanks, use of pulp
xii) Important considerations in coffee processing - harvesting of roof water, use of final washing water, managing dull weather and avoiding contamination
xiii) Buni drying - what and how to dry, avoiding rewetting, avoiding mixing of different stages and final buni moisture content
xiv) Common errors on pulper settings and their remedies - errors, causes and remedies

Methodology

i) Class lecture/field trainings sessions
ii) Discussions on various practices being carried out currently
iii) Demonstration on sorting, checking completion of fermentation and grading by density and gravity
iv) Group work practical sessions in a coffee factory setup

Teaching aids/materials

i) Trainers' manual/training posters
ii) Laptop/Projector, flip chart/white board and marker pens
iii) A moisture meter
iv) Illustrations of an eco-pulper, hand pulper and a motorized hand pulper
v) Some cherries -red ripe, Under-ripe, over-ripe, small cherries
vi) Some parchment and pulp

10.1 Introduction

Proper coffee processing is important as it sustains bean quality and thus assures better prices to growers. There are two methods of coffee processing namely wet and dry methods. Wet processing is the pre-dominant practice in Kenya. The process involves a series of stages and each must be undertaken in the right manner and with facilities which are in good order. The stages are:

10.2 Cherry harvesting

- Ensure timely and selective picking of bright red cherry. Avoid picking green and under-ripe berries which may cause pulping and fermentation problems
- Use clean harvesting bags, baskets or tins
- Avoid dropping cherry on bare ground during picking
- The harvested cherry should be kept under shade to protect it from direct sun
- Cherry should be transported in clean containers/bags
- Transportation of cherry to the factory should be done on the same day of harvesting
- Its important to note that the Kenyan law does not allow children to pick coffee

Cherry harvesting – pick only the red ripe

10.3 Cherry sorting

- Spread the cherry on a clean material/floor to avoid contamination
- Remove the green, under/over ripe, dry, insect infested/diseased berries, twigs, leaves and any other foreign materials such as stones
- Weigh and record the sorted cherry
- Process the sorted out lower grade cherry (under ripes, over ripes and greens) by the dry method as Buni

Cherry sorting

Sorted out leaves and cherries

10.4 Pulping and pre-grading

- Pulping involves the removal of the outer red skin (pulp) of the cherry
- The pulping machine used should be clean, in good mechanical order and well-adjusted depending on the size of beans
- Control the cherry feed rate to avoid overfeed that may cause too much pulp in the parchment
- Pulping should be done on the same day of cherry harvesting
- Processing water must be clean, free from colour and odours
- During pulping, pre-grade coffee parchment into heavy and light beans
- Re-circulate processing water to enhance subsequent fermentation. Dispose off the re-circulated water every day after pulping
- Flush the pulping system with clean water immediately after pulping

10.5 Fermentation and intermediate washing

10.5.1 Fermentation

- This is done to break down the mucilage into simple non sticky substances which are easily washed off from the coffee beans
- Mucilage attracts dust, taints coffee, inhibits drying and is a media of mould growth, all of which affect bean quality. Its removal is therefore important for drying
- Place the different grades of parchment in separate fermentation tanks. The tanks should be shaded to protect the parchment from direct sunlight and rainfall
- Fermentation is complete when parchment feels gritty and is no longer slippery upon pressing between fingers. To test, put some fermented parchment in a bowl, add enough water, wash and check for grittiness.
- Drain all the water and leave the parchment to ferment for about 16 hours and monitor closely till fermentation is complete. Warm weather conditions and re- circulation of pulping water quickens the process.
- The depth of parchment in fermentation tanks should not exceed 1 metre
- Always ensure that the fermentation tanks are free from cracks and are well painted with appropriate paints (eg epoxy/epilex paints) or non-acid corrosive/clay tiles which are acid resistant and compliant with health standards

Well painted fermentation tanks

Parchment fermentation

10.5.2 Intermediate washing

- This is normally done approximately 16 hours after pulping
- Wash the parchment in the fermentation tanks to remove the degraded mucilage and drain the water to allow fermentation to continue if necessary
- The fermentation procedure should be 'dry', followed by intermediate washing (after about 16 hours or so), then 4 to 6 hours of further dry fermentation if necessary, until the gritty feel is achieved

10.6 Final washing and grading of parchment

- Once fermentation is complete, fill the tank with clean water, stir vigorously with paddles, drain off the water and repeat several times to assist in detaching the mucilage from the parchment
- Wash the parchment thoroughly on well painted concrete channels using clean water and rubber paddles/squeezers
- Push the parchment against a stream of water to clean and grade it into parchment 1, 2, 3 and lights (PL)
- Take Parchment 3 and lights to the skin drying tables
- Put parchment 1 and 2 under water in separate soak tanks overnight. Thereafter, wash and take the parchment to the skin drying tables
- If the drying tables are inadequate, one may soak for longer periods, changing the water daily but usually not more than 7 days

10.7 Parchment drying

10.7.1 Skin drying of parchment (55 – 45% MC)

This is the removal of surface water and that between the parchment hull and the bean. It should be executed within the shortest time possible (2-3 hrs in a normal day). Parchment should not be left on the skin drying tables overnight

- Maintain a parchment layer of approximately 1 inch for even drying
- Frequently stir the parchment to enhance water removal and prevent parchment cracking
- Mechanical drying can be done if facilities allow.
- Sort out defective beans since they are easily distinguishable during this stage
- Transfer the parchment to the final drying beds when the skin of the parchment is free of surface moisture as well as beneath the hull
- Maintain drying tables in clean condition and absolutely flat for even drying
- Clear all leftover beans on the beds before placing new wet parchment

10.7.2 White stage (45-30% M.C)

- The beans are white when the parchment skin is removed
- Place the parchment on drying beds lined with sisaltex, hessian cloth, tilder/shade net maintaining a parchment depth of about 2.5 cm (1 inch)
- Practice slow and cool drying to avoid cracking
- Spread the parchment in a thin layer and stir regularly during the morning hours and in the evening
- Ideally, in the hot part of the day, a raised shade cover should be put in place to allow free air movement. Else, pile coffee into a ridge of about 4-5 inches deep along the centre of the table and stir regularly

- Finalise the sorting out of the damaged and defective beans
- In the evening and during rainy weather, cover the parchment with both hessian cloth and nylex
- Avoid dropping parchment on bare ground or on the grass. Any parchment collected should be put in the parchment light category

Parchment drying

Mettalic drying tables

10.7.3 Soft black stage (30 -20% M.C)

- At this stage the beans are soft and translucent
- The parchment depth can be increased to about 5cm
- Expose the parchment to sunlight for about 50 hours of actual sunshine
- Sun light is essential in the formation of the final bluish-green colour of the bean at this stage. Mechanical drying is not recommended

10.7.4 Medium black stage (20 -16% M.C)

- The beans are fairly dark and hard
- In case of congestion, temporary storage in ventilated bins is permitted
- Parchment can be dried rapidly without loss of quality and mechanical driers can be used

10.7.5 Hard black stage (16 -11% M.C)

- Fully hard beans and dark in colour
- Can be dried rapidly without loss of quality

10.7.6 Conditioning (11-10.5% M.C)

- This is normally done in ventilated stores or bins to even out moisture level
- The parchment is ready for storage when it has a moisture content of 11 to 10.5%. Use a well calibrated moisture meter to measure the moisture content in order to avoid over or under-drying

Moisture meter

Conditioning bin

10.8 The semi-washed processing method

- This process combines pulping and mechanical removal of mucilage by friction or attrition in one operation by use of eco-pulpers
- The mucilage is removed immediately after pulping using a demucilager
- Wash off any mucilage mixed with the parchment and soak the parchment under water overnight to improve the quality of the beans
- Grading can be done before the soaking to separate the different parchment grades. Soak P1. P2 can also be soaked if space allows

Eco – pulpers

10.9 Processing at small and medium estate farms

- In small and medium estate farms, drum pulpers, hand and motorized pulpers can be used for pulping
- Fermentation can be done in hard plastic containers. Fill the parchment up to
- ¾ depth to enable intermediate washing and final washing.
- The pulping yields mixed grades of parchment. After the fermentation, grading can be done if the farmer has grading channels. Soak P1 and P2 under water overnight before drying. Else, soak the whole lot

Drum pulper

Hand pulper

Motorised pulper

10.10 Storage of parchment

- Store bulk coffee in well ventilated bins or on wooden floors and stir regularly
- Place coffee bags on wooden pallets 15cm from walls and floors
- The coffee store must be well ventilated and corrugated iron sheet roof adequately insulated to minimize heat transfer
- Avoid storing coffee parchment in the same store with buni
- Avoid pro-longed storage as this leads to quality loss. Over stored parchment becomes "woody" after six months of normal storage in the factory
- In the event that sorting was not adequately done during the skin drying and white stage, it is important to sort the coffee before bagging and final delivery to the mills

N/B : Avoid the use of herbicides as a means of weed control at the wet mills

Storage on wooden pallets

10.11 Important considerations in coffee processing

- Fermentation tanks should be roofed to avoid direct sun
- Clean water can be harvested from the roofs during the rainy season and used for soaking P1 and P2
- Store the water used in final washing for pulping cherry the same day
- In cool, dull weather concentrate on drying the wettest coffee
- Nearly dry coffee (Medium black stage) can be placed in store to give space for wet coffee. Do not forget to take out this coffee when drying conditions improve
- Always wash your hands before handling the coffee
- Do not allow animals in the coffee processing area to avoid off-flavours

10.12 Factory Hygiene and maintenance

- All the factory operators, equipment and materials must be clean. Do not smoke or apply perfumes during processing
- The recommended maintenance procedures e.g. painting, repair of channels and cherry hoppers should be strictly adhered to.
- Wash the pulper immediately after pulping
- Ensure no berries are left out from previous days pulping on the processing lines to avoid formation of stinkers
- Clean the stores at the beginning of the season – remove dirt and old parchment
- Do not store any chemicals or fuels in a coffee store. Coffee beans can absorb odours thus affecting quality negatively

10.13 Coffee waste management

- Channel the waste water to the seepage/soak pits which should be located away from water bodies
- Minimize water usage by re-circulating pulping water and using the final grading water for pulping
- Remove the sludge from the bottom and sides of the seepage pits annually
- Pulp should be separated from waste water and the waste water should not be left to flow to water bodies
- The pulp should be composted and used in farms. Alternatively, the pulp can be used to produce bio-gas


Seepage pits

10.14 Buni drying (dry processing)

- Although wet processing is the most common practice in Kenya, dry processing is done for overripe, under ripe, stripping and in situations where wet processing facilities are not available
- Start drying cherry on a clean and well drained surface after harvesting. e.g. on a concrete surface
- Dry buni on raised surfaces or drying tables and cover with rain proof materials when there is rain to avoid re-wetting. This prevents mould growth
- Avoid mixing freshly picked or sorted out cherry with the drying ones. Each batch of buni should be dried separately to avoid mixed drying
- Ensure buni is properly dried to a moisture content of 12%

Correct Buni drying – on raised surface

Incorrect drying – on the soil

Moulds on Buni

10.15 Common errors on pulper settings and their remedies

Error	Causes	Remedies
Unpulped cherry passing through the pulper / repasser	Knives / Plough too far from the disc Too small beans	Adjust plough closer Proper sorting
Nipping of beans	Knives / plough too close to disc under-ripes, over-ripes	Adjust the plough / knife wider (a used hacksaw blade size), check and replace bearings
Whole cherry lost with pulp	Knife set too far from the disc	Adjust knife setting as above
Excess pulp in pulped coffee	Worn out disc surfaces Too high cherry feed rate into pulper	Re-spray discs Reduce feed rate
Disks rotates backwards	Reversed discs orientation during installation	Change disc orientation
Intermittent ringing sound coming from pulper	Knives set too close to loose disc shaft Cover plates touching disc Hard object trapped between disc and plough disc	Reset Knives correctly Check shaft bearings Correct by adjusting Remove the object

Module 11: Secondary Processing, Quality Assessment and Marketing

Objective

i) To impart knowledge on the necessary processes required for preparation of coffee for the market while retaining the quality attained from the farm
ii) To indicate the various marketing channels available for coffee farmers in order to realise the highest returns possible

Content

i) Introduction
ii) Secondary processing –preparations, bagging and weighing, transportation, weighbridge tickets, sampling, pre-cleaning, hulling and polishing
iii) Grading – purpose, parameters of grading, main grades and other grades
iv) Storage/warehousing – purpose, use of pallets and duration of storage
v) Quality assessment – attributes considered, quality descriptors and the liquoring procedure
vi) Coffee defects - types of defects, origin / causes and their remedies
vii) Coffee marketing – appointment of marketing agents, setting of reserve price, sale of noted coffee, Nairobi coffee exchange, direct sales and the Kenya coffee mark of origin

Methodology

i) Class lecture
ii) Demonstrations of the hulling, grading and the quality assessment
iii) Group work practical sessions preferably in a coffee mill/quality laboratory
iv) Visits to Nairobi coffee exchange

Teaching aids/materials

i) Samples of parchment, various grades of green coffee, defects, roasted beans, roasted and ground beans
ii) Illustrations of hullers and grading screens
iii) Illustrations of roasters, grinders and cupping apparatus
iv) Illustration of organoleptic quality assessment organ – the tongue sensory segments
v) A sample catalogue and a marketing agreement
vi) Illustration of the Kenya coffee mark of origin

11.1 Introduction

After the primary processing, the next step in the coffee value chain is secondary processing as a preparation for marketing of coffee. Quality assessment precedes determination of price.

