MINISTRY OF AGRICULTURE, ANIMAL INDUSTRY AND FISHERIES

CLIMATE SMART COCOA PRODUCTION MANUAL FOR EXTENSION WORKERS IN UGANDA

APRIL 2025

FOREWARD

Agriculture remains the cornerstone of Uganda's economy, contributing significantly to livelihoods, food and nutrition security, employment, and export earnings. The mandate of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is to transform and modernize the sector to ensure that it sustainably supports national development priorities, as outlined in Uganda Vision 2040, the Fourth National Development Plan (NDP III /IV), and the Program for Agro Industrialization Plan.

This publication comes at a pivotal moment when the agriculture sector is navigating emerging challenges such as climate change, land degradation, pests and diseases, market fluctuations, and post-harvest losses. These threats, if unaddressed, could reverse gains made in agricultural productivity and resilience. However, they also present opportunities to innovate, embrace resilient, sustainable agriculture, strengthen research-extension-farmer linkages, and promote inclusive value chain development.

The insights, recommendations, and strategies outlined in this document reflect commitment to the pursuit of sustainable solutions tailored to Uganda's unique agro-ecological realities. This publication serves as a practical guide for delivery of practical agriculture information to stakeholders (farmers, extension workers, agribusiness owners, development partners).

Special thanks go to the technical teams, researchers, and stakeholders who contributed to this work. Their dedication is a testament to the spirit of partnership and knowledge-sharing that MAAIF to promotes.

As we strive toward a resilient and commercially viable cocoa sector, I encourage all readers to adopt the principles and practices presented herein. Together, we can build a future with cocoa as a catalyst for transformation and national prosperity.

