MINISTY OF AGRICULTURE,
ANIMAL INDUSTRY AND FISHERIES

CLIMATE SMART COFFEE PRODUCTION MANUAL FOR EXTENSION WORKERS IN UGANDA

MAY 2025

FOREWORD

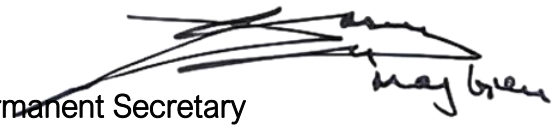
Coffee remains one of Uganda's most valuable agricultural commodities, providing livelihoods for millions of smallholder farmers and contributing significantly to the national economy. However, the effects of climate change ranging from unpredictable rainfall patterns to increased pest and disease pressure-are threatening the sustainability and productivity of the coffee sector.

Because of these challenges, the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) has prioritized the integration of climate-smart agriculture (CSA) into the coffee production systems. Climate-smart approaches offer a pathway to enhance productivity, build resilience to climate shocks, and reduce greenhouse gas emissions, thereby securing the future of coffee farming in Uganda.

This Climate-Smart Coffee Production Handbook for Extension Workers has been developed as a practical guide to support our frontline agricultural officers in delivering relevant, science-based, and actionable information to coffee farmers across the country. The handbook consolidates best practices, tools, and technologies that are locally adapted and climate-resilient, promoting sustainable land management, soil health, water conservation, and diversified income sources.

Extension workers play a critical role in the transformation of Uganda's agricultural sector. By Equipping them with this resource will improve capacity to support farmers in adopting climate-smart innovations that will sustain yields and incomes and contribute to national goals on climate change adaptation and mitigation.

On behalf of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), I thank all stakeholders, researchers, and development partners who contributed to the preparation of this handbook. Together, let us ensure that Uganda's coffee sector thrives despite a changing climate.



Permanent Secretary
Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Full Form
CSA	Climate-Smart Agriculture
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
NARO	National Agricultural Research Organisation
CBO	Community Based Organisation
NGO	Non-Governmental Organisation
DOM	Department of Meteorology
UCSATP	Uganda Climate Smart Agriculture Transformation Plan
NaCORI	National Coffee Research Institute
IPM	Integrated Pest Management
IWM	Integrated Weed Management
FFS	Farmer Field Schools
FAQ	Fair Average Quality
UGX	Uganda Shillings
CBA	Cost-Benefit Analysis
NPK	Nitrogen, Phosphorus, Potassium (fertilizer formulation)
ASN	Ammonium Sulphate Nitrate
DOM	Department of Meteorology
P2O5	Diphosphorus Pentoxide (phosphorus content in fertilizers)
MASL	Meters Above Sea Level

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

Coffee is Uganda's leading export crop and a major source of livelihood for over 1.7 million households. There are two types of coffee majorly grown that is Arabica and Robusta. Robusta coffee contributes about 80% of the coffee grown in Uganda and is grown in the low altitude areas, where as Arabica contributes 20% and is grown at high altitude. The productivity of Uganda's coffee sector is increasingly threatened by the adverse impacts of climate change such as extreme weather events. Climate change threatens coffee yields, quality, hence farmer incomes. As coffee is crucial for the country's economy and rural livelihoods, enhancing the sector's resilience to climate change is important for National growth and environmental sustainability.

1.2 PURPOSE OF THE MANUAL

The manual was developed for Agricultural Extension Workers, who serve as frontline agents of change within Uganda's coffee value chain. Its purpose is to strengthen capacity of extension workers to adopt climate-smart agriculture (CSA) practices in Robusta and Arabica coffee production. This manual complements other coffee management manuals and handbooks already in use by the sector.

1.3 OBJECTIVES OF THE MANUAL

The overall objective of this manual is to enhance the capacity of extension workers to support coffee farmers in adopting climate-smart agriculture (CSA) practices in Uganda. The specific objectives include:

- To increase understanding of climate change impacts on coffee production in Uganda.
- To provide practical guidance on CSA practices that enhance productivity, resilience, and sustainability in coffee farming.
- To equip extension workers with tools for farmer engagement, training, and CSA knowledge dissemination.
- To support alignment of coffee extension services with national climate change and agricultural development policies and strategies.

1.4 TARGET USER

This manual is designed for state and non-state actors, including agricultural extension workers, MAAIF staff, Non-Governmental Organisations (NGOs), Community Based Organisation (CBO) personnel, researchers, trainers, policymakers, and program implementers focused on coffee production in Uganda. Although primarily intended for

extension workers, the content is accessible and adaptable for various stakeholders engaged with coffee farmers.

1.5 OVERVIEW OF COFFEE PRODUCTION IN UGANDA

Coffee is a major source of income for Uganda, making up 14% of its exports and supporting millions of people. In 2023/24, Uganda produced 8.2 million bags and exported 6.12 million bags worth $1.145 billion. However, climate change, with its unpredictable weather and increased pests, poses a threat to coffee production, especially for the small-scale farmers who rely on rain. To combat this, the Ugandan government, through MAAIF, is focusing on climate-smart agriculture through various policies and programs like the National Climate Change Policy/strategy and UCSATP.

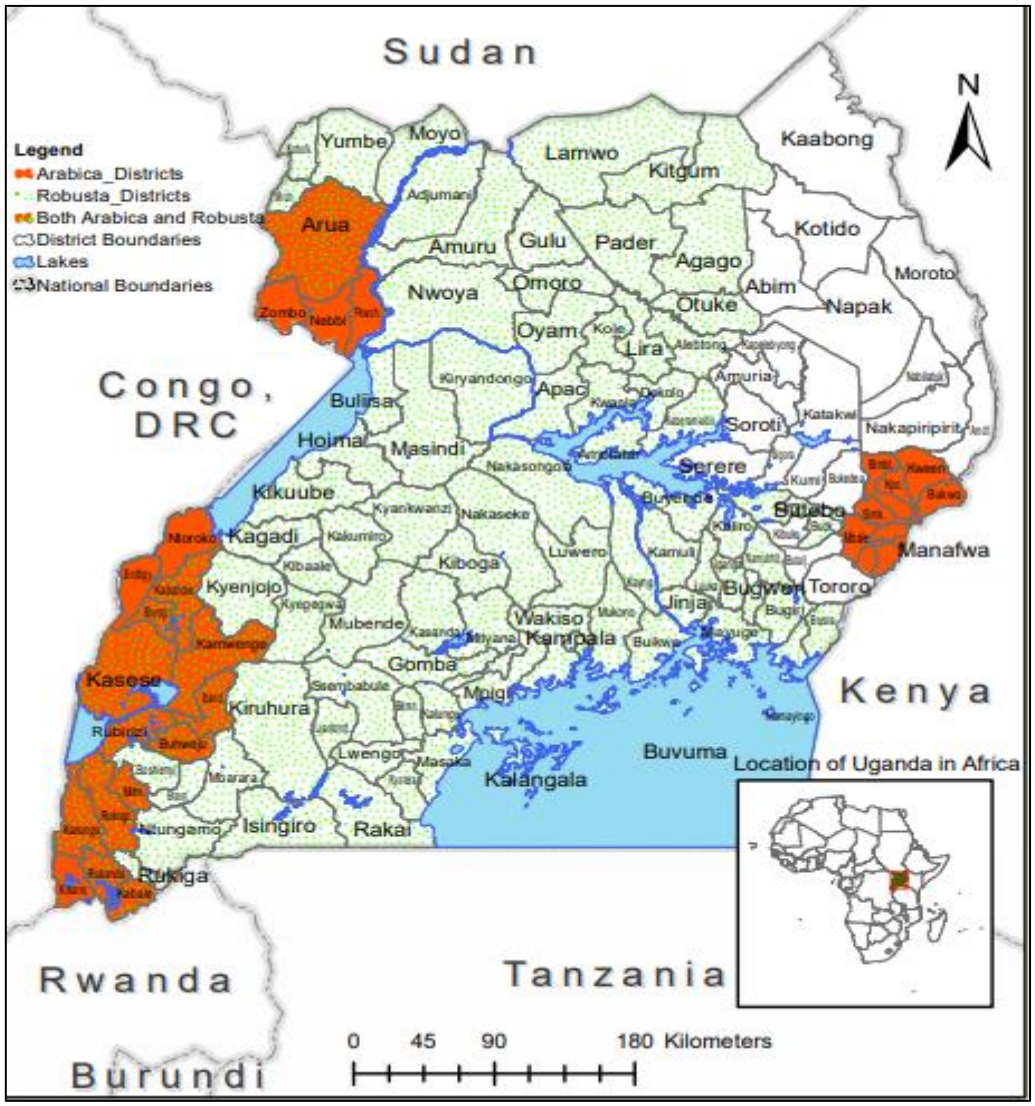


Figure 1: Map showing Arabica and Robusta growing areas in Uganda
Source: UCDA (2019), Arabica Coffee Handbook (Page 7)

CHAPTER 2: CLIMATE CHANGE IMPACT ON COFFEE PRODUCTION IN UGANDA

2.1 DEFINITION OF CLIMATE CHANGE

Climate change refers to a long-term alteration in average weather conditions, typically observed over a period of 30 years or more. One of the most visible indicators of climate change is the extreme weather events like erratic rainfall, prolonged dry spells and droughts, pest and disease resurgences.

2.2 CAUSES OF CLIMATE CHANGE

Climate change is largely driven by both human and natural factors.

2.2.1 Human activities

- bush burning,
- encroachment and destruction of wetlands,
- over grazing
- Deforestation
- Charcoal and brick burning
- Sand mining
- Burning of fossil fuels, such as oil and coal

2.2.2 Natural activities

- Volcanic eruptions
- Changes in the atmosphere e.g. solar radiation fluctuations
- Soil microbial activities releasing methane

2.3 OPTIMAL CLIMATIC CONDITIONS FOR COFFEE PRODUCTION

2.3.1 Robusta coffee

Robusta coffee is grown in the low altitude areas of Central, Eastern, Western and Southern Uganda which range from 900 – 1,200 meters above sea level (mask) and prefers long rainy periods and short dry seasons with optimum rainfall is between 2000 and 2500 mm normally received for at least 8 months per year with temperature range between 22°C to 28°C Robusta prefers a higher relative humidity of 75 %.

2.3.2 Arabica coffee

Arabica coffee is grown in the highland areas on the slopes of Mount Elgon in the East and Mt. Rwenzori and Mt. Muhabura in the South-western Uganda, of ranges between 1,500 – 2,300 masl with temperatures ranging from 15 °C and up to 25 °C and relative

Humidity of 60%. Arabica requires well distributed rainfall between 1200 and 1800 mm for a period of 9months.

2.4 CLIMATE SENSITIVE STAGES IN COFFEE PRODUCTION

2.4.1 Seedling

At this stage, the coffee needs adequate moisture to grow into a healthier seedling

2.4.2 Transplanting

After transplanting, there is need to shade the coffee seedlings from excessive heat stress. At this critical stage, adequate water should be supplied.