11.2 Secondary processing

Secondary coffee processing entails parchment milling, grading and classification of clean coffee. Prior to delivery of coffee for milling, a grower should ensure that a signed milling agreement has been registered at the coffee directorate. The milling agreement should clearly indicate what the parties have negotiated and agreed on, in terms of milling charges and other charges associated with milling process.

11.2.1 Preparations

Booking Slip

This is a document obtained from the mill confirming the date of intended coffee delivery

Movement Permit

This is a document issued by the Coffee Directorate/ County Government authorizing coffee movement within a specified time as specified in the booking slip. It is a must for this document to be issued before any coffee deliveries are made

Bagging

- Before bagging, the parchment should be confirmed dry. This enables the husk to be removed more easily
- Use clean, odor free sisal or jute bags for coffee as approved by KEBS
- Avoid using bags that have been used for chemicals or for animal feed

Weighing

- Weigh the parchment using a calibrated weighing machine before delivery
- Take into account the weight of the empty bag (usually 1 kg)

Grower delivery notes

- This document details the type and quantity of parchment to be transported to the mill by a vehicle at a time.
- It is filled in duplicate at the farm/ factory before transportation - one copy to the mills while the other remains at the farm/factory.

11.2.2 Transportation

- The vehicle must be visibly clean, dry and free of odours before loading
- Ensure there is a good tarpaulin to cover the parchment against rain and dust
- The body of the vehicle to be used for parchment transportation should not have protrusions that may cause bag damage resulting in spillage
- Sisal or jute bags are recommended for maintenance of quality
- Insurance cover is important to consider while coffee is on transit
- Armed security escort is recommended when transporting coffee.

11.2.3 Weighbridge tickets

When a vehicle transporting coffee arrives at the mill it is weighed before proceeding to the off-loading bay. A second reading is taken when the vehicle has been off-loaded. The empty parchment delivery bags are weighed separately

11.2.4 Sampling

- At the off-loading bay, a sample (1 kg) is taken from different bags to determine the pre-milling conditions of the coffee including the moisture content (MC)
- The ideal final moisture content is 10.5-11%. Moisture content lower than 10.5% leads to loss of weight. If the moisture content is higher than 11%, the parchment will undergo further drying by either the miller at a cost or taken back by the grower for further drying. After drying, the coffee is re-weighed to establish the final weight of the coffee delivered by the grower
- Upon confirmation that the MC is conducive for milling, the consignment is weighed and entered into the tracking system of the mill by being assigned a unique identification number called an outturn number
- Based on the pre-milling analysis, a milling order is given considering a millable lot of 50 bags of parchment. Below the millable lot, coffee is bulked based on its cup profile and green bean analysis.

11.2.5 Pre-cleaning

This is done to protect the equipment and ensure a clean product is obtained. It entails the removal of all foreign objects such as stones, nails, hair, etc

11.2.6 Milling

- Milling involves hulling, polishing and sorting of defects. Hulling is the removal of husk while polishing is the removal of silver skin from the clean/green bean surface. Milling yields a mixture of beans of various sizes, shapes and density
- On average, the milling losses (quantity of husk) for various parchment grades are 20% for parchment one (P1), 22% for P2, 32% for P3, 38% for PL and 50% for Buni

A coffee mill

11.2.7 Grading

GRADE	SCREEN NUMBER ON WHICH BEANS ARE RETAINED, SIZES AS PER ISO 4150*
E (elephant) Two beans joined together, it is a genetic defect. And includes very large (bold) AA.	Retained on 21 (size diameter 8,3 mm)
PB Peaberries One ovule develops instead of the usual two	Through 17 retained on 12 (4,76 mm)
AA Flat beans	Through 21 retained on 18 (7,2 mm)
AB Flat beans	Through 18 retained on 16 (6,35 mm)
C Smaller beans	Through 16 retained on 10 (3,96 mm)
TT Light density beans, from AA, AB and E grades by air extraction	
T Smallest, consists of brokens and small C	Through screen No.7 (2,9 mm)

Other Categories	
HE	Broken hulled ears from grade E
UG1 and UG2	ungraded coffee comes from P3 and PL coffee.
Grading of dry processed coffee is as follows	
MH	Mbuni Heavy
ML	Mbuni Light

11.2.8 Storage/warehousing

- Coffee Warehouse means any building, structure or other protected enclosure duly licensed by the relevant authority to be used for the storage or conditioning of coffee for the purposes of trading at the Exchange.
- It is specifically designed to ensure that the quantity, quality and safety of the coffee is maintained. Good storage should ensure that the commercial value is maintained for as long as possible
- The clean coffee is bagged into 61.2kg per bag. Bags are stacked on wooden pallets 0.5ft above ground level and 0.5ft away from the walls. Maximum care is taken to make sure that the coffee does not absorb moisture. This storage is done for a maximum of 6 months
- Warehouses store coffee on behalf of the farmer / buyer and play the role of coffee warrants preparation - legal titles of coffee under their custody
- Clean coffee is stored in the warehouse depending on the grade

Coffee warehousing

11.3 Quality assessment

Coffee classification in Kenya is done through cupping (liquoring). Cupping is a method used to systematically evaluate the aroma and the taste characteristics of coffee through taste sense (organoleptic method). This is the Devonshire method of classification

11.3.1 Attributes considered in quality assessment

In a coffee sample, several attributes are considered in order to determine the overall quality. These are;

The raw bean quality – the size of the beans, the color and the defects

- The size of bean is determined by the feeding regime
- Color ranges from bluish green to brown. It depends on geographical origin, age, processing, storage conditions and maturity of cherry at harvest

The quality of the roast - The type of roast, the center cut and defects present. Good quality beans have a white center cut

The cup quality - Acidity, body, flavor, off-flavors

- **Acidity -** Pleasing brightness or sharpness of coffee like for lemons, limes and orange. Acidity can be intense or mild.
- **Body -** The sense of weight or heaviness that coffee exerts in the mouth
- **Flavor -** The simultaneous sensation in the palate of aroma and taste. Good flavors includes:
    - » **Fine -** coffee with distinct quality characteristics e.g. acidity body and flavor
    - » **Pointed -** fine acid sharpness
    - » **Sweet -** a nice clean soft coffee free of any harshness

- **Off-flavors -** defect transmitted to taste properties of flavor. This constitutes the poor cup quality as a result of poor processing and husbandry practices. They include:
    - » **Coarse -** coffee lacking fineness
    - » **Flat -** lifeless coffee lacking in any acidity
    - » **Fruity -** strong overripe taste prevalent in beans left too long in the cherry
    - » **Grassy -** greenish flavor prevalent in coffee harvested when premature
    - » **Sour -** a sharp excessively acidic biting flavor
    - » **Thin -** flat lifeless coffee lacking in body or acidity
    - » **Woody -** hard wood like flavor found in old coffee which has been stored for too long.
    - » **Onion flavor -** delayed skin drying /heaping coffee at skin drying
    - » **Potato flavour -** Antestia and berry borers damaged beans
    - » **Musty -** beans stored in wet places
    - » **Earthy -** wet earth flavor- coffee that had contact with the soil

11.3.2 Quality descriptors

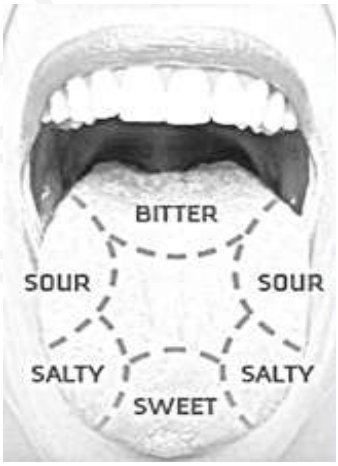
Several descriptors are used in determination of quality. These are;

- **Raw beans**
  - » Size: 1 - 6 Very bold - very small
  - » Colour: 1- 8 Bluish - brown
  - » Defects
    - * Coated : 1-2 Slight - Very
    - * Foxy : 1-2 Slight - Very
    - * Light : 1-2 Slight - Very
    - * Ragged : 1-2 Slight - Very
    - * Under-dried : 1-2 Slight - Very
    - * Unevenly dried : 1-2 Slight - Very
    - * Stinkers: 1-3 Odd - Many
    - * Triple centre cuts: 1-3 Odd - Many
- **Roast**
  - » Type of roast: 0 – 4 Brilliant –Dull
  - » Centre –Cut: 0 – 2White –normal
  - » Remarks
    - * Mixed: 1-2 Slight-Very
    - * Open: 1-2 Slight-Very
    - * Soft: 1-2 Slight-Very
    - * Pales: 1-3 Odd -Many
    - * Softs: 1-3 Odd –Many
- **Liquor**
  - » Acidity 0- 4 Pointed - Lacking
  - » Body : 0 - 4 full - harsh
  - » Flavor: 0 - 12 Fine - Foul
- **Overall Quality:** 0 - 10 Fine-Extremely poor

11.3.3 Coffee liquoring procedure

- Coffee liquoring is done by roasting about 100 to 300 g of clean coffee sample using a standard roaster to medium brown and allowed to cool for about 5 minutes before grinding to medium size particles
- About 10gm of ground coffee is placed in the cup, smelled and aroma noted
- Boiling water is then added to coffee in the cup and smelled again to note the aroma emanating from the cup while stirring gently
- Ground coffee particles are skimmed from the surface of the beverage and the froth discarded
- To perceive the taste, ones makes a rapid seep of the liquor so that it spreads over the whole tongue uniformly
- During tasting, the back of the tongue detects bitterness, the sides detect the sour and saltiness taste while the front detects the sweetness

Sample roaster



Human tongue

11.3.4 Coffee defects

- Amber beans which have yellowish appearance and usually due to iron deficiency
- Antestia damaged beans which have zebra stripes on the parchment when dried
- Black beans which have the surface and the interior partly black, which may arise from faulty drying or poor storage
- Diseased beans which arise from infections particularly from coffee berry disease and other fungal infection in the farm or storage
- Faded coffee which has whitish pale appearance due to mould growth on the surface. This defect occurs when under dried coffee above 11% moisture content is stored in humid conditions
- Foxy beans that have a brownish silver skin that results from wet processing of over ripe cherry
- Green water damaged beans that have a dark seaweed colour with brown and partly black patches. They appear shrunken and small in size. They arise from beans exposed to prolonged moisture in the drying stage. It's a pre- condition stage for the black beans development
- Stinkers - beans from previous lots which were left on the sorting yard, pulper, fermentation tanks, washing channels or pulping area
- Onion flavor coffee that occur as a result of heaping coffee at skin drying stage or prolonged fermentation
- Poor body that arise in coffee that lacks phosphorus in the soil
- Pulper damaged is due to poor setting of pulpier discs, pulping of under ripe and diseased coffee
- Coated - beans are covered with too much silver skin results from drought or overbearing conditions
- Discolored - beans that came in contact with metal. To avoid this, paint all metal surfaces before season commences