Permanent Secretary
Ministry of Agriculture Animal Industry and Fisheries

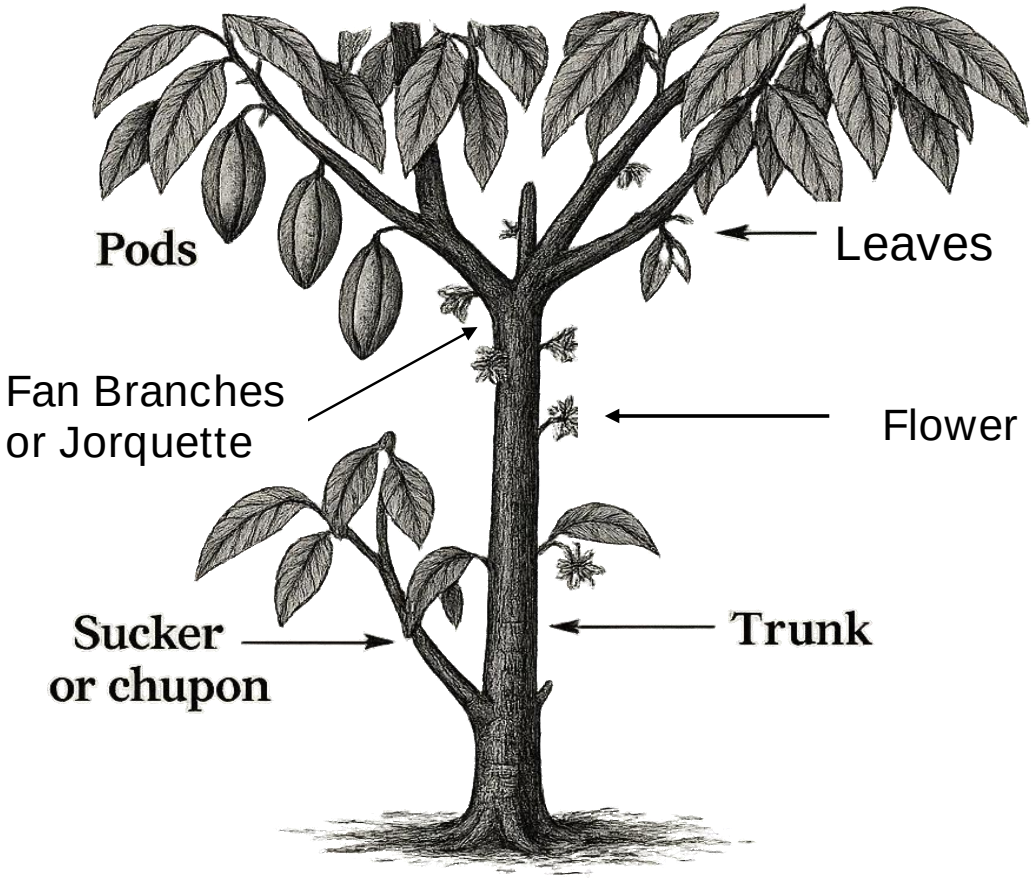
ACRONYMS & ABBREVIATIONS

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

KEY DEFINITIONS

cacao	Is used to describe the cacao bean in its raw, unprocessed state, before it's roasted or processed further cacao beans or cacao nibs (the roasted and shelled bean) labeled as "cacao".
cocoa	Cocoa refers to the processed powder made from roasted, ground, and then the cocoa butter separated cacao beans. This is the powder used for baking or making hot chocolate
Jorquete	a "jorquette" refers to the point where the vertical stem (chupon) of the plant branches out into fan-like lateral growth.
coupon	a side shoot coming from the root of a plant

The cocoa plant.



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CHAPTER ONE: INTRODUCTION & BACKGROUND

1.1 PURPOSE OF THE MANUAL

This manual is to equip extension workers and farmers with information on Climate Smart Agriculture (CSA) cocoa Technology, Innovations and Management Practices (TIMPs) to transfer the climate smart technologies and practices for resilient, adaptive and sustainable cocoa value chains

1.2 OBJECTIVES OF THE MANUAL

- To enhance knowledge and skills of extension workers and farmers on cocoa production CSA TIMPs
- To provide reference materials for extension officers to support them in training farmers.
- To promote adoption of CSA TIMPs to build resilience of the farming community.

1.3 TARGET USER

The manual will be used by both public and private extension officers.

1.4 OVERVIEW OF COCOA PRODUCTION IN UGANDA

Cocoa was introduced to Uganda by the British in 1901, initially planted in Entebbe Botanical Gardens. It is a perennial tropical crop suitable for regions within 100 degrees north and south of the equator. Cocoa trees begin production at 2-5 years, reach peak productivity at 7-30 years, and can produce for over 50 years, though yield declines after 30-40 years.

Currently, cocoa is a priority crop in Uganda, ranking second in foreign revenue contribution with a 58% increase over five years. Revenue rose from USD 89.73 million in 2019/20 to approximately USD 215.11 million in 2023/24, derived from an increase in production from 38,570 tonnes to 51,678 tonnes.

Most cocoa is produced by smallholder farmers in districts like Bundibugyo, Mukono, Buikwe, Hoima, Jinja, and Kamuli.

The crop has expanded to other regions such as West Nile, Acholi, Lango, Teso, Bugisu, and Busoga, driven by government initiatives in research, capacity building, and awareness. However, the industry faces challenges including low productivity, poor post-harvest practices, limited extension skills, inadequate market information, insufficient research funding, limited value addition, and infrastructure deficits.

1.5 IMPORTANCE OF COCOA

Globally, there is an ever-increasing demand for cocoa products mainly Chocolate and other semi-finished products such as cocoa powder, cocoa butter used as key

ingredients in manufacturing industries. The demand for these products is high in Europe, Asia and North America, the global production of cocoa beans is estimated at 3 million metric tons (valued at USD 5.1 billion) (www.worldcocoafoundation.org). Beyond global level, cocoa: -

- is a source of revenue to the country.
- provides employment opportunities and incomes along the value chain.
- husks can be used as manure for gardens which improves the fertility of the soils.
- is an agroforestry tree crop that contributes to carbon sequestration.
- is an important ingredient in the confectionary, food and beverage, pharmaceutical and cosmetics industries.
- is a multi-purpose Agro-commodity as shown in table 1.

Table 1: Industrial and agricultural uses of the cocoa

Raw material	Product	Industry
Cocoa liquor and other ingredients	Chocolate, other confectionary items	Food
Pressed cocoa liquor	Cocoa powder (flavored drinks, desserts and chocolate)	
Cocoa pulp juice	Soft drinks or fermented for alcohol	
Cocoa pulp	Pectin for jams	
Pressed cocoa liquor	Cocoa butter (chocolate, soaps and moisturizers)	Food and Cosmetics
Cocoa pod husks, ash	Soft soaps and fertilizer	Cosmetics &Agriculture

Source: Feasibility Study on ago-processing-Cocoa industry in Uganda. (Swiss contact 2012)

1.6 COCOA PRODUCTION, EXPORT VOLUMES AND VALUE BETWEEN 2019/20 TO FY 2023/24

In Uganda, current production of cocoa beans 52,712 Metric tons (source: BOU, 2022). This is extremely below the demand on the international market. Availability of this demand gap presents an opportunity for the farmers to produce more cocoa beans to satisfy the demand.