2.4.3 Flowering stage

- The growth of flower buds is stimulated by day length and cooler temperatures, conditions that are present at the beginning of the dry season.
- During the dry season, flower buds become dormant and flowering can only begin once the plant receives water. At this stage sufficient water is required.
- Robusta which requires cross-pollination could be affected if pollinators are impacted by climate change and variability.

2.4.4 Fruiting and ripening

- After successful pollination there is formation of green cherries. At this stage, cherries require sufficient water to facilitate fruit formation, development and bean quality especially the flavour.
- Temperatures exceeding 30°C can lead to physiological issues such as flower abortion, poor fruit setting, and premature ripening, while also reducing photosynthesis

2.5 IMPACTS OF CLIMATE CHANGE ON COFFEE PRODUCTION

Coffee is a climate-sensitive perennial crop, and any variability in climate conditions can significantly affect its yield, productivity, taste, aroma, and nutritional qualities. In Uganda, climate change is increasingly disrupting coffee production, threatening the livelihoods of millions of smallholder farmers and undermining the country's export economy. Rising temperatures, erratic rainfall, prolonged droughts, and increased outbreaks of pests and diseases have led to reduced yields, compromised bean quality, and a shift in traditional coffee-growing zones.

Both Robusta and Arabica coffee varieties are at risk, particularly in lowland and mid-altitude regions. Without timely and effective adaptation measures, the long-term sustainability of Uganda's coffee sector remains in serious jeopardy

2.6 CLIMATE SMART COFFEE PRODUCTION IN UGANDA

2.6.1 Why Climate Smart Agriculture?

Climate-Smart Agriculture (CSA) is an integrated and adaptive approach that aims to sustainably increase agricultural productivity, enhance the resilience of farming systems to climate variability, and reduce greenhouse gas emissions where possible. CSA also plays a pivotal role in ensuring food security and supporting broader socio-economic development goals.

In Uganda, where agriculture contributes significantly to both livelihoods and national GDP, CSA offers a transformative pathway to address the compounded challenges of climate change and food insecurity. The approach incorporates a wide range of sustainable land and resource management practices across key agricultural sectors, including crop production, livestock, forestry, and fisheries.

2.6.2 The three pillars of Climate Smart Agriculture

Productivity, Adaptation and Mitigation are identified as the three interlinked pillars of CSA as in the figure below.

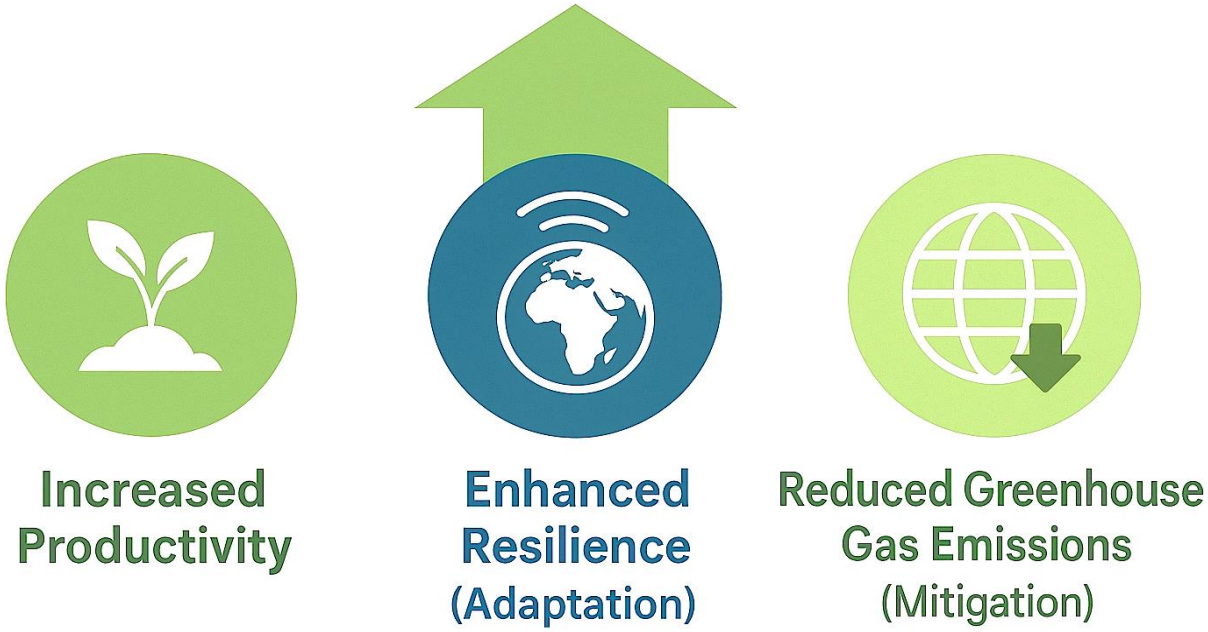


Figure 2: Illustration of the linkage of the CSA pillars

CHAPTER 3: ENTERPRISE PLANNING

3.1 GOAL SETTING

Coffee farming as a business requires farmers to set goals. A farmer should assess his/her strengths and weaknesses while reflecting on the following questions:

- What are your goals?
- Are they short term, medium or long term?
- Have you made any plans to achieve your goals?
- Are your plans climate smart?
- Note: During the goal setting, it is good to consult all relevant household members so that there is ownership and full support of the planned strategies.

3.2 BUSINESS CASE FOR COFFEE PRODUCTION

Cost Benefit Analysis is to ensure profitability before investing and it is crucial for farmers to understand the opportunities in the entire coffee value chain.

Table 1: CBA for Robusta Coffee Gross Margin per Hectare (UGX) (CBA)

ACTIVITY	Eligible (Y/N)	UNIT	COST (UGX)	ROBUSTA COFFEE			TOTAL
				QTTY	YEAR 1	YEAR 2	
Field preparation		Acre					
Bush Clearing	N	Acre	150.000	1	150.000		150.000
Land Opening - Ploughing	Y	Acre	150.000	1	150.000		150.000
Sub Total					**300.000**	**0**	**300.000**
Field establishment		Acre					
Organic Manure	N	Truck	150.000	2	300.000		300.000
Field marking	Y	Per hole	200	463	92.500		92.500
Digging planting holes for Coffee	Y	Per hole	500	463	231.250		231.250
Refilling the holes with soil and manure	Y	Per hole	500	463	231.250		231.250
Digging holes shade trees	Y	Per hole	500	40	20.000		20.000
Shade trees	Y	Seedlings	2000	40	80.000		80.000
Robusta seedlings	Y	seedlings	1500	463	693.750		693.750
Planting seedlings	Y	Per hole	500	463	231.250		231.250
Gap filling - Coffee	Y	Seedlings	1.500	93		139.500	139.500
Training for Robusta		Acre					100,000
Ring weeding		Acre			100,000	100,000	
Ring mulching		Acre					100,000
pruning		Acre					100,000

Table 2: CBA for Arabica Coffee Gross Margin per Hectare (UGX) (CBA)

ACTIVITY	Eligible (Y/N)	UNIT	COST (UGX)	ARABICA COFFEE			TOTAL
				QTTY	YEAR 1	YEAR 2	
Field preparation							
Bush Clearing	N	Acre	150.000	1	150.000	0	150.000
Land Opening - Ploughing	Y	Acre	150.000	1	150.000	0	150.000
Sub Total				2	300.000	0	300.000
Field establishment		Acre					
Organic Manure	N	Truck	150.000	2	300.000	0	300.000
Field marking	Y	Per hole	200	463	92.500	0	92.500
Digging holes for Coffee	Y	Per Hole	500	463	231.250	0	231.250
Refilling the holes with soil and manure	Y	Hole refilling	500	463	231.250	0	231.250
Digging holes shade trees	Y	Per hole	500	40	20.000	0	20.000
Shade trees seedlings	Y	Seedlings	2000	40	80.000	0	80.000
Arabica seedlings	Y	Seedlings	1500	463	693.750	0	693.750
Planting Seedlngs	Y	Per `hole	500	463	231.250	0	231.250
Seedlings gap filling -	Y	Seedlings	1.500	93	0	139.500	139.500
Training for Robusta		Acre					100,000
Ring weeding		Acre			100,000	100,000	100,000
Ring mulching		Acre					100,000
pruning		Acre					100,000

3.3 BUSINESS PLAN FOR COFFEE FARMING

A business plan is a written outline of a business's future, serving as a roadmap that details objectives and strategies for achieving them.

- It's essential for all businesses, regardless of size, as it promotes organization and ensures all necessary steps are considered.
- Additionally, it is a crucial document for obtaining funding or credit from financial institutions.

A Business plan serves 3 purposes:

- Communication tool-attracts capital, loans and partners.
- Management tool-tracks, monitors, evaluates business progress.
- Planning tool-guides you through various business phases.

Business Planning is a process and not an event hence requires simple business surveys and consultations. It is a living document and should be updated or reviewed during and after the season.

Figure 3: Illustration of a business plan
Source: Dream time.com

Figure 4: Components of a business plan

3.4 AGRO-ECOLOGICAL REQUIREMENTS AND SITE SELECTION

Table 2: Ecological Requirement and site Selection for Different Coffee types

Requirement	Robusta *(C. canephora)*	Arabica (*C. arabica*)
Soil type & pH	Fertile, free-draining, slightly acidic volcanic red earth or sandy loams; training pH 5.5–6.5 (lime if <5.5)	Fertile, well-aerated, free-draining, slightly acidic volcanic red earth or sandy loams rich in organic matter; pH 5.5–6.5
Soil depth	1–1.5 m in moist areas; up to 3 m in drier zones	≥ 1 m before encountering an impermeable layer
Altitude	900–1 500 m a.s.l.; higher-elevation Robusta (≈1 200 m) yields more acidity/complexity	1 200–2 500 m a.s.l. (premium quality at 1 500–2 500 m)
Temperature	22–28 °C optimum; tolerates heat better; above 30 °C causes physiological disorders; frost damage below 0 °C	Optimum daily 15–24 °C; < 15 °C or > 24 °C stresses the plant; frost susceptible
Rainfall	1 200–1 800 mm yr^{-1} over ≈9 months; 25 mm every 14 days (≈20 L/plant) to stimulate flowering/fruit set	1 200–1 800 mm yr^{-1}, well-distributed over ≈9 months; 50 mm every 10 days during dry spells
Relative humidity (RH)	60–75 %	40–60 %
Wind	Strong winds increase water demand and risk of breakage; establish windbreakers	Sensitive to strong winds (increased evapotranspiration, stem breakage); windbreakers recommended
Slope & drainage	Gentle slopes to level fields preferred to facilitate drainage and mechanization	Gentle to moderate slopes to ensure good drainage and avoid water-logging
Shade	Tolerates full sun but benefits from shade in in very hot/windy sites; shade trees improve micro-climate	Moderate shade recommended (shade trees reduce frost risk and buffer temperature extremes)

3.5 CLIMATE AND WEATHER INFORMATION

Timely climate information and effective weather forecast services are critical components of CSA in coffee production. With increasing climate variability, understanding weather patterns can significantly influence agricultural practices, productivity, and sustainability in the following ways.