Defects originating from the farm

Antestia damage

Berry borer damage

Pods

Amber beans

Defects originating from primary processing

Foxy beans

Stinkers

Pulper damaged beans

Berry borer damage

Coffee defects and off flavours - Causes and remedies

DEFECTS THAT LOWERS THE QUALITY OF COFFEE

Deffect	Appearance and quality effects	Cause	Remedy
From Farm			
Amber beans	Have yellowish appearance and usually develop in the farm where soils are acidic as a result of lack of iron. causes pales in a roast (Quakers) Very thin body and low acidity in the cup.	Iron deficiency in the farm	Correct, maintain Soil pH 4.4 - 5.4 Incorporate ferrous sulphate when spraying copper Process cherry from affected trees separately Control termites
Pods	Empty parchment Small beans	Poor nutrition in the farm	Proper feeding of the plant Sorting
Ragged beans	Have an ugly mis-shaped semi elephant's appearance arising from lack of nitrogen, un -pruned and un weeded coffee or drought -affected coffee which could have been of good grade and quality if there was adequate water. Grassy, straw like taste	Poor nutrition Lack of Nitrogen / Phosphorus, drought, weeds, poor pruning, low pH Drought in the farm	Proper nutrition weeding, pruning, water management Good moisture supply through irrigation when dry and pH correction
Insect damaged beans by berry borer	Bean with holes and tunnels caused by berry borers. The borer burrows into the cherry while still on the tree, tunnelling into the soft seed inside to reproduce. Impacts on the appearance of raw and roasted beans include dirty, sour, or moldy flavors	Damage by berry borer in the farm	Control berry borer
Antestia	Zebra strips are seen on the parchment when dried	Damage by Antestia bugs in the farm	Control of Antestia bugs
Diseased beans	Arise from infections particularly from Coffee Berry Disease and other fungal infection in the farm or farm storage level	CBD and other fungal infections in the farm and factory.	Control CBD

Deffect	Appearance and quality effects	Cause	Remedy
From Processing			
Foxy beans	Have a brownish silver skin that results from wet processing of over -ripe cherry. Over fermented and sour taste	Processing overripe cherry Delay in pulping in the factory	Avoid processing overripe cherry Pulp cherry same day it is picked
Pulper damaged	Pulper damage is due to poor setting of pulper discs, pulping of under-ripe and diseased coffee. Can cause earthly dirty, sour or fermented tastes. Affects appearance of the green and roasted beans	Incorrect setting of pulping knives in the factory. Lack of enough mucilage in the bean	Setting of pulping knives correctly Picking coffee at the right stage
Stinkers	Have a brownish yellow embryo that is destroyed. This is as a result of fungal infection during prolonged fermentation or overheating during early stages particularly the white drying stage Can produce sour, fermented or even a stinker taste, depending on the degree of bean fermentation. Affect appearance of the green beans	Severe form of over fermentation Old beans mixing with fresh coffee Poor sanitation at the factory	Timely fermentation, Use the "gritty feel" principle to determine when fermentation is complete Ensure no beans are left in fermentation tanks, soak tanks channels, or drying beds Maintain cleanliness in fermentation tanks
Musty Coffee/ Green water damaged	Have a dark seaweed colour with brown and partly black patches. They appear shrunken and small in size. They arise from beans exposed to prolonged moisture in the drying stage. It is a pre -condition stage for the black beans development. Stinker taste, dirty , moldy , sour taste	Rewetting dried coffee in stores Heaping under-dried coffee on drying tables. Beans that have been spoilt by moulds at farm. factory and stores	Avoid heaping under-dried coffee Dry coffee to 10.5-11% moisture content Avoid rewetting dried coffee Avoid heaping and covering cherry Shelter drying coffee from rain and dew

Deffect	Appearance and quality effects	Cause	Remedy
From Processing (Cont)			
Hulled Ears	This is a naturally occurring genetic phenomenon. The E grade that is normally two beans fused together separate into the ear and shell	Genetic resulting in elephant beans in the farm, Poor hulling resulting in disintegration of E grade at the mill.	Proper setting of the hulling equipment
Woody coffee (Aged) beans	Are brown in colour with a whitish coating on the surface. Harsh and woody taste.	Occur when hulled coffee is stored for too long in unconditioned stores with extreme temperature and humidity conditions	Avoid prolonged storage of coffee both parchment and clean coffee Deliver coffee to the mills immediately after drying
Softs	Softs	Under drying of coffee Pops during roasting	Dry coffee to correct moisture content

OFF-FLAVOURS DETECTED IN THE CUP THAT LOWERS QUALITY OF COFFEE

Off - Flavour	Causes	Remedies
Onion flavour	Prolonged fermentation Delayed skin drying due to heaping of coffee at skin drying stage	Use the "gritty feel" principle, Maintain a parchment depth of approx. 2.5 cm during skin drying and stir constantly
Potato flavour	Insect damage - Antestia damage	Sort coffee at skin drying or white stage
Earthy flavour	Coffee coming into contact with soil	• Sort coffee on canvas or nylex • Avoid dropping coffee on the ground while harvesting • Pulp coffee picked from the ground separately • Cover coffee during transportation to avoid dust
Fruity flavour	Over-ripe, cherry, Over fermentation	• Process over-ripes separately • Monitor fermentation
Musty flavour	Heaping under dried coffee and rewetting	Maintain proper parchment depth during drying and avoid rewetting
Woody flavour	Prolonged storage	Deliver coffee to the mills immediately after drying
Poor body	Lack of phosphorus in the soil	Soil analysis, application of Phosphorous
Grassy - greenish flavor	Prevalent in coffee harvested when not fully ripe	Harvest only red ripe cherry

11.4 Coffee marketing

There are two coffee marketing channels in Kenya - direct sales and the auction system at the Nairobi Coffee Exchange (NCE). Participants at the two marketing channels are the commercial coffee marketing agents, coffee dealers/traders and the growers

11.4.1 Appointment of marketing agents

- This is a requirement under the coffee regulations and should be done before the beginning of the season. The marketing contract is distinct from the Milling contract
- Some of the key considerations in choosing a marketing agent are fees and services offered such as market access, production support, whether certified or not etc.

Nairobi Coffee Exchange auction floor

Nairobi Coffee Exchange auction screen

11.4.2 Reserve prices

- Set by grower in consultation with the marketing agent
- Referenced on the prevailing prices at the New York Coffee Exchange
- Are based on the qualities of coffee on offer, supply and demand forces and the futures market predictions

11.4.3 Sale of noted coffees

- Noted coffees are those coffees whose final bid price is below the reserve price
- The rules allow for the marketing agents to revert to the final bidder and negotiate an a price or Re-offer the coffee in a space of 2 auctions after the 1st offer

11.4.4 Direct sales

- Should be facilitated by the appointed Marketing Agent
- Requirements:
  - A valid sales contract should exist
  - The prices should be higher than the prevailing NCE (Auction) average for similar qualities
  - Must be registered with Coffee Board of Kenya
  - The farmer ought to be paid within seven working days

11.4.5 Kenya Coffee mark of origin

- To enhance the visibility of Kenya's coffee in the world, the G.o.K through the Coffee Directorate developed the Kenya coffee mark of origin to be used for promotion of Kenya Coffee locally and internationally. Its tagline is "so Rich, so Kenyan"

- The Mark is awarded to coffee products that fulfil the specific standards as prescribed by Agriculture and Food Authority, Coffee Directorate. Stakeholders who wish to brand their coffee with this mark must meet the following minimum requirements:
- They must have a valid registration by the Authority
- The coffee must be 100% of Kenyan origin as demonstrated by the firm and verified by the Authority or its appointed agents
- The coffee must be manufactured and packaged in accordance with coffee industry code of practice, KS 2366:2013
- The coffee complies with other regulatory, as well as statutory requirements which are covered by other monitoring mechanisms

Module 12: Climate Change

Objective

i. To enable the trainees understand climate change, its causes and effects along the coffee value chain
ii. To enhance trainees capacity to adapt and mitigate the effects of climate change in coffee value chain

Content

i) Introduction
ii) Climate change - definition, causes effects of climate change
iii) Global warming - definition, Causes and effects
iv) GHGs
v) Impact of climate change on coffee
vi) Adaptation and mitigation to climate change.

Methodology

i) Lecture sessions on climate change
ii) Focused group discussions on global warming and GHGs emissions
iii) Presentations on climate change, Sharing experiences - prevailing changes on climatic conditions/Countries and regions, alternative energy sources
iv) Case studies

Teaching aids /materials

i) Overhead projector/presentations
ii) Flip chart board
iii) Hand outs
iv) Photos
v) Specimen e.g. crops affected by climate change

12.1 Introduction

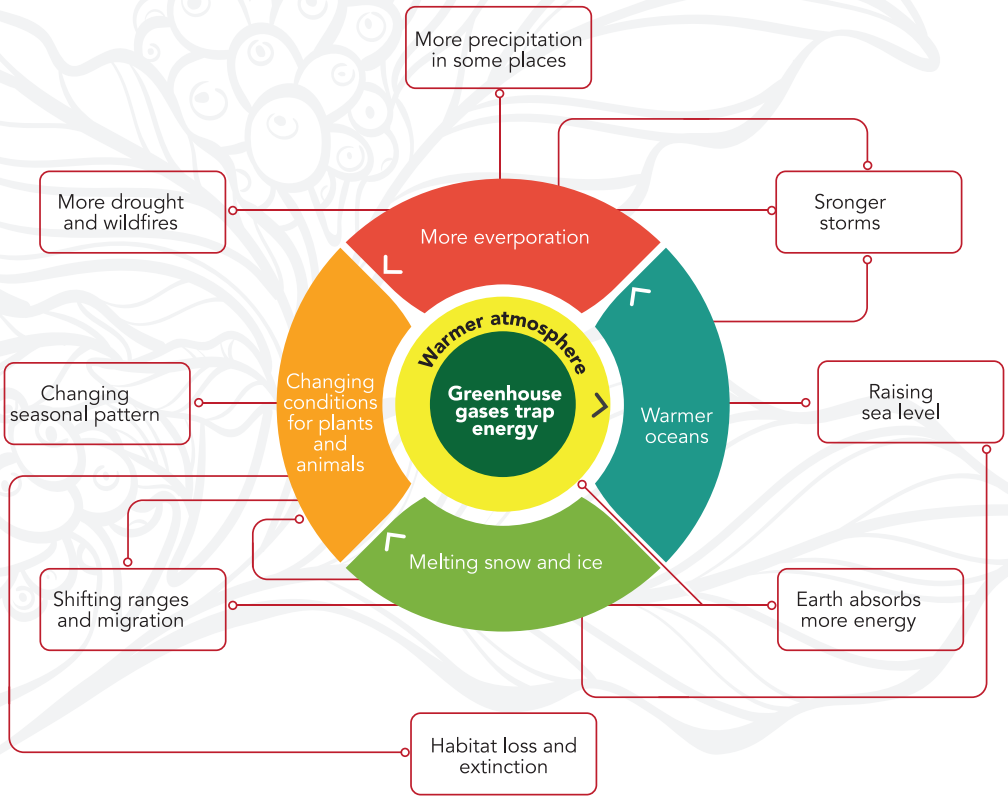
The module outlines the causes of climate change, impact on coffee value chain and existing adaptation and mitigation measures that can be applied to enable coffee farmers minimise the effects of climate change and thus maintain sustainable coffee production.