Table 2: Production volume (MT), Formal Export volume (MT) and Export value ($ Million) of cocoa in Uganda

	2019/20	2020/21	2021/22	2022/23	2023/24
Production volume (MT)	35,318	46,663	43,378	39,861	52 ,712
Formal Export volume (MT)	38,570	44,441	41,313	37,868	51,678
Export value ($ Million)	89.73	105.36	97.61	93.03	215.11

Source: UCDA, MAAIF, Bank of Uganda

1.7 COCOA VALUE CHAIN ACTORS

Figure 1: Cocoa Value Chain Actors

- The cocoa value chain actors include farmers, aggregators, traders, exporters, processors and consumers.
- while the support service actors include; the input suppliers, transporters, extension service providers' researchers, certification services, funders, Development partners and civil society organizations legal service providers, financial institutions and insurance providers.

Figure 2: Cocoa Value Chain Actors.

CHAPTER TWO: CLIMATE CHANGE IMPACT AND COCOA PRODUCTION IN UGANDA

2.1 DEFINITION OF CLIMATE CHANGE

Climate change is the shift in the average weather conditions of an area observed over a long period (30 years and above) of time. Climate Change effects are accelerated by human activities such as deforestation, burning of fossil fuels among others. Indicators of climate change include:

- Reduced weather predictability and cropping season planning.
- Overlapping seasons-impacts on harvest and post-harvest activities, reduced cocoa bean quality
- Increase in temperatures.
- Affects yield potential
- Increased frequency and intensity of prolonged dry spells, droughts and heat waves.
- Increases the frequency and intensity of floods, excessive rains, hailstorms and lightening.
- Increased water shortages.
- Increased pests and diseases build up

2.1.1 Causes of Climate Change

Climate change in Uganda is primarily driven by a combination of human activities and natural processes. Key factors include;

- Greenhouse gas emissions from agricultural practices, particularly methane from livestock and rice cultivation, as well as nitrous oxide from fertilizer use.
- Deforestation for agriculture, logging, and charcoal production significantly contributes to carbon dioxide emissions.
- Additionally, rapid urbanization and intensive farming practices disrupt ecosystems and increase emissions.
- The reliance on biomass for energy, coupled with limited access to renewable energy sources, further exacerbates the problem.
- Population growth intensifies the demand for land, water, and energy, leading to overexploitation of natural resources.
- Natural climate variability also plays a role, as changing rainfall and temperature patterns can amplify the effects of human-induced climate change. Addressing these causes is essential for mitigating climate change impacts and enhancing Uganda's resilience to future challenges

2.1.2 impacts of climate change on cocoa value chain

The climate change related factors in Uganda are a bit of a challenge to the farmers in the country. This has led to immature growth of the cocoa pods leading to losses on the

farm. There is also a problem of pests and diseases that attack the cocoa causing poor yields during harvesting period.

a. Effects on cocoa production
- Unpredictable rainfall patterns affecting planting time, flowering, yield, harvesting and post-harvest handling.
- Prolonged dry spells that result into water shortages and pest outbreaks.
- Floods destroy roots and lead to wilting of cocoa trees.
- In mountainous areas, excessive rain may cause landslide leading to destruction of cocoa plantations and infrastructure.

b. Effects on environment and socio-economic aspects
- Land degradation due to cutting down of trees.
- Water shortages and scarcity in communities.
- Increased incidence of wildfires.
- Silting of rivers, dams and destruction of riverbanks.
- Increased on-farm production costs, for instance increased irrigation and construction water conservation structures.
- Decreased household income and food security, increasing poverty levels.
- Increased rural-urban migration within communities.
- On-farm labour shortages due to rural-urban migration.
- Increase in human diseases, for instance, Cholera and Malaria