- Farmers make informed decisions
- Enhanced yields as a result of aligned sowing with optimal weather conditions
- Efficient water management especially during dry spells.
- Mitigation of risks associated with pest and disease outbreaks and extreme weather events.
- Engaging with extension services and digital platforms for real-time climate information.
- Farmers and all stakeholders should look out for seasonal, monthly, weekly and daily forecasts from the Department of Meteorology or agricultural extension workers in the districts for better decision making.

3.6 SOIL TESTING

- Soil testing is essential before starting a coffee plantation as it assesses soil composition, nutrients, and characteristics.
- This allows farmers to understand nutrient levels and implement evidence-based soil fertility management practices.
- Fertilizer and manure application should be based on the recommendations from the soil testing report.

3.7 VARIETY SELECTION

A prospective coffee farmer should carefully choose a mix of high-yielding coffee varieties that are also drought and disease tolerant. The planting material must be obtained from a MAAIF Certified Coffee Nursery.

CHAPTER 4: CLIMATE SMART PRACTICES FOR COFFEE PRODUCTION

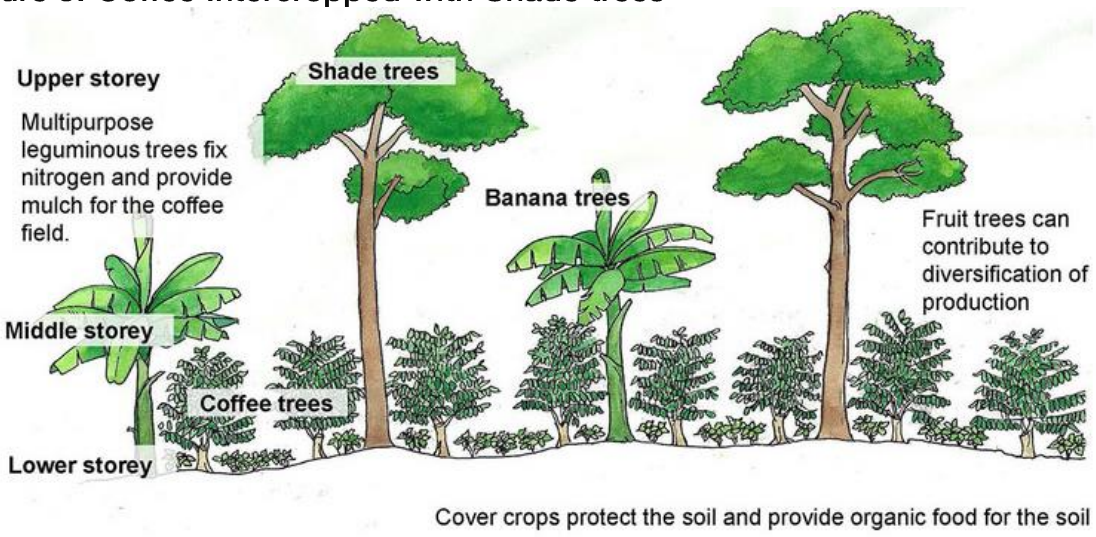
Climate-smart practices for coffee production aim to increase productivity and resilience while reducing greenhouse gas emissions. Uganda's coffee sector is especially vulnerable to climate change impacts such as unpredictable rainfall, rising temperatures, and increased pest and disease outbreaks (e.g., coffee wilt disease and coffee berry disease).

4.1 KEY CLIMATE-SMART AGRICULTURAL PRACTICES FOR COFFEE PRODUCTION

4.1.1 Agroforestry

- Practice: Planting shade trees (e.g., Albizia, Ficus, Grevillea) among coffee plants
- Recommended spacing for shade trees is between 20 and 40 meters, depending on the species and canopy size.
- Benefits: Regulates microclimate, reduces temperature stress, conserves moisture, improves soil fertility, and sequesters carbon.

Figure 5: Coffee Intercropped with Shade trees



https://www.organic-africa.net/organic-agriculture/organic-agriculture/crop-management/coffee/improving-productivity-of-coffee-gardens.

Table 3: Tree species are recommended for growing in different regions of Uganda

S/N	Region	Tree Species
1	Central Region	*Ficus natalensis* (Mutuba, *Albizia coriaria* (Mugavu, Musisiya, *Ficus mucuso* (Mukunyu, Kabalira
2	Mid-Northern Sub-Region	*Ficus natalensis* (Annar, Ananga), *Albizia coriaria* (Litek, Ober, abata, Latoligo Omogi, Ayekayek), *Cordia africana* (Akoiyi) *Ficus ovata* (kwoyo, pwoyo)
3	South and Western Region	*Ficus natalensis* (Mutooma, Ekitooma, *Ibizia coriaria* (Musisa, Murongo, Muyenzayenze, *Ficus mucuso* (Mukunyu)
4	Busoga Sub-Region	*Ficus natalensis* (Mugaire, Kiryanyonyi), *Ficus mucuso* (Mukunyu, *Ficus ovata* (Kookowe)
5	West Nile Region	*Ficus natalensis* (Mutuba, Ubi, Laru), *Albizia coriaria* (Oyo) *Ficus mucuso* (Uwi)

4.2 SOIL AND WATER CONSERVATION TECHNIQUES:

4.2.1 Minimum tillage

Minimum tillage is a sustainable soil management practice that involves minimal disturbance of the soil during land preparation. An example is the Strip and Spot Tillage, where only narrow strips or spots where planting will occur are tilled, leaving the rest of the soil undisturbed. This helps maintain soil structure, reduce erosion, and preserve soil moisture, especially crucial during unpredictable weather patterns.

4.2.2 Contour bunds and terracing in hilly areas

Contour terracing is a proven climate-smart technique for managing soil erosion and enhancing water retention, especially on sloped landscapes.

Figure 6: Planting along the contours

- It involves creating soil embankments along the natural contours of the land to slow down surface runoff and encourage rainwater infiltration.
- Two widely practiced methods are “Fanya Juu” where soil is heaped on the upper side of the trench and “Fanya Chini” where soil is placed on the lower side.

4.2.3 Mulching with organic material

Mulching, involves covering the soil around and between coffee trees with organic materials such as dried grass, maize stalks, bean haulms, coffee husks, straws, or compost manure.

Note: It's important to maintain a mulch layer of 5–15 cm depth and avoid direct contact with the coffee stem—keeping a distance of 15 cm for young trees and 30 cm for mature ones to prevent collar rot, pest

Figure 7: Coffee under mulch

4.2.4 Cover cropping

Integrating cover crops such as Mucuna, Lablab, and Indigofera spicata is a climate-resilient strategy widely applicable in Uganda. These leguminous plants suppress weeds, reduce soil temperature, and improve moisture retention. In monocropped coffee systems, such as those in Luweero or Mbale, cover crops offer essential soil cover especially during the dry season, and significantly enhance soil structure and fertility.

Figure 8: Intercropping with leguminous crop

4.3 SOIL FERTILITY MANAGEMENT

Soil fertility management is the practice of maintaining or improving the soils ability to provide nutrients for plants growth and ensuring the long-term productivity of the crop.

4.3.1 Organic manure

It is a natural fertilizer made from animal waste or decomposed plant matter. It includes farm-yard manure, green manure, oil cakes, and biological wastes (animal).

Preparation and application of organic manure

a) Heap Composting

The procedure for composting involves several layers to create a balanced and effective compost pile. Procedure:

- Lay a base of at least 30 cm of rough vegetation (e.g., dry maize stalks, hedge cuttings).
- Add 10 cm layer of manure, old compost, or slurry, topped with a light sprinkling of topsoil.
- Then add a 15-20 cm layer of green vegetation (e.g., grass, weeds), and if available, sprinkle wood ash on top of this layer. Water the pile adequately.
- Repeat layers in the same order until the pile reaches a height of 1-1.5 meters.
- Top the final layer with a 10 cm layer of topsoil to retain gases.
- Cover the entire pile with dry vegetation to minimize moisture loss.
- Water the compost every three days during dry weather, keeping it moist but not overly wet.
- Use a pointed stick to monitor moisture and temperature. Within 2-3 days, decomposition will generate heat. Check for adequate warmth and moisture using the stick.
- After six weeks (three weeks post-second turning), the compost is ready for use.

Process of composting

b) Pit composting

This procedure involves creating compost in dug-out pits in the ground as illustrated in Figure 12

Process

1. Create three adjacent pits, each 1.5-2m wide and 1m deep, considering local soil conditions.
2. Start with a 10cm layer of hard-to-decompose materials (twigs, stalks) at the bottom.
3. Add a 10cm layer of easily decomposable materials (green, fresh materials).

Figure 9: Process of making compost

4. Include a 2cm layer of animal manure (if available).
5. Top with a thin layer of surface soil to introduce microorganisms.
6. Repeat the layering process until the pile reaches 1-1.5m in height.
7. Cover the heap with grass or leaves (e.g., banana leaves) to prevent moisture loss.
8. later, move them to the third pit, while adding new materials to the first pit to maintain continual composting.
9. Once the compost is ready, store it properly to preserve its fertility.

Application:

Organic manure should be directly applied as a soil amendment (in planting holes) before planting or in top dressing

Organic manure application around a coffee tree (ring method application) looks like application of NPK

Ring method application Organic manure application around a coffee tree. Ring application is used as well in the application of inorganic fertilizers like NPK. The ring radius is the distance from the stem to the outer leaves of a plant.

Figure 10: Ring method of organic manure application

4.3.2 Application of mineral (inorganic) fertilizers

While using mineral fertilizer, consider the use of multi-nutrient formulations often consist of complete and balanced fertilizers that provide key nutrients like nitrogen, phosphorus, and potassium, along with micronutrients such as calcium, magnesium, boron, and manganese.