12.2 Climate Change

Climate change is any significant change in measures of climate such as temperature, precipitation and persists for an extended period of time (IPCC-2007) which may be limited to a specific region or may occur across the whole globe. This

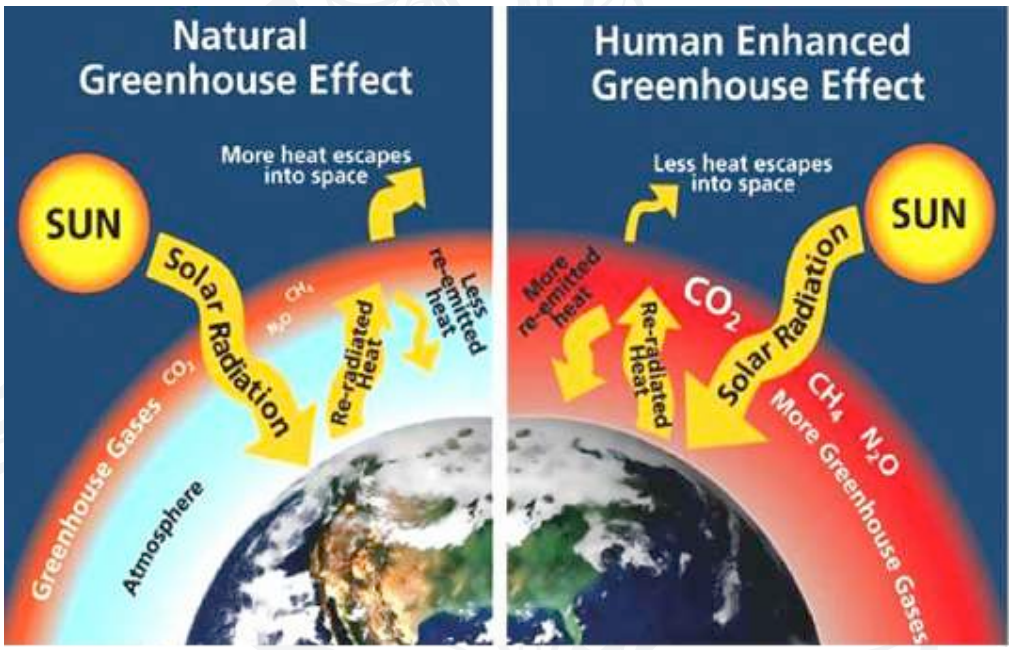
is caused by human activities or natural variability which results into instability of the ecosystem. These changes in turn affects agricultural productivity and hence livelihoods. It is characterized by frequent and prolonged droughts, floods, hailstorms, landslides, thunderstorms and erratic and unreliable rainfall. The connected systems of the sun, earth and oceans, wind, rain and snow, forests, deserts and savanna as shown below.This affects flora and fauna and hence agricultural productivity.

Climate Connections



12.3 Global Warming

Global warming is the slow increase in the average temperatures of earth's atmosphere. It is a result of increased amount of energy (heat) striking the earth from the sun being trapped in the atmosphere and not radiated out into space due to build-up of greenhouse gases. This concept is referred as greenhouse effect as illustrated below



(Source: NOAA – United States of America)

12.4 Causes Global Warming

Global warming is attributed to human activities that have increased the amount of carbon containing gases in the upper atmosphere. The gases released primarily by the burning of fossil fuels and the tiny particles produced by incomplete burning, trap the sun's energy in the atmosphere are known as "greenhouse gases" (GHGs).
Main sectors that produce the greenhouse gases include transport, industrial processes, land use changes, and agriculture.

Industries

Deforestation

Land use (agriculture and forestry) is a major source of greenhouse gases through:-

- Plant and animal respiration - Carbon dioxide is a by-product of respiration
- Soil respiration and decomposition - Plant roots, bacteria, fungi and soil animals use respiration to meet their energy requirements
- Livestock farming - During their normal digestion process they create large amounts of methane.
- Land use changes
    - Natural environment is converted into areas for agricultural land or settlements
    - Deforestation - cleared for timber or burned for conversion to farms and pastures, increases soil erosion and nutrient leaching which reduces ability to act as a carbon sink.

Others - Landfills and poor waste management, Biomass burning, use of fossil fuels, wetlands destruction

The main greenhouse gases include Carbon Dioxide (CO2), Methane (CH4), Nitrous oxide (NO/N2O), Fluorinated gases and Sulphur hexafluoride (SF6)

Change in land use

Biomass burning producing CO2

12.5 Impacts of Climate Change on Coffee

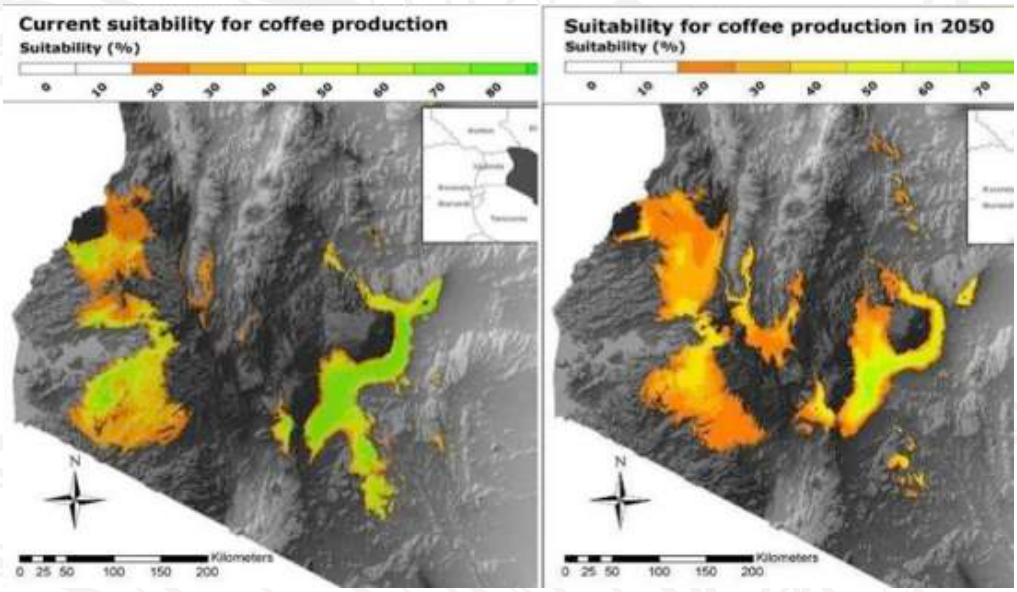
The change in the global climate has severe effects on coffee production which is heavily dependent on specific climatic conditions such as:-.

- A dry period of two (2) months before flowering
- Sufficient moisture to initiate flowering
- Ideal temperatures, Regular rainfall throughout the berry development stage.
- A drier period coming up during harvest to facilitate picking and sun drying

Climate change also broadly impacts on coffee production through:

- Shifting of coffee suitability areas
- Changes in rainfall patterns and temperatures leading to irregular flowering and difficulties in pests and diseases management
- Change in pest and disease incidence by affecting their distribution and severity

The overall impact of these climatic changes is a compromise in yields and quality hence incomes.



Changes of coffee suitability areas in kenya (Source : CIAT)

Different growth stages

Uniform flowering hence growth stages

Direct and indirect effects of extreme or unusual weather events on Coffee Arabica

Climate hazard	Direct impact on the tree	Indirect impact
High temperature	• Above 23°C: Fruit ripening accelerates, leading to progressive quality loss • Above 25°C: Photosynthetic rate is reduced • Above 30°C: Tree growth is depressed • High temperatures can cause leaf,stem and flower abnormalities and abortion	• Pests and diseases may increase
Heavy rain, hail,strong winds	• Tree damage, increased fruit fall, especially near harvest	• Soil erosion, landslides, subsidence, wash-away of agrochemical applications • Damage to roads and other infrastructure increases costs
Intermittent and unseasonal rain	Greater flowering frequency	• Possible increase of some diseases • Difficulties in crop protection • Post-harvest drying difficulties
Prolonged rain	May reduce flowering, affect fruit set, lower photosynthesis because of continual cloudiness	Increased humidity may favor some fungal diseases; may increase mortality of some insect pests such as Coffee Berry Borer (CBB)
Prolonged drought	Weaker trees, wilting, increased mortality of young trees	Stressed trees more susceptible to some pests

United Nations Development Program (UNDP), 2005

12.6 Adaptation and Mitigation to climate change

Mitigation involves reducing greenhouse gas emissions by carrying out activities that directly reduce or offset the greenhouse gas emissions. This includes the utilization of non-fossil-carbon-based fuels and GHG emission control through carbon capture and sequestration. Adaptation is the ability to manage, recover, or cope with the impacts of climate change, or actions that reduce the vulnerability of species and ecosystems to the effects of a changing climate such as planting drought-resistant varieties and shade trees.
Adaptation and mitigation of climate change can be achieved through the application of climate smart agriculture strategies. These include conservation agriculture, efficient energy use/conservation, biochar technology, planting drought resistant varieties and shade trees. Include diversifications, proper water management, post- harvest handling, precision fertiliser application; IPM; sound waste management practices.

12.6.1 Conservation Agriculture (CA)

Conservation agriculture is a set of soil management practices that minimize the disruption of the soil's structure, composition and natural biodiversity. It has proven potential to improve crop yields, while improving the long-term environmental and financial sustainability of farming. Some of the practices include:

- **Minimum Tillage –** Reduced water loss, Less CO2, reduced energy for tillage
- **Mulching –** Reduces water loss and acts as organic matter
- **Cover crops**

grass strips

Mulching

Bench terracing

Shade trees

12.6.2 Efficient energy use/conservation

Efficient energy use, sometimes simply called energy efficiency, is the goal to reduce the amount of energy required to provide products and services. Energy efficiency helps the economy too by saving consumers and businesses in energy costs. Some of the energy saving practices include: Energy saving stoves, Bio gas energy, Solar Energy, Wind energy and Geothermal.

Energy saving jikos

Solar energy

12.6.3 Biochar Technology

Biochar is charcoal used as a soil amendment. It is a stable solid, rich in carbon, has high tendency to adsorb gases including CO2 and soil H+ acting as ameliorant without neutralizing the acid radicals. It endures in soils for long period. It is normally made from biomass via pyrolysis.

Module 13: Sustainable Coffee Production

Objective

i. Enable trainees understand the concept of sustainable coffee production and apply the three pillars of sustainability.
ii. To impart knowledge on the importance and the necessary practices needed to ensure continuity of coffee production for years to come by taking care of the environment and the people.

Content

i) Introduction
ii) Definition of sustainability in coffee farming –
iii) The 3 pillars of sustainability
iv) Environmental pillar – protection of water sources, conservation of soil, protection of diversity, on farm energy conservation and waste management
v) Social pillar – hiring and employment practices, workers conditions and safety in workplace
vi) Economic pillar – transparency in financial practices, financial viability and food

Methodology

i) Lectures and workshops
ii) Focused group discussions on prevailing practices on environment, work conditions and social life
iii) Demonstrations of bench terraces, grass strips, water harvesting, energy saving jikos, making of biogas and briquettes
iv) Field visits
v) Case studies

Teaching aids/materials

i) Manual, Flip charts and marker pens or a chalk board and chalk
ii) Pictures/photos
iii) Videos
iv) Posters
v) Point presentations

13.1 Introduction

The module expounds on the sustainable coffee production which embraces a number of classifications used to determine the participation of growers (or the supply chain) in various combinations of social, environmental, and economic standards.

13.2 Definition

Sustainability refers to a system of farming that ensures high yields and quality, meets consumer demands, conserves the environment by avoiding environmental pollution, gives better returns to farmers and guarantees food security through crop diversification. It employs practices such as minimizing water usage, control discharge of untreated effluent in water bodies, planting shade trees in coffee and avoiding cutting trees and charcoal burning.