2.2 CLIMATE SMART COCOA PRODUCTION IN UGANDA

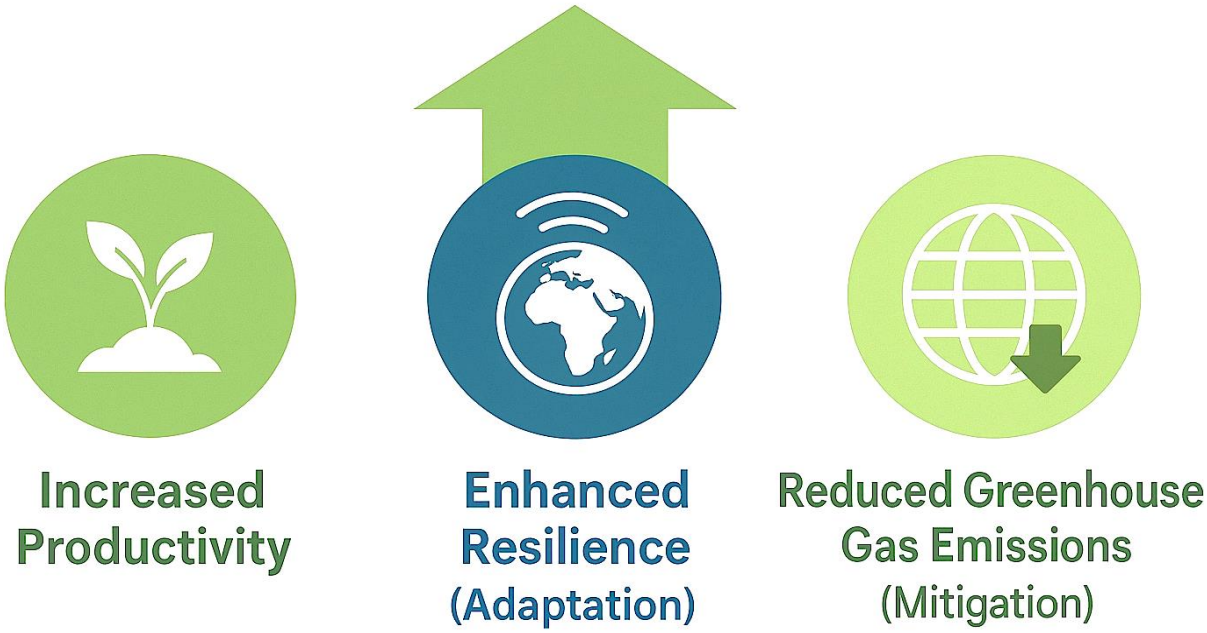
2.2.1 What is CSA?

Climate-smart agriculture (CSA) is a holistic approach to farming that aims to sustainably increase productivity, enhance resilience to climate change, and reduce greenhouse gas emissions, while also contributing to food security and broader development goals. CSA is an integrated approach to managing landscapes—cropland, livestock, forests and fisheries--that address the interlinked challenges of food security and climate change.

Benefits of climate smart agriculture
- Improving food security and livelihoods by enhancing agricultural production in a way that is environmentally sound and socially equitable
- Building the capacity of agricultural systems to withstand and adapt to the impacts of climate change, such as droughts, floods, and extreme temperatures.
- Minimizing the agricultural sector's contribution to climate change by reducing greenhouse gas emissions and enhancing carbon sequestration.

2.2.2 The three pillars of CSA.

The pillars of CSA include three main components, which are often referred to as the "triple wins" of CSA.



2.2.3 Sustainably increasing productivity and incomes

Ensuring that farming systems can produce enough food to meet the growing demand, while improving the livelihoods of farmers in a sustainable manner.

2.2.4 Enhancing resilience and adaptation to climate change

Building the capacity of agricultural systems to withstand and recover from climate-related shocks (e.g., droughts, floods, hail storms) by using practices that increase soil health, diversify crops, and improve water management.

2.2.5 Reducing greenhouse gas emissions

Reducing the carbon footprint of agriculture through practices that lower emissions, enhance carbon sequestration in soils, and decrease the overall environmental impact of farming activities.

2.2.6 Critical Stages of Cocoa Production Affected by Climate Change

Cocoa production is a complex process that involves several critical stages, each of which can be significantly impacted by climate change. Understanding these stages helps in assessing the vulnerabilities and potential adaptations necessary for sustaining cocoa yields.