Table 4: Fertilizer application program for Robusta Coffee

Period of Application	Fertilizer	Application Tree	Role	Amount Per Acre
About a month to planting	Lime (if soil pH is <5.5	100 g/hole	Neutralizing acidity	45Kgs
	Organic manure	20L basin of decomposed cattle manure (mix with soil)	Improving soil structure	450 basins
At planting	Single super phosphate (18-22% P2O5)	60 g/tree	Enhances early root formation, growth, wood and fruit formation	27Kgs
Young coffee (Newly planted)	Compound fertilizer: NPK (25:5:5)	If pH > 5.4 75 g/tree/rain season	Increase vegetative growth	33.75Kgs
	Urea	N- deficient 76 g/tree/rain season	Increase vegetative growth	34.2Kgs
Young coffee (More than 2 years)	Compound fertilizer: NPK (25:5:5)	If pH > 5.4 150 g/tree/rain season	Balance vegetative growth and berry production	67.5Kgs
	Calcium ammonium nitrate (26% N)	If Soil PH < 5.5, 250 g/tree/rain season	1st season (April) for inducing fruit formation & 2nd season for enhancing fruit ripening	112.5Kgs
	Ammonium sulphate nitrate (26% N)	Soil PH < 5.5, Use ASN (26 %) at 250 g/tree/rain season	Increase vegetative growth	112.5Kgs
	Urea	250 g/tree/rain season	Increase vegetative growth	112.5Kgs
	Cattle manure	10 Kg/tree/year	Increase vegetative growth	4.5tons
Mature coffee (5 options)	Murate of potash (62% K2O	200 g/tree/season	For fruit maturation Increased ability to withstand pests &	90Kgs

			diseases, drought, frost Improves quality (aroma, colour, taste, shelf-life)	
	NPK 15:2:31	250 g/tree/rain season	Balances vegetative growth and flowering	115.2Kgs
	Calcium ammonium nitrate (26% N)	Soil PH < 5.5, 256g/ tree/season	1st season (April) for inducing fruit formation & 2nd season for enhancing fruit ripening	115.2Kgs
	Ammonium sulphate nitrate (26% N) OR	Soil PH < 5.5, 250 g/tree/season ASN	Supplies nitrogen, reduces pH	115.2Kgs
	Double Super phosphate (40-49% P2O5)s	P -deficient 200 g/tree/year	Supplies phosphate Early maturity of berries	90Kgs
	Compound fertilizer (NPK 25:5:5)	250 g/tree/rainy season	Balance vegetative growth and berry production	115.2Kgs

4.3.1 Using climate-resilient coffee varieties

Adopting the disease- and drought-tolerant varieties such as those bred by the National Coffee Research Institute (NaCORI). Examples include varieties resistant to Coffee Wilt Disease (CWD), the Kintuza Robusta (KR) clones.

Figure 11:Coffee seedlings in nursey Bed

4.3.2 Efficient Water Use and Irrigation

Methods like drip irrigation, use of water-harvesting structures like ponds or tanks. This is important and critical for maintaining production during dry spells.

Figure 12:Coffee under drip irrigation

Figure 13:Pond water harvesting structure for irrigation

4.3.3 Weather and climate information services

Department of meteorology Services (DOMs) provide short-term weather forecasts, seasonal climate predictions, and long-term climate information. Weather forecasts and climate information can be accessed through District production offices or sub county notice board, radio, SMS, or apps. This helps farmers time planting, spraying, and harvesting more effectively.

4.3.4 Training or Bending of Coffee Stem

The multiple-stem training system is recommended for Robusta coffee farming to enhance productivity and climate resilience, particularly in taller, traditional varieties. The process of how to train coffee to develop multi stems is presented in figure 14

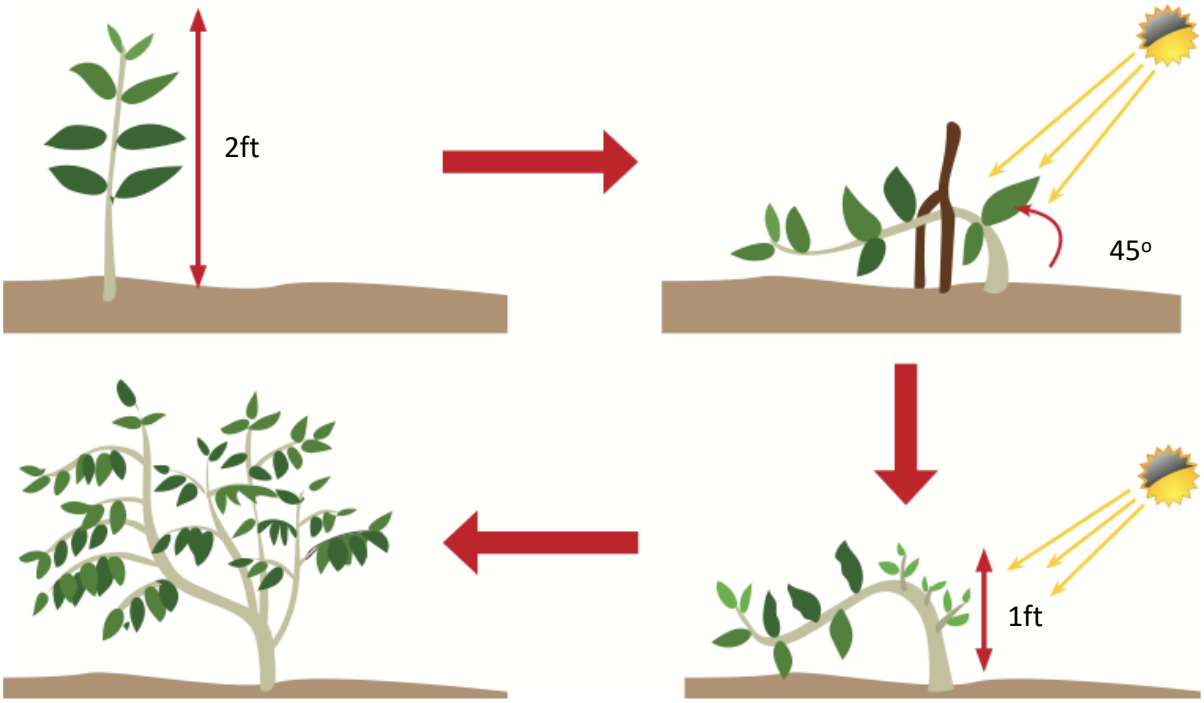


Figure 14: Process of training coffee plant for multi stems
Source: UCDA charts

Bend the main coffee stem at 5–6 months post-planting (when It has reached about 60cm) in an East–West direction and peg it at a 45° angle to promote the growth of multiple vigorous suckers and fosters faster canopy coverage

Steps:

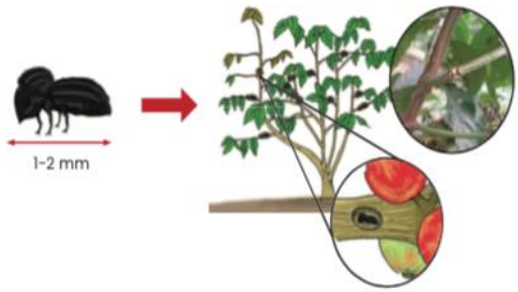
- Select three strong stems—either two new suckers and then bend
- Ensure the sucker is about 15cm from the ground and evenly spaced for balance and airflow to mitigate pests and diseases.
- For drier regions like Teso and Luweero, an alternative method called “capping” is suggested, where the main stem is cut back to 15–30cm to encourage sucker growth and conserve soil moisture.
- Once the suckers reach 30cm, the bent stem can return to an upright position.
- Consistency in bending direction across all plants is key, along with integrating mulching and soil conservation strategies for improved long-term productivity amid climate challenges.

CHAPTER 5: PEST AND DISEASE MANAGEMENT

Coffee plants can be affected by pests and diseases while in the nursery as seedlings, in the field or garden, at tender to mature trees bearing cherries and as stored products.

5.1 COMMON COFFEE PESTS

a. Black Coffee Twig Borer



Symptoms

- Galleries made into the heartwood of the coffee
- Death of the most precious part that carries coffee beans.

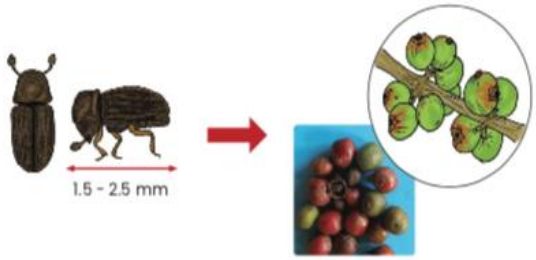
Management Practices

- Pruning off unwanted stems and branches.
- Disinfect materials used to cut off the twigs or unwanted branches.
- Use Brocca traps – baited traps to capture the marauding adult female

Cultural control which includes;

- Use of phytosanitary measures like cutting, chopping and burning affected plant parts (stems/ primaries).
- Avoid use of alternate host trees of the black coffee twig borer such as Musizi (*Maesopsis eminii)* and *Musambya (Markhamia platycalyx*) as intercrops/shade trees.
- Use of pest-free planting materials from only
- Enhance plant nutrition through soil fertility and moisture management
- Use the NARO-Uganda Beetle Trap Technology/ Brocca trap

b. Coffee Berry Borer



Symptoms

- Small, round holes (1 mm diameter) visible near tip of berry.
- Beans become blue-green, young berries may rot.
- Adult borer present in or on berries or beans.
- Small white larvae seen in bean.

Management Practices

- Orchard hygiene (keeping the area clean, removing dropped cherries, removing carry-over fruit from coffee bushes are suggested),

- Crop bags should be fumigated before being transported to other coffee growing areas.
- Use of Ethyl alcohol and methyl alcohol at a rate of 1:1 is effective in trapping
- Careful drying of coffee cherry or parchment reduces reproduction of the pest
- Prune shade trees and apply their recommended spacing
- Spray coffee trees with Imax (Imidacloprid) at 4mls per litre mixed with ORIUS (Tebucozanole) at 6m/s per litre.

c. Scales (various species)

Symptoms

- Discolouration and deformation of leaves and other plant parts.
- Leaves turn yellow and droop.
- Roots become stunted.
- Gradual dieback of plant observed.
- Scales produce (sugary) honeydew that drips onto leaves and plant parts

Management Practices

- Regular inspection of trees is important in order that infestation can be identified at an early stage and apply management approaches swiftly before the insect numbers become too high

d. Scales (various species)

Symptoms

- Wilting of leaves yellowing and falling from the plant.
- Plant may die in whole or parts

Management Practices

- Complete removal and replacing of badly damaged or dead trees remove suckers and branches that touch the ground to prevent ants has in some cases been effective.
- Apply oils (such as vegetable oils, neem oil or mineral oils) or soapy solutions (1 to 2%) to kill mealy bugs by suffocation
- Use soapy water or oils only during non- hot and non-sunny periods to prevent discoloration of leaves.
- Use of predator such as the mealy bug ladybird to feed on.

e. Scales (various species)	Symptoms
	➢ Wilting of leaves yellowing and falling from the plant. ➢ Plant may die in whole or parts

Management Practices

- Use a coffee white stem borer pheromone trap, i.e. cross-vane pheromone trap, to catch beetles during flight periods; keep spacing of 20m between traps.
- Look for zigzag tunnels in the woody tissue by splitting branch/trunk, and excreta tightly filled by grubs.
- Look for infested plants showing yellowing and wilting of leaves, presence of ridges on the stem, wilted branches and drying plants.
- Look for ridges on the main stem for thick primaries and the level of infestation.
- Identify, remove and destroy (burn) borer infested plants (before the beetles emerge - flight time) to reduce pest infestation.
- Apply paste of neem, garlic, and marigold flower in equal proportion mixed with vegetable oil on the stem twice a year (September and March).

f. Termites	Symptoms
	Dead wood encourages termites to build nests. Management practices in next page

Management Practices

- Plant coffee in clean ground where all tree parts, of dead wood including roots have been removed.
- Effective pruning of dead wood on coffee trees..
- Permethrin 60 to 80 g/L sprayed on the ground and on base of coffee trees after planting will assist

5.2 INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM) in coffee is a sustainable, environmentally friendly approach that combines multiple strategies to control pests while minimizing risks to humans, animals, and the environment. In coffee cultivation, IPM aims to manage pests like insects, diseases, and weeds using a combination of biological, cultural, mechanical, and chemical methods.