13.3 Pillars of sustainability in coffee farming

Sustainability is based on three pillars which include:

- Environmental
- Social
- Economic

13.4 Environmental pillar

This refers to the farming practices that take into consideration the protection and preservation of the environment. Aspects of the environment that are impacted upon by coffee producers include Flora, Fauna, Wildlife, Soil, Air and Water. Various activities at the farm level might impact negatively on the environment and need to be addressed. For example, lack of soil conservation measures leads to loss of soil and water through surface run off. Measures that can be undertaken to ensure environmental sustainability include:

- Protection of water sources
- Soil conservation
- Protection of biodiversity
- Energy conservation
- Waste management

13.4.1 Protection of water sources

The main sources of water include rivers, springs, boreholes, lakes and wetlands. To protect these sources;

- Do not interfere with the natural vegetation within at least 30 metres for big water bodies and 6 meters for small water bodies or streams. This should be on both sides of the water resources measured from the highest water mark level. This avoids contamination through soil sedimentation, fertilizers, chemicals and waste residues depositions.
- Undertake regular water monitoring by carrying out prescribed chemical, physical and biological analyses and ensuring that the water meets the set limits as guided by the applicable legislation
- Minimize water consumption. Do not extract more water than is needed. Keep records of the volume of water used daily
- Do not apply agrochemicals within 6 metres of small streams and springs and 30 metres for big rivers or as guided by the applicable legislation
- Undertake water conservation measures which include recycling of water used in coffee processing, harvesting of roof water, harvesting of run-off water, use of eco-pulpers in coffee processing and construction of weirs and dams

River protection

Shade trees in coffee

13.4.2 Soil conservation

Soil conservation is the application of practices that reduce soil loss and at the same time maintain soil fertility. This can be achieved through erosion control, soil fertility management, contour farming, etc

13.4.3 Soil erosion

This refers to the detachment of the loose soil particles from the earth surface that could be predisposed by action of wind, water and human activities. Soil erosion can be controlled by:

- Undertaking bench terracing where the land has a slope of more than 5%
- Planting stabilizing grass on the embankments of the terraces such as blue grass (Makarikariensis sp)
- Mulching,
- Contour planting,
- Planting cover crops
- Grass strips
- Minimum tillage (tilling after 2 – 3 years)
- Use of shade trees to accumulate litter that improves soil structure
- Cut off drains along the roads and planting grass on the edges to reduce water runoff
- Avoiding cultivation on slopes of more than 60%. Instead, plant grass or woodlots.
- Vegetative covers on water bodies; planting grass along waterways and gulleys to slow down run-off and eventually fill up the gulleys
- Construction of gabions

13.4.4 Maintenance of soil fertility:

Soil fertility and hence productivity can be achieved through:

- Accumulating pruning biomass as trash lines which will eventually decompose to raise soil fertility.
- Planting appropriate leguminous shade trees which fix nitrogen. e.g. the tall Pigeon pea, Cordia abssynica, Grevillea spp, Leucaena spp, Albizia spp. etc
- Reducing fertilizer use gradually as you step up the frequency of applying organic manure and mulch
- Soil nutrient monitoring through regular soil analysis
- Using appropriate fertilizer recommendations

Bench terrace planted with grass to control soil erosion on sloppy land

13.4.5 Protecting biodiversity

Biodiversity (biological diversity) is a variety of fauna and flora in a particular habitat. Measures to conserve biodiversity include;-

- Maintaining ecosystems in their natural state for co-existence of species through avoiding indiscriminate use of pesticides, using IPM etc
- Sustainable management of indigenous trees such as shade trees within the coffee farm.
- Planting shade trees where they do not exist e.g. Grevillia spp, Albizia spp, Sesbania Sesban etc (and those recommended- KEFRI)
- Protection of wildlife on farms
- Knowledge of the species of wildlife within the area should be consolidated by sound biodiversity practices.
- Maintain an inventory of the wildlife in the area
- Special attention should be directed towards endangered species to ensure that there is no extinction
- Dedicate a portion of the farm for maintaining indigenous vegetation e.g. an indigenous woodlot
- Controlled introduction of the invasive/alien species-
- Protect aquatic ecosystems- application of pesticides and fertilizers away from the water bodies, Sustainable harvesting of resources (Terrestrial and Aquatic)

13.4.6 Energy conservation

Energy conservation is the deliberate effort to reduce energy consumption. This can be achieved through utilizing renewable energy and other energy conservation technologies which include:

Conserving electric and fossil energy

- Use sun drying instead of mechanical driers
- Ensure irrigation systems are efficient by keeping irrigation engines well serviced.
- Replace old large motors with high efficient smaller ones to reduce energy consumption.
- Install motion detectors to control security lights so as to keep them off most of the time.
- Use energy saving bulbs
- Maintain trucks and tractors properly

Use of renewable Energy

This is energy generated from natural resources including sunshine, wind, hydro, geothermal grids and biogas. Farmers can develop renewable energy for their use by installing biogas, solar and wind energy generating systems, growing/converting biofuel crops e.g. oilseed and utilize coffee husks to make charcoal briquettes

Energy conserving technologies

These include technologies that aim at improving efficiency, reducing wastage and losses. They include:

- Energy conserving jikos – jiko - koa, clay lined jikos, kuni moja e.t.c
- Fireless cookers
- Install biogas systems as an alternative energy source

Kuni moja jiko

Clay lined jikos

13.4.7 Sound waste management practices

Waste management practices are the activities and actions required to manage waste from its inception to its final disposal. It involves the collection, transportation, disposal or recycling and monitoring of waste. Some of the practices include:

- No burning of wastes or open dumping of wastes
- Use of 4Rs; Re-use, Recycle, Recover, and Reduce farm waste e.g. composting
- Dumping of waste away from water sources.
- Rinse the pesticide containers thrice and puncture before disposal
- Proper waste disposal e.g the use of the soak pits

Some of the environmentally friendly waste management practices in primary coffee processing include:

- Installing a water recirculation system to minimize water use
- Monitoring water usage by use of water meters
- Composing pulp for use in coffee farms

13.5 Social pillar

This refers to the social aspects that relate to workers welfare and community well- being that including wages, working hours, housing, provision of clean portable water and sanitary facilities among others.

Social sustainability entails appropriate practices in:

- Hiring and employment
- Workers conditions
- Safety in work place
- Social corporate responsibility

13.5.1 Hiring and employment

All hiring and employment procedures and practices should ensure that:

- There is no gender discrimination during hiring. A gender sensitive employment policy should be put in place
- Workers are provided with working contracts
- Workers are paid at least the minimum recommended by the Kenyan labour laws or the Collective Bargain Agreement (CBA)
- Workers are regularly paid as agreed upon hiring
- Working hours do not exceed the limit stipulated in the national labour laws or ILO
- Workers are paid accurately for worked overtime as provided for by the law
- Overtime should be voluntary and must be compensated as per the national labour laws or ILO, whichever is stricter.
- No employment of persons less than 18 years of age - no children are hired
- Employees have access to records of their earnings
- No sexual harassment
- Workers are free to be union members
- No financial disciplinary measures are imposed on employees
- All employees are allowed sick-offs
- No use of forced labour
- Workers take annual leave as per the prescribed applicable legislation

13.5.2 Workers' conditions

Workers conditions cover a broad range of topics and issues, from working time (hours of work, rest periods, and work schedules) to remuneration, as well as the physical conditions and mental demands that exist in the workplace. Good working conditions should be accorded to the workers. These entail:

- Encouraging education of children and workers
- Having a care plan in case of sickness
- Providing workers with clean drinking water
- Having adequate toilets for the population and separate ones for men and women
- Having expressing facilities for breastfeeding mothers
- Decent housing for workers in applicable cases
- Nursing breaks for the nursing mothers

Nursery school for workers' children

Signage on policy

13.5.3 Occupational safety and health at work place

Occupational safety and health (OSH) is the science of anticipation, recognition, evaluation and control of hazards arising in or from the workplace that could harm the health and well-being of workers, the surrounding communities and the general environment. It involves the implementation of policies and procedures to ensure the safety and health of employees within a workplace.

- Poor working conditions can affect the environment workers live in. This means that workers, their families, other people in the community and the physical environment around the workplace can all be at risk from exposure to workplace hazards.
- There is an unlimited number of hazards that can be found in almost any workplace. These include unguarded machinery, slippery floors and insidious hazards (those hazards that are dangerous but which may not be obvious)

- Insidious hazards include: chemical hazards arising from liquids, solids, dusts, fumes, vapours and gases; physical hazards, such as noise, vibration, unsatisfactory lighting, radiation and extreme temperatures; biological hazards, such as bacteria, viruses, infectious waste and infestations and psychological hazards resulting from stress and strain among others
- Management commitment to health and safety and strong worker participation are two essential elements of any successful workplace safety and health programme
- The management should ensure that the organization has appropriate policies and programs and that sufficient human and financial resources are provided to ensure a healthy and safe work place.

To achieve this:

- Regular training should be carried out to employees
- Emergency handling procedures and equipment should be in place
- Proper safety signage within the farm should be well put
- Agrochemicals storage facilities should be constructed in a way to reduce risks
- Proper PPE should be used during working sessions
- There should be proper sanitary facilities within the farm
- Medical check-ups should be carried out on people who handle agrochemicals

- An employee should have overall responsibility for protection of workers safety and health and provide leadership for occupational safety and health in the organization.
- OSH addresses the broad range of workplace hazards. It aims at preventing rather than attempting to solve problems after they have already developed. For more information refer to the Occupational Safety and Health Act (OSHA), 2007.

13.6 Economic pillar

The pillar aims to support systems that contribute to fair distribution and sharing of resources. It ensures mutual support, strong local economies/livelihoods and

networks that serve the needs of local people and our ecosystems. The key component under economic pillar is food security.

13.6.1. Food security

Food security is a situation where all people at all times have physical, social and economic access to sufficient, affordable, safe and nutritious food that meets the dietary needs and food preferences for an active and healthy life.

Measures for ensuring food security in coffee growing areas

- Intercropping
- Diversification

13.6.2 Intercropping of food crops in coffee

To increase the level of proteins, vitamins and minerals in the diets, coffee farmers are advised to intercrop coffee with suitable crops. Such crops are early maturing, non-climbing and not alternate host to coffee diseases and pests. These include legumes e.g. beans, pigeon peas, cow peas, dolichos (njahi) and green grams (ndengu) as well as onions and Irish potatoes

Intercropping can be at specific stages of coffee production cycle to increase economic benefits without affecting yields and quality. The stages are: during establishment of coffee, during change of cycle by clean stumping and when the coffee is under rehabilitation.

13.6.3 Diversification in coffee farming

This is a system of farming that encompasses several concurrent enterprises aimed at spreading risks, increasing income and enhancing food security at the household level. On separate fields, plant fruits such as guava, pawpaws and tree tomatoes that are rich in vitamins for both domestic and export market. Local vegetables e.g. pumpkins, amaranth (terere) and black night shade (managu) are good food security and nutrition crops as they are rich in vitamin C and iron. They grow fast and can be planted in small plots that satisfy the family's food needs.

Diversification can also entail having other farm enterprises that are complementary to coffee production. These include:

- Livestock farming - indigenous cows can be bred with exotic breeds to improve milk yields
- Fish farming (Aquaculture) - Farmers in areas with streams or rivers can utilize the water to create fish ponds. Fingerings can be obtained from various fishery departments across the country.
- Bee keeping (Apiculture)
- Poultry farming

Enterprise diversification

Module14: Certification

Objective

i) To create awareness on the various certification schemes targeted for coffee production at coffee
ii) Enable the trainees understand nexus between certification and coffee production

Content

i) Common words in certification – standards, policy, certification body, certified farm, audit and traceability
ii) Common certification standards in Kenya – UTZ, Fairtrade, Rainforest, Nespresso AAA, CAFÉ practices and Organic
iii) Certification principles hinged on the sustainability
iv) Common Coffee certification standards and their key focus
v) Benefits and advantages of certification – to the buyers, to farmers, employees and overall benefits

Methodology

i) Videos
i) Power point presentation on the requirements of certification, audit preparations etc
ii) Discussions on the requirements for various certification schemes

Teaching aids/materials

ii) Standards and checklists/compliance criteria
iii) Flip charts and whiteboards
iv) Posters
v) Photos

14.1 Introduction

Certification is a process through which an accredited organization grants recognition to an individual, organization, process, service, or product that meets certain established standards.

Certification communicates information about the quality, traceability, social, environmental and financial conditions surrounding the production of goods or provision of services. It represents a guarantee that the product i.e. coffee was produced in an environmentally and socially responsible way.