Flowering Stage: The flowering stage is crucial as it determines the number ofpods that will develop into cocoa beans.

Cocoa trees typically flower twice a year, and the flowers are sensitive to temperature and humidity levels. Excessive heat can cause flowers to shrivel or drop prematurely, leading to reduced pod formation

Figure 3: Reduced pod formation

Pod Development: After successful pollination, cocoa pods take about five to six months to mature. High temperatures can stress the plants, leading to smaller or underdeveloped pods. Additionally, erratic rainfall can result in either drought conditions or excessive moisture. For instance, prolonged dry spells can hinder photosynthesis and nutrient uptake, while flooding can lead to diseases such as pod rot.

Harvesting: Cocoa is harvested during two main periods: the main crop from September to March and a mid-crop from May to August. Changes in climate can shift these harvest periods or reduce overall yields due to poor pod development from previous stages.

Post-Harvest Processing: Once harvested, cocoa beans undergo fermentation and drying processes that are essential for developing flavor profiles. High humidity levels during drying can lead to mold growth on beans, compromising quality

CHAPTER THREE: ENTERPRISE PLANNING

3.1 GOAL SETTING

Cocoa 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 COCOA PRODUCTION

The cocoa production industry presents a compelling business case due to several factors, including market demand, profitability potential, and sustainability practices.

Key components that contribute to the viability of cocoa production as a business venture.

- Market Demand
- Sustainability Practices
- Competitive Advantage
- Profitability Potential which requires understanding a cost benefit of coca production as below:

3.2.1 Cost Benefit Analysis

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. The cost benefit analysis of one acre of cocoa is presented in table 4.

Risk analysis

(5% increase and decrease in price and yield) for making an informed decision to produce cocoa.

Scenario1

- ➢ 5% decrease in yield 5/100 X 450=22.5, (450-22.5=427.5kgs)
- ➢ 5% increase in price 5/100 X 27000=1350, (27,000+1350=28,350)
- ➢ New Gross Income 427.5 X 28,350= 12,119,625

Scenario 2:

- ➢ 5% increase in yield 450+22.5 =(472.5kgs)
- ➢ 5% decrease in price 27000-1350=26,650
- ➢ New Gross Income 472.5 X26650=12,562,125

Note: Improve on the volume (yields) at current market price for better income

Table 3: Cost Benefit Analysis for one acre of Cocoa

Establishment Cost Structure for 1 acre of Cocoa (2025)

Activity	Quantity	Rate	Year 1	Year 2	Year 3	Year 4
Land clearing	1	120,000	120,000			
Land opening	2	120,000	240,000			
Field marking	lumpsum	50000	50,000			
Farm tools	lumpsum	200,000	200,000		210,000	60,000
Labour for digging holes	450	500	225,000			
Seedlings	450	1000	450,000			
Transportation of seedlings	lumpsum	300,000	300,000			
Manure(FUSO truck)	1	400,000	400,000		400,000	
Labour Manure application and planting	450	500	225,000			
Fertilizer (bags per year)		160,000	160,000	320,000	320,000	320,000
Labour for fertilizer application			25000	50,000	50,000	50,000
Weeding (labour)	40	10,000	400,000	400,000	400,000	400,000
Gap filling	4	7,000	28,000			
Mulching material	lumpsum	400,000			400,000	
Soil and water conservation	lumpsum	100,000	100,000			100,000
Pruning	1	30,000	30,000	30,000	30,000	30,000
Shade trees	20	5,000		100,000		
Labour for planting shade trees	20	500		10,000		
Harvesting and pod breaking	lumpsum				150,000	150,000
Fermentation	lumpsum				100,000	100,000
Drying	lumpsum				150,000	150,000
Total Production Costs			2,768,000	750,000	1,950,000	1,250,000
Farm gate price	450	21,000				
Total Income per acre			0	0	9,450,000	14,175,000
Gross margin (Profit)			**-2,768,000**	**750,000**	**7,500,000**	**12,925,000**

3.3 AGRO-ECOLOGICAL REQUIREMENTS

Farmers need to consider several factors before planting cocoa in a new area to make sure that they make the best use of land, labour and inputs in order to get the highest production. Factors to consider include; climate, soil fertility, type of vegetation, source of quality of the planting material.