5.2.1 IPM components used in managing coffee pests

a. Monitoring and Identification

- Regular scouting for pests like coffee berry borer (Hypothenemus hampei), leaf rust (Hemileia vastatrix), and coffee mealybugs.
- Use of traps (e.g., alcohol-baited traps for berry borers) and field sampling.

b. Cultural Controls

    - Shade management: Optimizing shade trees to regulate microclimate and pest populations.

c. Pruning and sanitation

    - Removing infested or diseased branches and berries to reduce pest breeding grounds.

d. Proper spacing and drainage

    - Reducing humidity and disease pressure.

e. Biological Controls

    - Natural predators and parasitoids
    - Promoting or releasing beneficial insects such as Phymastichus coffea, a parasitoid wasp that attacks the coffee berry borer.

f. Mechanical and Physical Controls

    - Traps: For monitoring and mass-trapping pests (especially borers).
    - Hand-picking: Removing and destroying infested berries or branches.

g. Chemical Control

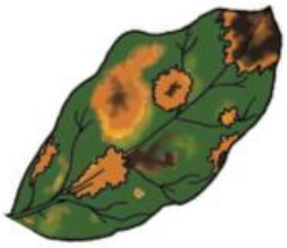
    - Used as a last resort.
    - Use of selective, low-toxicity pesticides only when economic thresholds are exceeded.
    - Application should follow best practices to avoid resistance and harm to beneficial organisms.

h. Use of. Resistant Varieties

- Planting coffee varieties that are resistant to diseases like coffee leaf rust

5.3 COMMON COFFEE DISEASES

a. Disease Coffee Leaf Rust (Fungal)



Symptoms

- Yellow-orange powdery spots on underside of leaves.
- Corresponding yellow-white patches on upper surface of leaf

Management Practices

- Good field management practices starting with proper field preparation,
- Clean planting materials from recommended nurseries,
- Cultural practices such as proper pruning, weeding etc.
- The use of resistant/ tolerant varieties if available is effective.
- Chemical control is not economical and is not recommended in the case of Robusta Coffee but rather in Arabica where it can be very destructive.

b. Coffee Berry Disease (Fungal

Symptoms

- Dark brown-black, slightly sunken lesions develop on green berries.
- Pink powder (spores of fungus) may be visible on lesions.
- Berries eventually rot.

Management Practices

- Improve soil fertility by adding manure / fertilizer
- Apply copper based fungicides

c. Coffee Wilt Disease (FUNGUS)

Symptoms

- Cause leaves to fall and branches to die
- Cherries to appear ripe prematurely.
- Leaves yellow up, dry and fall from tree.
- Blue-black discoloration of wood beneath bar
- Tree eventually dies

Management Practices

- Good planting materials
- Trees attacked by the disease must be destroyed
- land should be left fallow or an alternative crop grown

- Treat wounds with disinfectant or a suitable fungicide soon after the wounds are made
- Infected field by coffee wilt disease should not be replanted with coffee for at least 11/ years.
- Uproot the infected trees
- Garden tools in infected fields must be sterilized with disinfectant e.g. Jik

d. Coffee Red Blister

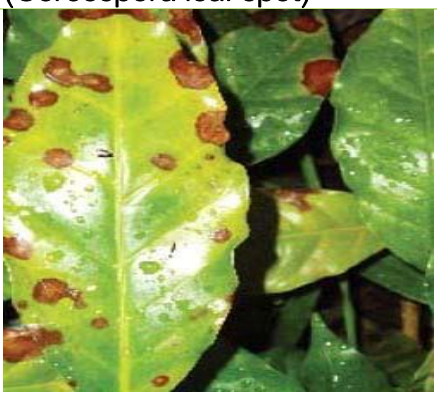
Symptoms

- Cause leaves to fall and branches to die
- Cherries to appear ripe prematurely.
- Leaves yellow up, dry and fall from tree.
- Blue-black discoloration of wood beneath bar
- Tree eventually dies
- Uganda and Bukoba area in Tanzania.
- It occurs in both Robusta and Arabica Coffee grown in the low land areas.

Management Practices

- use of tolerant/resistant varieties
- Good soil fertility management plan by adding NPK or organic manure.
- Maintain proper pruning, proper plant spacing and destroy infected coffee debris.
- Ensure proper drainage.

e. Brown Eye Spot (Cercospora leaf spot)



Symptoms

- Small pale yellow-white circular or angular spots develop between leaf veins on upper
- Leaf surface. Spots enlarge to become reddish-brown with greyish center.
- Leaf spots may be surrounded by a yellow border.
- Reddish-dark brown patchy lesions develop on berries (‘
- Small red spots (‘red blister’) appear on green or ripening berries.

Management Practices

- Maintain well-fertilised plants with 50% shade cover.
- Should not be needed with good management.
- Copper sprays such as the following will give control in severe cases on isolated plants: copper cupravit (85% WP) at 80g/20L water, Copper oxychloride 80 g/20 L water, Copper hydroxide at 40 g/20 L water.

5.4 INTEGRATED WEED MANAGEMENT PRACTICES IN COFFEE PRODUCTION

Integrated Weed Management (IWM) is a comprehensive approach that combines various strategies to control weed populations effectively while minimizing environmental

impact. In coffee production, IWM practices are essential for maintaining healthy plantations and ensuring high yields.

5.4.1 Key components of IWM in coffee farming

i. Timely Weeding

Implementing timely weeding practices is crucial for effective weed management through addressing weeds when they are small makes them easier to control and prevents them from becoming established.

ii. Manual Control Methods

- Manual weed control involves physically removing weeds from the plantation
- Hand Weeding: Farmers use tools such as hoes and machetes to uproot or cut weeds.
- It is labour-intensive but allows for precise targeting of unwanted plants, especially when they are young.

iii. Cultural Control Methods

- Cultural practices in weed control are non-chemical methods that involve modifying farming techniques or environmental conditions to reduce weed growth and competition. examples:
- Crop Rotation, cover Cropping, (e.g., mucuna) helps suppress weeds by shading them out and competing for nutrients and water., mulching, tillage and soil preparation, planting Density and Row Spacing Sanitation Practices, proper fertilization and irrigation and Shade Management:
- Mulching: Applying organic or inorganic materials around coffee plants to suppress weed growth by blocking sunlight and preventing seed germination.

iv. Chemical Control Methods

- Chemical methods involve using herbicides to manage weed populations effectively.
- Pre-emergent Herbicides: These are applied before weeds germinate, creating a barrier that prevents seed sprouting. They are particularly useful against annual weeds.
- Post-emergent Herbicides: These are used on already emerged weeds and can be selective (targeting specific species) or non-selective (affecting all vegetation). Selective herbicides are preferred in coffee plantations to minimize damage to the coffee plants themselves.

5.5 SEASONAL FORECAST IN PESTS AND DISEASES

Seasonal forecasting in pests and diseases refers to the prediction of pest and disease outbreaks based on weather patterns, climatic conditions, and biological cycles of pests. This forecasting is crucial for agricultural management as it helps farmers and agronomists prepare for potential infestations or disease outbreaks that could affect crop yields.

CHAPTER 6: COFFEE HARVESTING, POST-HARVEST HANDLING AND VALUE ADDITION PRACTICES

6.1 HARVESTING PRACTICES

6.1.1 Timely harvesting

This is crucial in the coffee value chain for maintaining quality.

This process involves picking ripe coffee berries, which ripen at intervals of 10-15 selectively picking of only red ripe cherries at an interval of 10-15 days

.

Figure 15: A farmer harvesting ripe coffee Cherrie

6.1.2 The Do's and Don'ts during coffee harvesting

- Use clean containers while harvesting
- Use clean tarpaulin
- Immediately after harvesting, remove leaves, twigs and start drying the coffee
- Avoid harvesting over-ripe and immature cherries because they result into poor cup taste in addition to the possibility of mould growth.
- Avoid strip picking of coffee at all costs.
- Apart from stripping immature cherries destroying leaves, it also damages coffee bearing loci and parts of the primary branches, thereby, reducing yields in the subsequent season.

Figure 16: Appearance of strip-picked coffee

6.2 COFFEE DRYING PRACTICES AND TECHNIQUES

6.2.1 Drying coffee under Sun

This is a simple, natural method of drying coffee cherries directly after picking.

- This process primarily uses the sun and takes 14-30 days, depending on weather.
- Drying is crucial for reducing the moisture content of coffee beans from 55-60% to a target of 12-14% before sale or further processing.
- Proper drying also influences the coffee's taste and aroma and is vital for preventing mold growth, including Ochratoxin A (OTA).
- Dried coffee should be black, odorless, and free of foreign material like stones, dust, and mold, with a minimum out-turn of 50%.
- Acceptable drying surfaces include cemented floors, tarpaulins, raised tables, and raised wire mesh.

Figure 17: Drying of Coffee on cemented concrete/Tarpaulin

Figure 18: Drying on bare ground: Not recommended

6.2.1 Improved drying methods for coffee

Raised drying beds

Improve airflow and reduce contamination risk.

Figure 19: Drying of Kiboko Coffee on raised tables

Figure 20: Coffee drying on raised mesh

6.2.2 Energy efficient drying

Use of large- or small-scale solar driers:

To quicken the drying time, use solar dryers as shown in Figure 21 and 22.

Figure 21: Large scale solar drier

Figure 22: Small-scale solar drier

Cherries must be turned with a rake to allow uniform drying and should be covered at night and during rainfall to avoid re-wetting.

During the first two or three days of drying ensure that the coffee layer is as thin as possible (not more than 4 cm or 1.5 inches thick) to speed-up the drying process and avoid mould growth.

6.3 COFFEE PROCESSING PRACTICES

Climate-smart coffee processing practices aim to reduce the environmental impact of coffee production while increasing resilience to climate change. These practices focus on minimizing water use, reducing greenhouse gas emissions, improving energy efficiency, and promoting waste recycling

6.4 KEY CLIMATE-SMART PRACTICES IN COFFEE PROCESSING:

6.4.1 Wet processing and Water-Saving Techniques

Eco-pulpers: Use less water than traditional pulping machines to remove the coffee cherry skin. A coffee echo pulper, also known as a disc pulper, is a machine used in coffee processing to remove the pulp (the fleshy outer layer) from the coffee cherry, leaving the parchment coffee.