Most certification standards originated from the need to assure the consumers on the quality of the product, production conditions and to ascertain that the producer receives a fair return for their effort.

There are mandatory standards under the Kenyan context under Kenya Bureau of standards which include food safety, weight and measure amongst others

14.2 Common used words in certification

- **Standard –** document approved by a recognised body that provides for common and repeated use, rules, guidelines or characteristics for products or related process or production methods with which compliance is not mandatory.
- **Certificate;** means a written confirmation issued by certification body that an entity is found to comply with a given standard.
- **Certification policy -** set the rules that describe what can be certified, what it means to be certified and the process for achieving and maintaining certification.
- **Certification cycle;** a certification cycle is the period from the point of initial certification to re-certification, or from re-certification to the following re- certification.
- **Certification body –** means an independent third party, or third parties, to whom the owners of the standard has/have the delegated the function of inspection and certification.
- **Certified farm;** an individual or farm that has successfully completed a certification process and for a supplier has been notified in writing by the certification body that certification has been achieved.
- **Audit –** A systemic, independent and documented process for obtaining evidence against compliance and evaluating it. In coffee sector audits carried out by certification body to confirm whether the farm is complying with a certain standard
- **Traceability –** Having a system for tracking the coffee from the tree to the cup and the flow of payments back to the producer. It touches on the source of the coffee, production conditions, trade up to consumption. To achieve this, exhaustive records must be maintained detailing all fields, processing and marketing activities

14.3 Common Certification standards in Kenya

Some of the certification standards in Kenya include UTZ, Fairtrade, Rainforest Alliance, Nespresso AAA, CAFÉ practices of Starbucks, 4C and Organic. Their logos are as shown below. Except the rest, Nestle and café practices are verification standards.

14.3.1 UTZ Certified

Sets standard for responsible coffee production and sourcing. UTZ which means "good" inside in Maya language gives an assurance of the social and environmental aspects in coffee production. The UTZ program enables farmers to learn better farming methods, improve working conditions and take better care of their future and the environment.

14.3.2 Fairtrade certification

Third-party certification process that sets standards for the way coffee is produced and how much a farming cooperative earns for coffee sold. It aims at improving the livelihoods and well-being of small producers and workers. It's a standard that promotes sustainable development and poverty reduction through fairer trade.

14.3.3 4C Certification

The Common Code for the Coffee Community (4C) was created through a participatory, extensive, transparent and balanced consultation with coffee stakeholders worldwide, and is operationalized by 4C Services. The 4C certification aims to gradually raise the social, economic and environmental conditions of coffee production and processing worldwide.

14.3.4 Rainforest Alliance Standard

Aims at building a future in which nature is protected and biodiversity flourishes; where farmers, workers and communities prosper, and where responsible land use and business practice are the norm.

14.3.5 Nespresso AAA

Protects coffee ecosystems by promoting sustainable agricultural best practices in ecosystem conservation, wildlife protection and water conservation. The Nespresso AAA Sustainable Quality Coffee Program sets out to ensure cultivation of highest quality coffee in ways that are environmentally sustainable and beneficial to farming communities.

14.3.6 C.A.F.E. (Coffee and Farmer Equity) Practices

Is a private verification standard established by the Starbucks coffee company.
C.A.F.E. Practices ensures that Starbucks is sourcing sustainably grown and processed coffee by evaluating the economic, social and environmental aspects of coffee production. These aspects are measured against a defined set of criteria detailed in the C.A.F.E. Practices Generic and Smallholder Scorecards.

14.3.7 Organic

The standard aims at probing that agricultural and food products have been produced with emphasis on the protection of soil and water, enhanced biodiversity and the responsible use of energy and natural resources.

14.4 Certification principles

The certification principles and compliance are anchored in the three sustainability pillars under which specific requirements of each standard are defined. The pillars include social, economic and environment (Details on 13.3).

14.5 Benefits of certification

- Improved quality and productivity,
- Improved organizational efficiency through proper record keeping, corporate governance
- Opportunities for market access and favourable prices for increased bargaining power
- Producer support
- Safeguards the buyer (quality assurance)
- Creates incentives for farms and firms to improve their environmental and socio-economic performance
- Catalyst for improved working conditions (occupational health, workers' welfare)
- Improved traceability of coffee from the farm and the payments received by the farmers
- Strengthens business relationships with brands

Module15: Gender and Youth in coffee value chain

Objective

i. To outline the inclusion of men, youth and women in the coffee value chain so as to achieve gender equity and equality for sustainable coffee farming
ii. To understand what gender and gender mainstreaming is in the coffee value chain

Content

i) Introduction
ii) Definition of terms – gender, gender equity, gender equality, gender , Gender sensitive, gender analysis and family business
iii) Gender gaps in the coffee value chain – Access and control of incomes, assets, credit and inputs, sharing and equal opportunities of training and leadership and flexible working arrangement for nursing mothers. positions,
iv) Gender mainstreaming in the coffee sector – in terms ofasset ownership, membership, payment, access to credit and savings, compliance to a third gender rule, equality in training, gender based programmes, pre-finance -, community driven initiatives and advocacy
v) Strategies for youth involvement in the coffee value chain – train in GAP and Agribusiness, form youth teams, modern technologies, prompt payment, youth development fund, tax exemptions and more youth in leadership

Methodology

i) Lectures on gender gaps, gender mainstreaming and youth involvement
ii) Experience sharing/ group discussions on agribusiness, youth teams and gender based programmes
iii) Case studies on successful gender and youth programme
iv) Group discussions
v) Role play
vi) Illustrations

Teaching aids/ materials

i) Power point presentations
ii) Charts on society membership
iii) Posters
iv) Video clips of advocacy programmes

15.1 Introduction

In the current global set up, equality in the coffee value chain is a great concern to all industry players. Research has shown a significant disparity between male and female coffee producers in Kenya. Much of this is due to deeply rooted social biases that create numerous disadvantages for women compared to men. Similarly, youths from coffee growing zones have been discouraged from being stakeholders in the multi-billion shilling industry. This scenario pauses a big succession challenge.

15.2 Definition of terms

Gender - The Culturally and socially ascribed roles and responsibilities of men and women that are constructed by the society within a specific place and time. It refers to the way a community defines what is to be woman or man. Each community expects men and women to think, feel and act in certain ways simply because they are women and men.

Gender equality means that women and men have equal rights and opportunities and are free to develop their personal abilities and make choices without being hindered by stereotypes, rigid gender roles or prejudices.

Gender Equity: Means fairness in women's and men's access to socio-economic resources.

Gender mainstreaming: A strategy for making the concerns and experiences of women as well as of men an integral part of the design, implementation, monitoring and evaluation so that women and men benefit equally, and that inequality is not perpetuated

Gender sensitive: When we are aware that men and women perform different roles and have different needs in the process of achieving institutional objectives.

Gender Analysis. The process of determining the different needs of women and men while recognizing the unequal gender relations between them and the impact that a particular program or policy may have on or between them.

Family Business: An ideal situation where men, women, boys and girls are involved in farming as an enterprise in their household

15.2 The Gender Gap in Coffee Value Chains

Women in the coffee farming communities in Kenya:

- Are not involved in family financial planning and spending.
- Have access and no control over land use
- Have limited access to credit, market information and farm inputs
- Have limited access to training and leadership opportunities.
- Work for longer hours per day than their male counterparts since they are responsible for both household and farm work- triple gender roles
- More involved in coffee production activities but less represented in decision making

15.3 Gender mainstreaming in the coffee sector

It involves the integration of the gender perspective into every stage of the coffee value chain and aims at promoting equality between women and men. This can be achieved by empowering women to realize their full potential and participate in the coffee value chain as decision-makers.

15.3.1 Gender mainstreaming strategies:

Empower women and men to equally access financial resources by;

- Creating awareness on benefits of women inclusion in coffee business
- Promoting savings groups and micro-credit schemes
- Encouraging co-ownership of land plus other assets and their control
- Sensitizing farmers on household financial planning

- Compliance to a third gender rule constitutional requirement along the coffee value chain
- Training and extension services;
- Awareness-raising within the organization about the importance of women attending training
- Adjusting the time or location of training to make it easier for women to attend.
- Use participatory training methods and create a safe environment to promote active participation of all (for example by having separate discussion groups for men and women at certain moments)Create or support gender programs to compliment technical training and extension services
- Importers, roasters and baristas to play a role in ;
- Purchasing and marketing coffee that promotes women's inclusion.
- Supporting projects in coffee supply chains that promote gender equality by donating, participating, or linking gender programs into their own supply chain
- Offer pre-finance in the supply chain that includes women farmers
- Promote community driven initiatives that create balanced households by Introducing methodologies that promote joint labor, decision-making, and ownership of property within households
- Involving experts in gender to work with community leaders who then become the trainers
- Advocate for gender equality by publicly supporting the cause to catalyse social change.
- Exposure programs in local and international forums
- Creation of centres of excellence and documenting success stories

When a critical mass of stakeholders recognizes that gender equality is beneficial for everyone, minimizing the gender gap will become a common goal.

Training of women on top-working coffee

15.4 Strategies for youth involvement in the coffee value chain

Over the last decade, organisations in various parts of the world have launched projects to increase the number of youth involved in the coffee sector.

Some of the strategies are:-

- Training and engaging them as agribusiness service providers in the areas of good agricultural and manufacturing practices. This will boost youth's interest in coffee and involvement in coffee production
- Forming coffee youth teams and creating forums for them to learn from each other and introduce a competitive culture among them
- Promote the use of modern technologies in the coffee value chain
- Enhance prompt payments for coffee deliveries
- Establish a youth development fund on coffee
- Exemption of commercial coffee equipment from excise duty to attract youth to open coffee houses with low capital input
- Reserve some slots for youths in the Societies boards of management

Youth training on coffee grafting and top-working as a job creation venture

Module 16: Coffee Corporative Societies Governance and Prudential Standards

Objective

iTo enable trainees understand the key factors on good governance, application of prudential standards, best practices and consequences of non-compliance so as to enhance the performance of the coffee cooperative sub-sector

Content

i) Introduction
ii) Essentials of good corporate governance in coffee cooperatives
iii) Disclosures of interest
iv) Wealth declaration and indemnity
v) Code of conduct
vi) Prudential standards on good corporate governance in the coffee societies
vii) Consequences of non-compliance with prudential standards
viii) Committees of the Board and Succession planning

Methodology

i) Lectures on corporate governance, code of practice and interventions.
ii) Experience sharing/ Group discussions – comparison of different societies.
iii) Case studies – performance of different societies.
iv) Literature review – on existing reports.

Teaching Aids

i) Slides.
ii) Charts – production and pay out rates by different societies.
iii) Video clips – experiences and success stories.

16.1 Introduction

Prudential standards are intended to provide minimum standards on good corporate governance required for members, the Board, Management and the Chief Executive Officer in the management of the coffee corporative societies. They ensure that each exercise their duties and responsibilities with clarity, assurance and effectiveness. They promote standards of conduct and sound management practices.

As a general rule, prudential standards should be drawn from the constitution and relevant applicable policies and laws in Kenya. In addition, the Commissioner for Co- operative Development issues guidelines from time to time to Societies spelling out new or improved compliance standards.

Other sources of compliance standards for Co-operatives may be drawn from the Leadership and Integrity Act, SACCO societies Act (SSA), Cooperatives societies Act (CSA), the lending policy' accounting standards, supervisory committee manuals and the Code of ethics and conduct.

Administration block of a well-managed co-operative society - Kasinga FCS

16.2 Essentials of good corporate governance in coffee cooperatives

- Lays solid foundations for management and oversight - Recognize and publish the respective roles and responsibilities of board and management.
- Structure the board to add value - Have a board that is gender sensitive, of an effective composition, size and commitment to adequately discharge its responsibilities and duties.
- Promote ethical and responsible decision-making - Actively promote ethical and responsible decision-making.
- Safeguard integrity in financial reporting - Have a structure to independently verify and safeguard the integrity of the company's financial reporting.
- Make timely and balanced disclosure - Promote timely and balanced disclosure of all material matters concerning the Society.
- Respect the rights of shareholders - Respect the rights of members and facilitate the effective exercise of those rights.
- Recognize and manage risk. Establish a sound system of risk oversight and management and internal control.
- Encourage enhanced performance - Fairly review and actively encourage enhanced board and management effectiveness.
- Remunerate fairly and responsibly - Ensure that the level and composition of remuneration is sufficient and reasonable and that its relationship to corporate and individual performance is defined.
- Recognize the legitimate interests of members - Recognize and emphasize on legal and other obligations to all legitimate members and the importance of a code of conduct that creates social purpose with clear and enduring values and principles that are integral to and will guide co- operative practice.