3.3.1 Climate and Rainfall Requirement

Cocoa is a perennial crop that responds well in rainy tropical areas and require a high amount of rainfall: 1,250-3000 mm per year. Cocoa grows best in warm temperatures

i.e.,18-320C.

3.3.2 Soil Requirement

Cocoa requires deep and well drained soils with a pH range of 5-7.5. It is a forest crop and so it is suited to fertile soils.

3.3.3 Altitude.

Cocoa thrives well in areas where the land is relatively flat. Where the land is slopy, soil and water conservation measures should be deployed.

3.3.4 Shade Requirement

Cocoa grows well under shade these enable good field establishment of the cocoa plant and improve soil fertility. Two types of shade trees permanent shade and temporary shade:

- During field clearance for cocoa production, farmers should leave selected permanent shade trees that are complementary with cocoa.
- Permanent Shade trees include; Maeopsis eminii (Musizi), Terminalia sp., Milicia excelsa, Grrevillea, Gliricidia sp., Acacia sp, Albizia sp among others.
- Bananas , pigeon peas and cassava can be used as a temporary shade crop.
- When establishing a new cocoa farm, farmers are advised to intercrop the cocoa with food crops such as banana, cassava, yam, beans, soya bean, groundnuts, maize, etc., to provide initial shade for newly planted cocoa seedlings and also serve as source of food and income.
- Choose varieties that provide maximum shade and consider optimum spacing when intercropping.

3.4 SITE SELECTION

Cocoa production requires careful site selection to ensure optimal growth and yield of cocoa trees. The following factors are crucial in determining a suitable site for cocoa farming:

- Soil Quality: Cocoa trees thrive in soils that are rich in nutrients with a depth of at least 1.5 meters and well-drained.
- Soil pH: Cocoa trees prefer a slightly acidic to neutral pH range of 5 to 7.5.
- Topography: A relatively flat or gently sloping land.
- Climate Conditions: Cocoa trees require a hot, moist climate with average rainfall between 1150 mm and 2500 mm annually, along with temperatures ranging from 18°C to 32°C.
- Shade Requirements: Young cocoa trees benefit from shade during their early growth stages to protect them from excessive sunlight and help maintain moisture levels in the soil.

- Avoid of Hardpans and Rocky Areas: Sites with hardpans (compact layers that restrict root growth) or rocky terrain should be avoided

3.5 CLIMATE AND WEATHER INFORMATION

Accessing climate and weather information can be got from several sources such as; Department of Meteorological Authority (DOM) in the Ministry of Water and Environment. DOM provides official weather forecasts, climate outlooks, and other weather-related information through the District Production Offices. Farmers then can access the District or Sub-County notice board.

3.6 SOIL TESTING.

Soil testing is crucial for successful cocoa production in Uganda, ensuring optimal conditions for plant growth and maximizing yields. It helps determine the soil's nutrient content, pH level, and other physical characteristics, allowing farmers to tailor their fertilization and cultivation practices accordingly.

3.6.1 Why soil testing is important for cocoa production in Uganda:

- Optimizing Nutrient Management:

Soil tests identify any deficiencies in essential nutrients (like nitrogen, phosphorus, and potassium) and help farmers determine the right type and amount of fertilizer to apply.

- Understanding the soil's composition and pH, farmers can take steps to improve its structure, drainage, and overall health.
- Boosting crop productivity
- Supporting Environmental management

Soil testing allows for targeted fertilization, reducing the risk of nutrient runoff and environmental damage boosting crop productivity.

3.6.2 Soil Requirements for Cocoa

- Depth and Drainage:

Cocoa requires deep, well-drained soils with good aeration to support healthy root development.

- pH Level:

Cocoa thrives in soils with a slightly acidic to neutral pH (around 6.5-7.0).

- Organic Matter:

Soil with sufficient organic matter improves its ability to retain nutrients and moisture, crucial for cocoa growth.

- Nutrient Content:

Cocoa requires adequate levels of essential nutrients, particularly nitrogen, phosphorus, and potassium, as well as micronutrients.

- Soil Texture:

Deep, fertile loam to clay soils and sandy loam soils are generally considered suitable

for cocoa.

3.6.3 Soil Testing service providers in Uganda

Several companies and organizations offer soil sampling, analysis, and testing services in Uganda, including

- Balton Uganda Limited, AgroCares, Organizations and other Agencies like the Zonal, Agricultural, Research, Development, Institutes (ZARDIs)
- Consult with your extension worker/ nearest ZARDI for further information on soil testing services.