Figure 23: Coffee echo pulper machine

Operating the pulper

- Prepare the Coffee Cherries.
- Start the flow of water through the pulper.
- Feed the coffee cherries gradually into the hopper
- Don't overload the machine, as this can reduce efficiency and potentially cause blockages.
- Monitor the Pulping Process
- If you notice a lot of unpulled cherries or damaged beans, you may need to adjust the clearance between the discs and the breast.
- After pulping, separate the parchment coffee from the pulp and water.
- The parchment coffee will still be wet and needs to undergo further processing, typically fermentation (depending on the desired coffee profile) and washing to remove any remaining mucilage (a sticky layer beneath the pulp) and then drying.
- Dispose of the Pulp, the coffee pulp is a byproduct. It can be used as compost or for other purposes

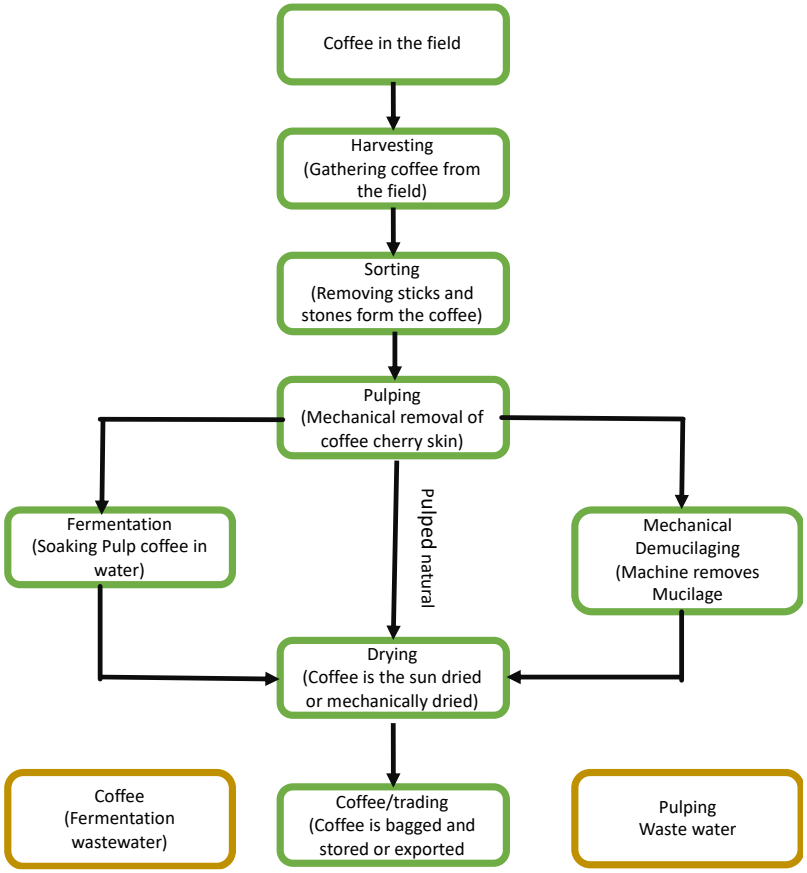


Figure 24: Wet processing flow chart method

6.4.2 Dry processing

Robusta coffee can be dry processed, but the drying process should start immediately after harvesting to avoid mold infestation.

Recommendations practices for proper drying of coffee

- Avoid drying coffee on the bare ground, instead use mats, tarpaulins, concrete floors or mesh on raised platforms in order to maintain good quality
- Spread the beans to a thin thickness and turn frequently to ensure even drying.
- Dry the coffee in batches as it is harvested and avoid mixing coffee harvested on different days.
- Each batch should be dried properly to 12 % moisture content before selling or delivering to the milling center.

6.5 STORAGE AND PACKAGING

Properly storing of coffee is crucial for maintaining its freshness, flavour, and aroma. It protects the coffee from oxidation, moisture and odours, which can all lead to a decline in quality.

6.5.1 Do's and Don'ts in coffee storage and packaging

- Isolate coffee store from strong smelling liquids such as petrol or paraffin or diesel, or agricultural fertilizers and chemicals to avoid contamination of the final cup.
- Dry coffee cherry (Kiboko) should either be stored in silos or clean sisal bags.
- Do not store parchment or Kiboko in polyethene bags as they will absorb moisture and grow mould due to condensation.
- The coffee store should have cemented floor, plastered wall and must be well ventilated and leak proof

- The coffee bags should be placed on pallets that are raised to at least 15cm to avoid wetting by ground moisture and stacked bags should be placed at least 30cm away from the walls and ceiling.

Figure 25: Coffee bags placed on pallets in a warehouse stack card

6.6 MANAGEMENT

6.6.1 Waste Management and By-product Utilization

- Composting coffee pulp and mucilage: Converts waste into organic fertilizer.
- Biogas digesters: Use coffee pulp and wastewater to produce methane for energy.
- Vermiculture: Use earthworms to process organic coffee waste into nutrient-rich soil.

6.6.2 Practices to achieve better wastewater management

a) Use of compost from coffee husks and pulp

Composting coffee pulp and other organic waste can provide valuable nutrients for soil enrichment, improving soil health and reducing reliance on synthetic fertilizers

b) Biogas production

- Utilizing coffee pulp for biogas production can generate renewable energy, reducing reliance on fossil fuels and creating a circular economy.
- Biogas production from coffee pulp involves preparing the pulp, mixing it with water, and using anaerobic digestion to convert it into biogas.
- The process typically includes pre-treatment of the pulp, inoculation with microorganisms, and digestion in a closed reactor.

c) Animal Feed

Coffee pulp can be used as a supplementary feed for livestock, providing a valuable source of nutrients and reducing waste.

d) Biochar Production

Pyrolysis of coffee waste can produce biochar, a carbon-rich material that can improve soil structure, water retention, and carbon sequestration.

e) Coffee Briquettes

- These are compressed blocks of ground coffee beans, often mixed with sawdust, that serve as a sustainable, eco-friendly fuel alternative to firewood and charcoal.
- They are formed by compressing coffee grounds into solid blocks, resulting in a fuel source that burns hotter and longer than traditional wood.

6.7 COFFEE VALUE ADDITION

Value addition focus on increasing the economic benefits for all actors, from farmers to exporters, by processing coffee beyond the basic green bean stage. This involves upgrading processing facilities, improving quality control, and exploring opportunities for local coffee consumption and branding

6.7.1 Key value addition practices for coffee

a). Processing and Roasting:

Investing in improved processing facilities, including washing facilities and modern mills, ensures higher quality green beans.

Roasting locally allows for the creation of finished products like ground coffee and instant coffee, increasing value and reducing reliance on export of raw materials.

Figure 26: Simple Coffee Roasting

b) Quality Control:

Implementing robust quality control measures throughout the value chain, from farm-gate to milling and export, helps ensure that Ugandan coffee meets international standards and commands higher prices.

Figure 27: Good quality coffee beans

c) Branding and Marketing:

Developing a unique Ugandan coffee brand that emphasizes the distinct characteristics of the coffee can help increase demand and premiums in the global market.

Figure 28:Sample of branding in coffee products

d) Promoting Local Consumption:

Encouraging local consumption of Ugandan coffee through initiatives like promotion campaigns helps build a domestic market for finished products and reduces reliance on export.

Figure 29: Person drinking coffee

e). Value Chain Linkages:

Strengthening linkages between farmers, cooperatives, processing plants, exporters, and local consumers can ensure a more efficient and profitable value chain for all actors.

f). Financial Support:

Providing access to affordable financing, such as through the Uganda Development Bank, can help value chain actors invest in value-adding equipment and technologies.

CHAPTER 7: SCALING UP CLIMATE SMART AGRICULTURE APPROACHES IN COFFEE VALUE CHAINS

This chapter highlights the technology dissemination approaches extension officers can adopt to engage farmers for facilitating the technology transfer of the CSA knowledge and skills discussed in the previous chapters above.

7.1 APPROACHES TO CSA UPSCALING

I) Individual/Household Approach:

- Tailored advisory services promoting resilient coffee varieties (e.g., drought-tolerant, early-maturing types).
- Promotion of soil and water conservation practices (e.g., mulching, minimum tillage).
- Supporting adoption of climate-informed planting calendars using timely seasonal forecasts.
- Encouraging home-based composting and organic manure use to reduce reliance on chemical inputs.
- Facilitating access to weather information to guide daily farming decisions.

II) Community Based Facilitators & farmer to farmer approach

The approach will involve;

- training selected local farmers as Trainer of Trainees (TOT) who in turn serve as resource persons for training of fellow farmers within their farmers groups, villages and parishes.
- encouraging Peer-to-peer learning and eases technology transfer by observation and demonstration among farmers communities.

III) Demonstration Plots (Demos) approach

This approach will involve on-farm demonstrations of technologies or practices and comparative demos (e.g. old Vs new, variety to variety)

IV) ICT-Based Extension Services approach

Disseminate of agricultural information and support farmers will offer a wide range of methods including;

- Use of mobile phones, radio, and apps for disseminating information
- Mobile social media and Digital platforms are now trending for real-time support to farmers with Smart Phones and tablets.

VI). Field Exchange Visits; it involves farmer-to-farmer visits across group-group, parish, sub county, district etc. where best practices, technologies and innovations in coffee production are shared

VII) Farmer Field Days

- These are educational events where farmers gather on site to learn about CSA TIMPs
- Organized events to showcase technologies and practices
- Participation of multiple stakeholders

viii) High-Level Farmer Organizations

A "high-level farmer organization" typically refers to a national farmer groups, associations, or cooperatives that represent and advocate for the interests of farmers at a broader level.

7.2 GENDER INTEGRATION IN CSA

Gender integration in climate-smart agriculture (CSA) is crucial for ensuring that both men and women can equally benefit from agricultural practices designed to enhance food security, improve resilience to climate change, and reduce greenhouse gas emissions in developing countries where they constitute approximately 60% of the agricultural labor force.

7.2.1 How to integrate gender in CSA

i) Gender-responsive extension services

- Develop climate-smart extension messages tailored to the needs and knowledge gaps of women youth and men in coffee farming.
- Train extension agents in gender-sensitive CSA communication, ensuring inclusion of women's voices in decision-making and learning.
- Use inclusive training schedules and venues to accommodate women's time constraints and domestic roles.

ii) Promoting women's access to CSA innovations

- Facilitate access to climate-resilient coffee varieties for women farmers through targeted seed distribution.
- Support women-friendly climate-smart technologies:
- Labour-saving tools (e.g., solar-powered threshers, planters)
- Clean energy drying solutions (e.g., solar dryers to reduce post-harvest losses)
- Provide targeted training for organic fertilizers and bio-inputs application for sustainable soil health.

iii. Strengthening women's role in climate-resilient value chains

- Engage women in CSA practices across the coffee value chain production, processing, storage, and marketing.
- Promote climate-resilient aggregation models where women can lead or co-manage collective coffee marketing initiatives.
- Support women cooperatives in accessing climate finance (e.g., weather-index insurance, green loans)

iv. Enhancing women's access to climate information

- Use gender-sensitive ICT platforms (radio, SMS, WhatsApp) to disseminate weather forecasts, climate alerts, and CSA tips.
- Involve women in community-based early warning systems and ensure they can act on the information (e.g., changing planting dates, pest control strategies).

v. Empowering women through climate-smart Farmer Field Schools (FFS)

- Design gender-balanced FFS groups with active participation of women in CSA trials and learning.
- Promote women as climate-smart lead farmers or FFS facilitators, reinforcing their role as knowledge carriers.