16.3 Disclosures of interest

- On election into the Board, all members should disclose to the Board, any business or other interest that is likely to create potential conflict of interest
- This should include business interests, membership in trade, business or other economic organizations; shareholding, or other interests in the cooperative society; and any gifts, monies, commissions, benefits or other favours extended or received from a party in respect of or in relation to any business dealings with the cooperative society

16.4 Wealth Declaration and Indemnity

- Each member of the committee should declare his/her wealth within 30 days and shall also file his/her indemnity to the society within 14 days upon taking office with the Cooperative Ethics Commission and the Commissioner for Cooperative Development respectively.
- Board members who fail to comply with the requirements of the above rules automatically ceases to be committee members

16.5 Code of conduct

- It is recommended that Boards should approve a written code of best practice setting the ethical and behavioural expectations of the members, directors and employees
- A code of ethics needs to be developed in full consultation with all stakeholders. This will include;

  - » Directors of the co-operative;
  - » All employees of the co-operative;
  - » The members of the co-operative; and
  - » Other relevant stakeholders.

- A code of ethics can be of considerable value in co-operatives, which rely on maintaining member commitment and assurance that fair treatment is the norm.

16.6 Prudential standards

The Co-operative Societies Act and Rules provides for minimum compliance standards to be observed by Societies in their day to day business operations

- **Prudential standards on registration of coffee co-operative societies and amalgamation**
  - » Provides information and guidance to those organization seeking to obtain registration of a co-operative society in Kenya in compliance with sections 4, 5, 6 and 7 of the Co-operative Societies Act, Chapter 490.
  - » Prepared according to Section 29 of the Co-operative society's Act to assist co-operative societies intending to amalgamate
  - »
- **Prudential standards on corporate governance**
  - » Intended to provide minimum standards on good corporate governance required for members, the Board, Management and the Chief Executive Officer in the management of the coffee corporative societies. The standards aim at promoting standards of conduct, sound management practices as well as ensuring that the office bearers exercise their duties and responsibilities with clarity, assurance and effectiveness.

- The Board of each society is responsible for formulating policies and procedures that ensure:
  - The board, Chief Executive Officer and management are fully aware of their duties, responsibilities and code of conduct
  - All management decisions are made in accordance to the prudential standards of the society
- The supreme authority of a cooperative society is vested in the General Meeting at which members have a right to attend, participate and vote on all matters irrespective of gender
  - The society shall give at least 15 days written notice to the members.
  - Encourage members to send any additional agenda before the meeting
  - The notice must specify the agenda of the meeting.
  - The quorum of the Annual general meeting (AGM) should be specified by the society by-law
  - The procedure of the meeting should be restricted to the agenda for the day


AGMs in progress

- **Prudential standards on size of the board**
  - Size of the board should be restricted to between 5 and 9 board members. Any number greater than the stated; will require the Minister's approval. The composition of the board should be guided by the average production of the society for the last three years shall base as follows:
  - 1,000,000 kgs and below (5) board member
  - 1,000,001 – 5,000 000kgs seven (7) board members
  - 5,000 001 and above nine (9) board members
  - Where the members have agreed on zones in a general meeting Societies may stick to those zones so long as they don't go against the set standards.

- **Prudential standards on ethical practices**
  - » Provides for minimum standards that co-operative societies' stakeholders should observe in carrying out their duties and responsibilities.
  - » It is the responsibility of the board to ensure that the co-operative society develops ethical standards and policies that enhances good governance.
  - » Objectives of the code of ethics are;
  - » To set out the values, ethics and beliefs upon which the co-operative society bases its policies and behaviour:
    - * To set down and promulgate the basic ethical principles to be observed;
    - * To secure adherence to uniform principles of good practice;
    - * To promote and maintain confidence in the integrity of the co-operative;
    - * To harmonise the concepts of social responsibility, public accountability and profitability;
    - * To prevent and resist the development of undesirable practices; and
    - * To lay down standards for personal and institutional behaviour.

- **Prudential standards on strategic planning**
  - » Provides for minimum standards on how to define the co-operative strategy or direction and make decisions on allocation of resources to pursue this strategy
  - » This standard provides best practices in strategic planning
  - » It is the responsibility of the board, the management and staff of co- operative society to ensure that the co-operative develops policies that lead to best practice in strategic planning

- **Prudential standards on human resource management**
  - » Sets certain minimum standards that the co-operative societies should have in order to enjoy improved personnel relations
  - » Each co-operative should formulate its own detailed HR policies, taking into account its special needs and circumstances
  - » Aims at maximizing the return on investment from the human capital
  - » It is the responsibility of the head of human resources to carry out the HR function in an effective, legal, fair, and consistent manner

- **Prudential standards on procurement**
  - » Provides for minimum standards to ensure that co-operative societies improve the speed and efficiency of the procurement function to reduce costs and improve the co-operative society's overall performance
  - » Each co-operative should formulate detailed procurement policies in line with The Public Procurement and Disposal Act, 2005 that take into account its special needs and circumstances
  - » The standard provides some suggestions in procurement management process optimization and supplier performance management
  - » It is the responsibility of the board to ensure that the co-operative society develops procurement policies that would lead to best practice in procurement function

- **Prudential standards on financial management**
  - » Concerned with the rational matching of funds to their uses in the light of appropriate decision criteria so as to create and maintain economic vale and wealth. It covers: - Financing, Investment, and dividend policy decisions
  - » Some aspects of financial regulations that govern co-operative societies are found in their by-laws and the Co-operative Societies Act
  - » The co-operative society should comply with the provision of those laws and any other relevant Acts, rules and regulations that affect the sector

SACCO services and milk cooling plant at Gakundu FCS - a diversification strategy

- **Prudential standards on investment**
  - » Investment decisions by co-operative societies are made for purposes of improving the members' economic wellbeing or satisfying their felt needs
  - » Coffee co-operative societies due to their localized activities tend to concentrate on sub-sector core-activity and provision of auxiliary services like inputs and other services.
  - » Due to their reliance on traditional sources of finances notably capital and statutory reserves, they have a low capital base to invest outside the core activity.
  - » Investment should be promoted in the sub-sector particularly in commodity value addition along the chain.
  - » The board is responsible for formulating, reviewing and adjusting the investment policy.

- To enable them make right investment decisions, the following measures should be undertaken:
  - Increased capacity training for members and management committees in relation to their current and purposed future investments
  - Investments should centre around the core activity and value addition along the value chain
  - Feasibility studies should be undertaken and financial economic viability evaluated before the project selection and investment decisions are made.
  - Proof of economic and financial viability of projects includes Net Present Value (NPV), Internal Rate of Return (IRR) and Cost benefit Analysis (CBA).
  - Members should be pivotal in making decisions on investments which should be discussed in the Annual General Meeting.

- **Prudential standards on risk management**
  - The objective is to test the society's preparedness against unexpected losses.
  - Depending on the nature of business the cooperative societies are exposed to varying degrees of risks, necessitating the need to undertake appropriate risk management practices to cushion against likely losses of property, theft, fraud and forgeries, fire, rapid depreciation and wastages and fatal damages.
  - In measuring risk the Society must, identify the areas where risk can arise, measure the degree of risk, agree on the level of risk as opposed to possible gain and control and monitor that risk.

- **Prudential standards on borrowing**
  - External borrowing is defined as funds received in the form of a loan or non-member deposit individual, donors or other financial institutions in which the society has entered into an agreement and must repay the funds with or without interest of at a later date.
  - A co-operative society which under its By-laws has power to borrow money should from time to time at a General Meeting fix the maximum liability which it may incur in loans or deposits from non-members.

- **Prudential standards on production determination of break-even points and cost of production at the factory level**
  - Break even analysis is relevant and must be taken as a priority in every performing factory.
  - The Break Even Analysis is the process used to determine profitability at various levels of sales.
  - The prudential standards to determine break even points at the factory level are:-
    - Prepare and implement Factory Budgets.
    - Develop Business Plans to Support the Budget
    - No. of discs, employees, and kilograms
    - Apply Break Even Analysis formula

- **Prudential standards on milling and marketing**
  - » Management committee to appoint the miller in accordance with CCD Circular
  - » Vetting the marketers and preparing a list by the management committee before proposing them to the AGM.
  - » Coffee should be taken to the miller within 3 month upon drying
  - » Management committee proposes to the AGM.
  - » The AGM appoints a marketer from the list.
  - » Societies that have marketing licenses, should sell their coffee through the central auction or direct sales.
  - » Auction System involves
    - * Preparation of a sale catalogue
    - * Delivery of samples to the central auction
    - * Presentation of the reserve price
    - * Negotiation for any noted coffee a day after the auction
    - * Direct Sales

- **Prudential standards on information and communication technology**

  - » This standard is intended to provide the minimum standards that the co-operative society should develop so as to capture and disseminate adequate information relating to their products or services. Each co- operative should formulate its own detailed information communication
  - » and technology (ICT) policies, taking into account its needs and circumstance
  - » The board of directors, management and staff are responsible for ensuring that the co-operative society's information system avails information to the right person at the right time.
  - » The co-operative where possible should install an electronic information and communication system that enhances its efficiency in communicating with members and in service delivery

- **Prudential standards on management**
  - » These standards should address governance and management structures, production, processing, marketing, institutional capital, provisions for loan loss, external borrowing, investments, fixed assets, shares, liquidity, and records keeping

16.7 Consequences of non-compliance with prudential standards

There are specific actions designed to secure enforcement by imposing a penalty for violation of the law or offering a reward for its observance. It constitutes a punitive act taken by the Regulating Authority against a co-operative society that has violated the applicable laws. Anybody who commits any offence under the CSA and/or any other laws related to the Cooperatives is liable for a severe punishment that may include:

- Fine, or fine and imprisonment
- Repaying the amount involved
- Restoring the property
- Being rremoved from office

- Being surcharged
- Administrative sanctions may also be applied

16.8 Committees of the Board and Succession Planning

- The Board shall establish the following key sub committees; executive, supervisory, education, field, human resource, and finance /investment /procurement.
- In order to ensure continuity of the Board, the appointment of the members of the Board should be staggered and the practice of 1/3 rotation of directors be applied.
- They should ballot immediately after the elections whereby a third of the members retire in the first year, the second lot retires in the second year and the entire board retires in the final year
- The chairman should be the last to retire. The members of the board are eligible for re-election. At least 30% eligible women and youth member should be re- elected.

Module 17: Farming Coffee as a Business

Objective

To equip growers with appropriate analytical skills and business management tools in order to maximize profits

Content

i. Introduction
ii. Business management skills - business terms and concepts, costs and benefits, savings, value addition ,risk management, bargaining, farm record, performance monitoring and evaluation, benefits
iii. Factors affecting profitability - productivity, market price, exchange rate, milling loss and production cost, value addition, management and governance.
iv. How to enhance profitability - increased production per tree, production cost reduction through use of resistant varieties, appropriate quality farm inputs soil analysis, pest scouting , enhanced processing procedures and improved management and governance systems .
v. vStandard task rates - operations, unit cost, task rates (low, average and high)
vi. Financial literacy - definition , aspects of financial management principles of good financial management- budgeting, credit management and financial planning
vii. Record keeping - importance, basic farm records; farm details, activity, input, production, stores and financial records
viii. Risk management - benefits of risk management ,type of risks; production, environmental and market related risks; strategies for risk mitigation
ix. iInformation and communications technology (ICT) in the coffee sector – importance of ICT in the coffee value chain, Key areas of its application

Methodology

i. Lectures on business management skills ,factors affecting profitability ,record keeping and financial literacy
ii. Group discussions/ Experience sharing on success stories on coffee farming business
iii. Simulation relating to trends on market prices and production over a given period of time
iv. Demonstrations on record preparation and task calculations
v. Case studies – of successful business farms and societies

Teaching aids

i. Video clips of a model farm
ii. Charts of farm records
iii. Slides on different presentation of coffee business
iv. Visits –Benchmarking

17.1 Introduction

The module is designed to equip trainees with skills that will assist them in fully understanding the commercial potentials of coffee production. It helps to assess capacity, identify shortcomings and propose strategies affecting the households' business success. Coffee farming must be approached as any other business with the goals of minimizing costs and risks and maximizing profits.