7.2.2 Outcomes of Gender-Smart CSA Integration

- Addressing gender inequalities in agriculture can lead to increased productivity and improved food security, as women often play a crucial role in farming but face systemic barriers.
- Gender integration empowers women by ensuring they have access to resources, information, and opportunities, allowing them to participate fully in agricultural decision-making and benefit from agricultural development.
- Integrating gender issues in agriculture can lead to sustainable practices and exacerbate inequalities, hindering overall development efforts.
- Increased resilience among women and their households to climate shocks (e.g., drought, erratic rains).
- Enhanced mitigation through promotion of sustainable practices like minimal tillage, crop rotation, and organic fertilization—led by both women and men.

CHAPTER 8: SAFE HANDLING AND USE OF AGRO-CHEMICALS

Agrochemicals are crop protection products used in production and preservation of crops or crop products. Agrochemicals are becoming an increasingly integral part of crop production.

8.1 GROUPS OF AGRO-CHEMICALS

- Herbicides (for killing weeds/herbs)
- Insecticides (for insect pests
- Fungicides (for fungal diseases)
- Nematicides (for nematodes)
- Rodenticides (for rodent pests)
- Fertilizers (providing plant nutrients)

However, Agro-chemicals are very harmful if not properly handled, can cause detrimental health hazards to the user, consumer and the environment.

8.2 SAFE USE OF AGRO CHEMICALS

To optimize use of agro-chemicals, it is important that proper identification of the exact problem is undertaken.

8.2.1 Buying agro-chemicals

- Always buy chemicals from licensed and registered agro-input dealer shops.
- Read the label on the container for expiry date and any other important messages e.g. active ingredient.
- Always buy pesticides in their original containers and also make sure the containers are intact.
- Where possible verify whether chemical is not a counterfeit by using Kakasa (e-tag) application
-

Figure 30: Farmer buying input from agro-input shop

- Always get a receipt from the agro-input dealer indicating date of purchase, name of chemical and batch number

8.2.2 Transporting the agro-chemicals

- Farmers should transport agrochemicals safely by ensuring containers are properly labeled, free from damage, and that loading/unloading is done with protective clothing.
- Open or partly used containers should not be used for transport, and agrochemicals must be secured to prevent spillage or vaporization during transit.
- Additionally, follow specific regulations and licensing requirements During Transportation:
- Keep agrochemicals away from food, drink, and other potentially contaminating items.

8.2.3 Storing Agro-Chemicals

In case a farmer is not using the agro-chemical immediately, he should store agro-chemicals in safe isolated places (cupboards, shelves that are safely located) away from children and family members.

8.2.4 Application of Agro chemicals

(a) Reading the Product label

- The label provides all the necessary information such as, active ingredient, mixing and application rates, first aid, disposal of containers, pre-harvest and pre-entry intervals etc. Read the product label and follow instructions on how to handle and apply the chemical.
- If you do not understand the instruction, seek advice from extension Officer or the agro input dealer agent
- Put on the necessary protective clothing as recommended on the product label (cap, masks, overalls, gumboots, gloves, goggles)
- Look out for color coding, warning symbols, pictogram, or any additional safety instructions on the label.
- (Agro- chemicals are also classified according to their toxicity and should be used as recommended on the label of the product)

8.2.5 Color Coding

Class 1a	**RED - C**	**Extremely Toxic**
Class 1b	**RED - C**	**Highly Toxic**
II	**YELLOW - C**	**Moderately Toxic**
III	**BLUE 293 - C**	**Slightly Toxic**
V	**GREEN 317 - C**	**Handle with care**

8.2.6 Determining how much pesticide to use

The single most asked question in pesticide application is: "How much pesticide (ml) do I put in a knapsack (20lts)?"

- The answer is; it depends on the calibration of your sprayer.
- In short, how many square metres one spray pump full of water + pesticide will cover.
- Always Read the label for dilution rate or dosage.
- It is important that the amount of pesticide to be used is precise to avoid excess that could lead wastage of resources, damage of the crop and contamination of the environment
- When quantity is inadequate, it is likely that the pest will not be controlled which could also result into pest resistance.

8.2.7 Steps of calibration of a knapsack sprayer

- Calculate the amount of chemical for a knap sack of 20lt capacity
  - The standard is 200lts of water is needed to dilute 1.5 Litres of Round up.
  - 1 litre of water will require 1.5/200
  - Therefore, a knapsack will require: 20lts x (1.5lts/200)= 0.15lts of Roundup.
- Therefore, 1litre = 1000ml. 0.15 x 1000ml = 150mls
- Thefore, 150 mls of chemical required for of water

NOTE: Mixing and filling operations are the highest risk time for pesticide accidents.

8.2.8 Safety instructions

- Read the label carefully and understand the instruction.
- Ensure recommended rates are followed
- Always mix and fill outdoors to avoid pesticide fumes that can concentrate in closed area
- Open pesticide containers with extreme care
- In case of spillage, wash it off with clean water as soon as possible
- Use clean water to mix chemicals
- Use suitable equipment for measuring out chemicals.
- Never use hands as scoops or for stirring liquids
- Add only enough pesticide to the tank for the job you will be doing

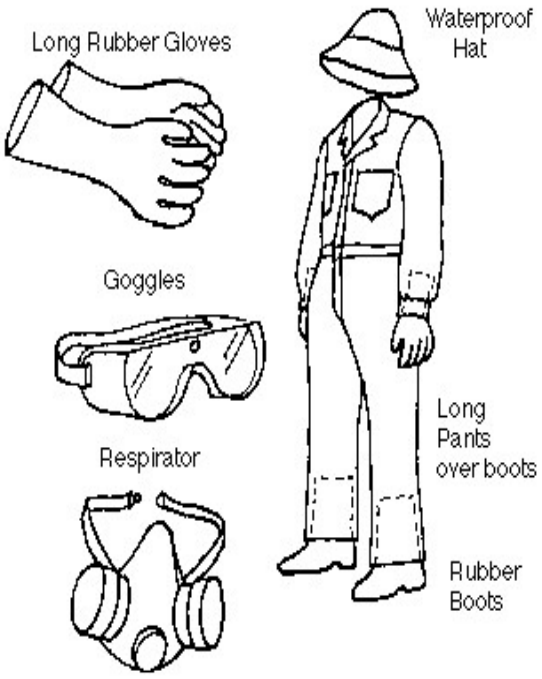


Figure 31: Personal protective Gear

8.2.9 Before spraying

Before spraying, check the spraying pump for any leaks, use the right nozzle for the particular activity, i.e. the flat nozzles are for herbicide application; the cone nozzles are for spraying fungicides and insecticides.

Check the nozzle for blockages, if clogged, do not try to blow it out with your mouth, use a small soft twig or grass or soft brush to remove the clogs.

Wear protective gear before spraying activities

8.2.10 During spraying

- Put warning signs in field during spraying to alert the community.
- Do not spray near other people or water sources.
- Spray in the direction of the wind.
- Walk within the rows and direct the nozzles to the targeted pest.
- Preferably spray in the morning hours before 11.00 am or late in the evening after 4.00 pm bearing in mind when the pest is most active.
- Do not spray when it is about to rain or when it is raining.
- Do not eat, drink or smoke while working with chemicals.

8.2.11 After spraying

- Make sure to properly dispose of empty pesticide containers
- Use all the product in the container according to the instructions.
- Triple-rinse the container and use the solution like the full-strength pesticide.
- Punch multiple holes in the empty container so it won't be used again.

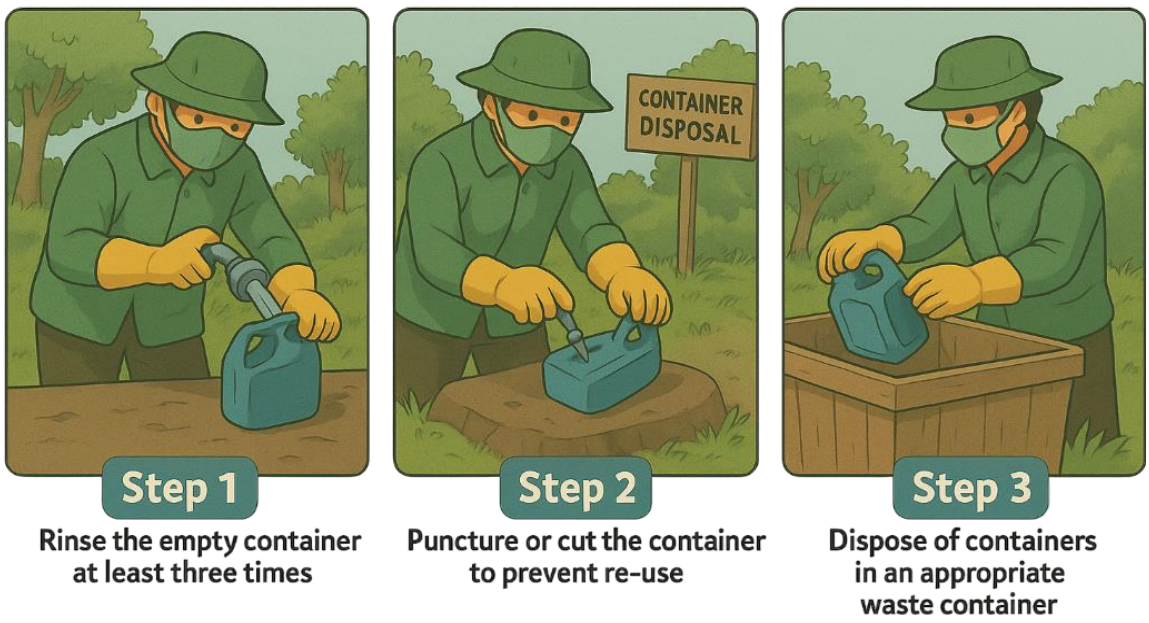


Figure 32: Disposal of pesticide container

Figure 33: Clean the spray pump and Bath/shower after spraying

CHAPTER 9: MONITORING AND RECORDS KEEPING

Extension workers play a crucial role in the implementation of climate-smart agriculture (CSA) practices. Their monitoring efforts are essential to ensure that interventions are effective and that they adapt to changing climatic conditions.

9.1 KEY AREAS WHERE EXTENSION WORKERS SHOULD FOCUS THEIR MONITORING INDICATORS

a). Agricultural Productivity

Record yields for different crops under various management practices; this allows farmers to analyze which methods are most effective in enhancing productivity while being environmentally sustainable.

Track the diversity of crops grown and any shifts in land use patterns as farmers adopt CSA methods.

b). Resource Use Efficiency

- No of farmers adopting the use of particularly in irrigation systems, to determine improvements in water management.
- No of farmers practicing soil conservation practices to assess soil nutrient health

c). Climate Resilience

- Tracking incidents of crop failure or loss due to extreme weather events.
- Monitor changes in farmers' adaptive capacities, such as their ability to implement new technologies or practices that mitigate climate risks.

d). Greenhouse Gas Emissions

No of farmers adopting specific CSA practices, such as reduced tillage or agroforestry.

e). Socio-Economic Impacts

- Assess household economic diversification among farmers adopting CSA techniques.
- Monitor number of households experiencing food insecurity before and after implementing CSA practices.

f). Capacity Development

Track participation rates in training sessions and workshops aimed at enhancing knowledge about climate-smart practices among farmers.

g). Gender Dynamics

- Track participation in CSA initiatives by gender to understand how men and women benefit differently from these interventions.
- Monitor access to resources (e.g., land, credit) for both male- and female-headed households involved in CSA activities.
- Community Engagement and Participation
- Measure levels of stakeholder involvement in decision-making processes regarding CSA implementation at local levels.
- Track feedback mechanisms established for farmers to report challenges or successes with CSA practices.

9.2 RECORD KEEPING

Maintaining accurate records help farmers monitor their practices, assess outcomes, and make informed decisions based on data. The types of records that extension workers should train farmers to maintain include:

a) Crop Production Records

Farmers should document details about each crop cycle, including planting dates, varieties used, input applications (fertilizers, pesticides), and harvest dates. This information helps in evaluating the effectiveness of different practices and making adjustments for future seasons.

b). Soil Health Records

Keeping track of soil health indicators such as pH levels, organic matter content, and nutrient profiles is essential. Farmers can record results from soil tests and monitor changes over time to assess the impact of their management practices on soil quality.

c) Water Usage Records

If using irrigation, farmers should record irrigation schedules, amounts used, and rainfall data to understand water availability and consumption patterns. If not using irrigation system, farmers should record number of rainy and shiny days

d). Pest and Disease Management Records

Farmers need to keep detailed logs of pest and disease occurrences, including identification, treatment methods applied, and outcomes. This helps in developing integrated pest management strategies that are more sustainable.

f). Financial Records

Maintaining financial records is vital for assessing the economic viability of CSA practices. Farmers should track expenses (inputs like seeds and fertilizers) and income (from sales) to evaluate profitability.

g). Climate Data Records

Recording local climate conditions such as temperature variations, rainfall patterns, and extreme weather events can help farmers adapt their practices to changing climatic conditions.

h). Training and Adoption Records

Extension workers should encourage farmers to document any training received related to CSA practices along with the adoption rates of these practices on their farms.

I). Marketing Record

- Expenses:
  Keep detailed records of all marketing-related expenses, including advertising costs market dues and taxes.
- Market Research:
  Store all market research reports and data, including customer surveys, focus group results, and competitors.
- Communication and Interactions:

Keep records of all communications with customers, prospects, and other stakeholders, including, phone calls, and meetings.

- Feedback and Reviews:

  Track customer feedback and reviews, both positive and negative, to identify areas for improvement.

9.3 COFFEE MARKETS

Marketing includes strategies to promote coffee products ranging from Green Coffee Beans, Roasted Coffee Beans, Ground Coffee, Instant (Soluble) Coffee, Coffee Capsules & Pods, Cascara (Coffee Cherry Tea and Coffee Oil & Extracts. Coffee markets include domestic, regional, and international channels.

9.3.1 Domestic Market

- Local Roasters & Breweries buy high-quality beans.
- Retail and hotels such specialty coffee in cafes, hotels, and supermarkets buy from businesses with a brand.

9.3.2 Regional Market

Kenya & Rwanda, South Sudan & DRC

9.3.3 International Export (bulk Buyers)

- Europe (Germany, Italy, Netherlands)- buy quality coffee
- United States & Canada: buy specialty coffee of single-origin, organic, and fair-trade beans.
- Asia (Japan, South Korea, China): buy premium and instant coffee

9.3.4 Specialty and Certified Markets

Certification Schemes such as Fairtrade, Organic, Utz, and Rainforest Alliance requirements.

Single-Origin and Specialty buy coffee with cup quality profiling, cupping labs, and traceability to differentiate in premium markets

9.4 STRATEGIES OF MARKETING COFFEEAND ITS PRODUCTS

- Framer cooperatives, sell directly to consumers, traders, digital marketing, traceability, trade shows and events, through chefs, branding and packaging.
- Role of extension officers;
  - Collect and disseminate price trends, buyer requirements, and certification opportunities.
  - Train farmer groups on post-harvest handling, quality grading, and record-keeping.
  - Organize field visits, trade fairs, and buyer seller forums.

- Facilitate small-scale processing demos and packaging workshops.
- Guide farmers through export paperwork and certification audits.

9.5 MARKET REQUIREMENTS

- Good Bean Quality of Uniform bean size, shape, and color.
- Moisture Content of 10–12% moisture; use calibrated meters and raised drying beds to achieve consistent drying.
- Free from Foreign Matter such as stones, twigs, dust. Remove by sieving, winnowing, and hand-sorting at collection centers.
- Grade by size (large, medium, small) and sort out defective beans (mouldy, discoloured, insect-damaged) using mechanical graders or manual tables.
- Use food-grade, poly-lined jute sacks labeled with lot codes, weight, harvest date, and origin; store in cool, dry, ventilated warehouses.
- Comply with Organic, Fairtrade, Utz, or Rainforest Alliance standards through self-assessment, gap-filling, audits, and annual surveillance.

ANNEXES

ANNEX 1: SAMPLE RECORD-KEEPING TEMPLATES FOR CLIMATE-SMART COFFEE PRODUCTION.

1. Farm Planning Schedule Template

Activity	Planned date	Actual Date	Responsible person	Remarks
Land Preparation	01/03/2025	03/03/2025	Farmer	Delayed due to rainfall
Fertilizer Application				
Mulching				
Pruning				
Harvesting				

2. Production Record Template

Date	Activity	Input used	Quantity	Labor used (person-days)	Weather conditions	Remarks
10/04/25	Fertilizer Application	Organic Compost	5 bags	3	Sunny	Applied to block A
22/04/25	Mulching	Banana Leaves	15 sacks	2	Cloudy	Mulched young trees
05/06/25	Pest Control	Neem Extract	20L	1	Rainy previous day	Sprayed affected plants

3. Harvest and Yield Record

Block/Field	Variety	Harvest Date	Quantity (kg)	Quality Notes	Remarks
Block/Field	Variety	Harvest Date	Quantity (kg)	Quality Notes	Remarks
Block A	SL28	15/10/2025	120	Good size, uniform ripeness	Early harvest
Block B	Ruiru 11	22/10/2025	95	Smaller beans	Due to dry spell

4. Marketing Record Template

Date	Buyer Name	Product sold	Quantity (kgs)	Unit Price (USD)	Total (USD)	Payment Method	Remarks
25/10/25	Local Coop	Parchment Coffee	150	2.00	300.00	Bank Transfer	Paid in full
05/11/25	Exporter A	Green Beans	75	3.50	262.50	Cash	Quality premium paid

5. Financial Record Template

Date	Income/Expense	Item Description	Amount (USD)	Category	Remarks
10/04/25	Expense	Compost Purchase	50.00	Input Cost	For fertilizer application
25/10/25	Income	Coffee Sale	300.00	Revenue	From Local Coop
02/11/25	Expense	Labor (weeding)	30.00	Labor	Paid 3 workers

6. Climate and Weather Record Template

Date	Rainfall (mm)	Temperature (°C)	Extreme Event (if any)	Notes
01/04/25	5 mm	25	None	Light showers
03/04/25	0 mm	31	Heat wave	Trees showing early wilting signs

7. Sample income and expenditure (Receipts and payment/cash record)

Receipts	Amount	Payment	Amount
Total		Total	

8. Sample farm inventory (Tools and Properties) record

Serial #	Description	Purchase Date	Purchase Cost	Repairs	Current Worth	Sale Price

9. Sample profit and loss record

REVENUE	2017	2016
Sales revenue		
Service revenue		
Other revenue		
Total Revenues		
Expenses		
Advertising		
Commissions		
Cost of goods sold		
Total Expenses		
Net Income Before Taxes		
Income Tax Expense		

10. Sample yield (Production record)

Date	Kg/Debes of Cherry	Cumulative Total	Comments

11. Sample labour record

Start Date	Activity/ operation	Days	Cost/Man day	Total Cost (UGX)	Cumulative Total (UGX)

12. Sample stores record

Date	Received (Quantity)	Taken out (Quantity)	Balance (Quantity)	Comments

13. Sample sales record

Date	Coffee Product(UGX)	Retail Price/Kg	Amount Sold	Total Sales (UGX) (Kg)

ANNEX 2: SELLING AT VARIOUS NODES OF THE COFFEE VALUE CHAIN

Table 2. Scenario 2 - Value Addition for FAQ at local market

FAQ costs	Rate/kg	%	Kg	UGX
Volume			1,000	
Loading to hulling factory	10			10,000
Transport to hulling factory per kg	20			20,000
Off-loading	10			10,000
Out-turn		58%		
Total kg FAQ			580	
Hulling cost per kg	150			87,000
Commission per kg	50			29,000
Total cost				146,000
Price per kg (FAQ) local market				13,000
Total income for FAQ				7,540,000
Margin				7,394,000
Additional income case 1				394,000
Additional income case 2				1,304,000
Additional income case 1 %		32		
Additional income case 2%		52		

Table 4. Scenario 4 - Selling Graded Coffee for Export Markets Value addition to graded FAQ for Export Markets

FAQ Costs	Rate/Kg	%	Kg	UGX
Volume			1,000	
Loading to Hulling Factory	10			10,000
Transport to Hulling Factory Per Kg	20			20,000
Off-Loading	10			10,000
Out-Turn		58%		
Total Kg FAQ			580	
Hulling Cost Per Kg	150			87,000
Transport To Kampala (FAQ)	50			29,000
Graded Coffee Percent		0.925		
Graded Coffee Volume			536.5	
Cost of Grading	150			80,475
Commission Per Kg (Group Level)	50			29,000
Commission Per Kg (Association Level)	50			29,000

Total Cost				284,475
Price Per Kg (Graded FAQ)				6,400
Total Income For FAQ				3,712,000
Margin				3,427,525
Additional Income Case 1				1,127,525
Additional Income Case 2				1,426,525
Additional Income Case 1 %		49		
Additional Income Case 2 %		71		
Additional Income Case 3				296,525
Additional Income Case 3 %		9.5		

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