17.2 Benefits of business management skills

- Helps to understand business terms and concepts
- Assist in comparisons of the costs and benefits of different approaches to business management and farming
- Understand the value of saving compared to credit costs
- Assists in investigating various value-adding strategies.
- Assists in formulating risk management strategies.
- Reviewing market access and market alternatives.
- Understanding the potential benefits of collective actions through associations with other farmers.
- Understanding simple and informative farm records
- Understanding farm accounts for good decision-making and business performance monitoring & evaluation.
- Developing indicators to measure progress of the farm as an enterprise

17.3 Factors affecting coffee profitability

- Productivity in terms of kilograms per tree, acre or hectare
- Market price as influenced by quality, supply and demand
- Exchange rate which fluctuates depending on market forces
- Milling loss - dependent on parchment type. On average P1 has a milling loss of about 20%, P2 22%, P3 32% , PL 38% and Buni 50%
- The cost of production
- Prudence in management and governance

17.4 How to enhance coffee profitability

- Improve production per coffee tree: the higher the production per unit area, the lower the cost per kilogram of cherry.
- To enhance profitability farmers are advised to:
  - » Plant disease resistant varieties or convert the traditional varieties to the improved ones
  - » Practice regular change of cycle
  - » Implement a standard fertilization schedule supported by soil analysis based recommendations
  - » Undertake timely scouting and management of insect pests
  - » Use labour prudently
  - » Undertake proper processing procedures

17.5 Standard task rates

Labour costs account for a significant percentage of the overall farm budget. In order to enhance profitability, farmers need to increase efficiency in labour utilization by following labour task guidelines shown in the table below

Table on Standard task rate

Operation	Unit/ Man day	Work rate at different levels		
1. Coffee Establishment		Low	Average	High
Uprooting old coffee trees :- tractor assisted Manual uprooting	Coffee stumps	160 8	180 10	200 12
Digging holes (60cm x 60cm)	Holes	18	20	24
Mixing and filling holes	Holes	40	50	55
Planting seedlings	Seedling	85	90	100
2. Canopy Management				
Pruning	Trees	25	30	40
Handling	Trees	35	40	45
De-suckering	Trees	230	250	260
Sucker selection	Trees	180	200	240
Conversion(Top-working)	Trees	80	100	130
3. Fertilizer Application – Manual				
	Trees	530	560	600
	Bags	2	2.5	3
4. Fungicide Application: -Knapsack sprayer				
		180	200	240
5. Insecticide Application				
Insecticide Application	Trees	200	220	250
Banding	Trees	350	400	450
Granular insecticides	Trees	560	600	640
6. Weed Control				
Herbicide application:-Knapsack sprayer	Trees	200	220	250
Hand weeding	Trees	350	400	450
Hand slashing	Trees	560	600	640

7. Mulching				
Cutting grass; collecting & Loading	Hectare	10	15	20
	Hectare	8	10	12
8.. Irrigation				
	Hectare	4	3	2
9 Harvesting				
Main picking	Debes	4	5	6
Light picking	Debes / Mday	2	2.5	3
10. Factory Processing				
(Mdays / Ton of clean coffee)		58	60	62

Source: KALRO, Coffee Research Institute

The low, average and high figures indicate the range by which each task can vary depending on the prevailing circumstance(s). The managers should therefore avoid any wide deviation from the stated figure(s).

17.6 Financial literacy

Financial literacy is the possession of the set of skills and knowledge that allows an individual to make informed and effective decisions with all of their financial resources. It often entails the knowledge of properly making decisions pertaining to certain personal finance areas like, insurance, investing, saving, tax compliance and planning for retirement. It also involves intimate knowledge of financial concepts like compound interest, financial planning, advantageous savings methods, consumer rights, time value of money, etc.
It focuses on the capability of an individual or organization to have knowledge on critical aspects of financial management which include;

- Making informed choices between different financial products and services
- Understanding how to draw up and live within a budget
- Knowing why and how to save
- Investing prudently
- Borrowing responsibly and avoiding becoming over indebted,
- Managing business efficiently and accessing productive credit
- Protecting themselves against financial risks

17.6.1 Principals of good financial management

Budgeting

It is the process of creating a plan to spend money by balancing one's expenditure with income. Creating the spending plan allows one to determine in advance whether there will be enough money to do the things you need to do or would like to do.

Why is budgeting important

- Estimates the level of resources that will be needed during a specified period of time to support the activities along the coffee value chain
- To identify and assess alternative ways that resources could be used more effectively to accomplish a given set of policy goals
- Allows for strategic and long-term planning for everything from current operating costs to potential expansion.
- Opens up the ability to hire new staffers, invest in new product lines and set earning goals in line with the organizations' corporate financial objectives.
- The potential to attract investors and open up lines of credit
- The ability to make decisions about salaries, bonuses, benefits and overhead operating expenses
- Easier tax preparation

Credit Management

Credit management is the process of granting credit, the terms its granted on and recovering this credit when its due. This is the function of an organization to control credit policies that will improve revenues and reduce financial risks. Organizations should ensure that credit is only sought only when there is need and mechanisms should be put in place to ensure prudence in utilization of the resources.

Financial planning

Financial planning begins by knowing the financial status of an individual or Organization. This is by determining the income, expenses, assets and liabilities. To attain financial planning, one need to;

- Enhance savings for known-expenses, emergencies and investments.
- Prudently manage credit- Credit is good if used for investment but could easily lead to financial difficulties if not controlled.
- Analyse possible investment options – some options are of high risks and others are of low risks. Investment options include; shares, Stocks, savings, Life, education & health insurance policies
- Diversify your investment to minimize risks
- Insure against emergencies. This ensures one's wealth or savings is not wiped out by unexpected event e.g. theft, fire, accidents, illness and terror attacks

17.6.3 Record Keeping In Coffee Farming

Importance of keeping records:

- Provide data for planning, monitoring operations and measuring performance
- Enable the assessment of credit worthiness
- Facilitate traceability of end products
- Gives history of a farm
- Helps a farmer to know business status
- Used to calculate and compare actual performance indicators with standard task rates.

The following records should be kept and maintained by the farmer:

- Farm details
- Farm layout/map
- Farm activity records
- Farm input records
- Harvesting and delivery records
- Stores records
- Financial records- purchase and expenditure records

Farm details

Name of the farm	
Owners Name	
Address	
Size of the farm	
Area under coffee	
Number of coffee trees per variety	
Total number of trees	
Date planted	
Source of planting material	

Farm activities record

A record of activities should indicate when a task was performed, the time taken and the cost.

Date	Activity/ operation	Task	Mandays	Actual	Totalcost	Cumulativetotal (Ksh)	Remarks

Farm activities include weeding, picking, fertilizer application pruning, spraying

Farm input record

Date	Input	Quantity received (units)	Block	Rate	Area/no.of trees	Remarks

Farm Inputs includes; manure, fertilizer,lime ,herbicides, pesticides, fungicides

Harvesting and delivery records

Date	Block (s)	Man days	Cost Ksh	Delivery to factory		
				cherry	Buni	Total

Stores Record

Item……Sheet/Folio No……

Date	Received (quantity)	Issued (quantity)	Balance (quantity)	Comments

This record needs to be kept for each item e.g. CAN, NPK, Roundup, Copper e.t.c

At the end of a production/marketing cycle, the farmer can use the records to make a profit and loss statement, calculate performance indicators and evaluate his business performance

Financial Records
Income and Expenditure records
Cash flow
Petty cash
Cash book Balance
Sheet Budget

Purchase record

Date	Item	Quantity	Price/unit	Total	Cumulative Total

Items include fertilizers, herbicides, insecticides and fungicides

Expenditure Records

Date	Activity / item	Quantity	Price/unit	Total	Cumulative Total

17.6.4 Risk management

Risk is any change in circumstances causing a business not to achieve its agreed target or budget and may to lead to reductions in profitability or even financial losses.

A business that effectively identifies, prioritizes, monitors and manages risks will perform best over a period of time. A comprehensive risk management strategy may involve a combination of risk avoidance, risk reduction and risk transfer.

The national coffee sub-sector is faced with risks that affects production, curtail potential markets, reduce margins and even ruin entire networks of growers, roasters, marketers, traders, and exporters.
The prevalence of these risks plays a part in reducing the incentives and willingness of financiers to lend to the sector.

17.6.5 Benefits of Risk Management

- Household empowerment
- More effective strategic planning
- Fewer costly surprises,
- Better outcomes in terms of effectiveness and efficiency
- More likelihood of attaining goals and objectives
- More likelihood of outcomes being sustainable
- Improved governance

17.6.6 Risks in the Coffee Sector

Production risks:

- Weather related events - droughts, floods, frost, sudden drop or increase in temperature
- Pest and disease outbreaks
- Fire outbreaks
- Theft
- Low involvement of women during planning and training
- Improper transition of farm management to youth and women

Enabling environment risks:

- Changes in government or business regulations
- Macro-economic environment
- Political risks
- Conflicts
- Trade restrictions

Market risks:

These are risks that materialize on the market level. They include:-

- Commodity and input price volatility
- Exchange rate and interest rate volatility
- Counterpart default risk.

Strategies of mitigating risks

- Producer associations to partner with supply chain actors (buyers) to benefit from the use of price risk management instruments
- To counter the effects of climate change, sub-sector actors need to invest in research and development to come up with sustainable strategies such as selection of drought and heat tolerant varieties, opening up of new coffee growing areas, planting shade trees, and soil and water conservation measures.
- Provide smallholder associations with technical training and support to improve governance, ability to financially manage their enterprises and improve their ability to access finance from commercial lenders.
- Facilitate lending to smallholder producer groups ;buyers to assist their suppliers in improving their access to finance by using their balance sheet strength to provide collateral on their behalf
- Encourage buyers to build direct relationships with Producers. This is based on mutual benefit with buyers securing quality supplies (and quantity) and producers accessing more affordable finance and receiving value-adding extension services to improve their productivity.
- Financial management knowledge

17.7 Information and communications technology (ICT) in the coffee sector

ICT covers any product that will store, retrieve, manipulate, transmit or receive information electronically in a digital form, e.g. personal computers, digital television, email, robots, digital phones and software application

17.7.1 Importance of ICT in the coffee sector

- Substitutes other more expensive means of communicating and transacting business such as physical travel. It thus reduces transaction costs and improves accuracy and efficiency for both farmers and service providers
- Monitoring - the Board of Directors are able to log in and electronically monitor transactions thus enhancing transparency and effectiveness of official controls
- Increases choice in the market place and provide access to otherwise unavailable goods and services
- Widens the geographic scope of potential markets
- Improved efficiency and accurate reporting by the coffee sub-sector.
- Enhanced revenue generation in the sector

17.7.2 Key areas in the coffee value chain where ICT can be targeted

- Farmers records – area under coffee, tree population, cherry deliveries, varieties, membership, men, women, youth
- Factory records – Inventory - drying lines, production, Activity records, Inputs records, Labour records, Financial records
- Factory and society costs records – pulping labour, drying, sorting and sales,
- Farmers Payments record – totals, rates per kg,
- Identification of problems in the farms – insect pets, diseases, nutritional deficiencies,
- Production of financial reports
- Markets exploration
- Calculation of indicators for monitoring and evaluation – Cherry /clean coffee, etc
- Collection of farm data using Mobile Applications
- Sharing the training materials in mobile applications

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Notes