3.7 SELECTION OF COCOA TYPES

Three main morphological groups or clusters of cocoa are grown in Africa are criollo, Forastero and Trinitario. Characteristics of these cocoa clusters are shared in detail below.

a. Criollo

Criollo produces very high-quality grade of cocoa with exceptional flavour and aroma. However, it is relatively low yielding, tends to have a lower vigour and susceptible to pests and diseases. The pods are long, yellow or red in colour when ripe, deep furrow, big warts, sharp pointed ends and have few big sized seeds.

b. Forastero (Amelonado)

The cocoa trees in this cluster bare many pods. The pods are short, yellow in colour when ripe, shallow furrows, smooth without warts, ends are blunt/not pointed and have many small seeds.

c. Trinitario

cocoa is a hybrid from a cross between criollo and forastero clusters. Has good quality in terms of aroma and flavor, tolerant to pest and disease and high yielding. The pods can either be short or long, red or green in color, have shallow furrows and sharp pointed ends.

3.7.1 Production Inputs

Certified seedlings from a known source, manure, shade tree seedling, fertilities, garden tools (secateurs, pangas, hoes, pruning saw), protective wear, pesticides, fermentation devices (fermentation box, baskets)

3.8 RESOURCE MOBILIZATION FOR COCOA PRODUCTION

3.8.1 Sources of finance

Savings: Saving is an act and a habit of putting money away to use at a future date. This can be in the form of cash or material goods whose value appreciates over time.

It entails discipline and sacrifice, as one postpones consumption from now to a future date. It leads to capital accumulation over time, which can be invested in profitable enterprises.

Figure 4: Women in group saving session

3.8.2 Why saving is important?

- Source of capital for farm investment
- Easy source of soft loan for the farmer
- It helps in meeting household needs like paying school fees, hospital bills and buying food
- Money can be used to expand a business.
- Many organizations that provide loan will want to see that a farmer has the ability to save before giving him/ her a loan.
- Saving can be used to meet urgent unforeseen emergencies.
- Saving allows a farmer to keep their money safe.

3.8.3 Loan or Credit

A loan or credit is money borrowed by an individual from relatives, friends, groups, moneylenders, micro-finance
institutions (MFIs) or banks in order to meet either social or economic obligations. A loan is usually paid back

3.8.4 Farm planning Schedule

These are details of the planned farm activities and the tentative dates for carrying them out. The planning schedule should be among the first records a farm manager produces. An example of a farm planning activity schedule for starting cocoa production is presented in table 4.

Table 4: Cocoa Farm Planning

Activity	Timeframe
Buying tools and equipment	1st Month
Preparing land including clearing and ploughing	
Marking the field	
Digging planting holes	
Buying bean seeds and staking materials	
Gap filling	2nd- 4th Month
Routine management (weeding, etc.)	
Looking for markets	

CHAPTER FOUR: COCOA ESTABLISHMENT AND MANAGEMENT

4.1 LAND PREPARATION

Clear the land of any bush, shrubs, anthills, tree stumps etc. (some trees compatible with cocoa should be reserved during land reparation to provide shade for cocoa plants/trees).

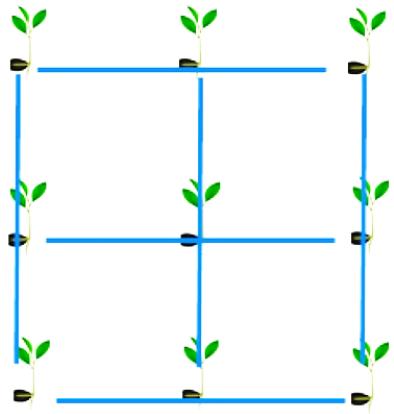
- First and second ploughing should to be done on time before the onset of the rainy season. This will enable the plant benefit from the soil nitrogen flush and to ensure that the planted seedlings get adequate water amounts to prevent moisture stress during the early establishment stage.
- Remove all perennial weeds like couch and spear grass
- If the land is large consider blocking into smaller units for easy management and farm operations.
- The field should be pegged at 10 x 10 feet (3 x 3 meters) in straight lines; marked using sisal strings. Illustrate pegging process.

4.2 LINE FIELD PLANTING

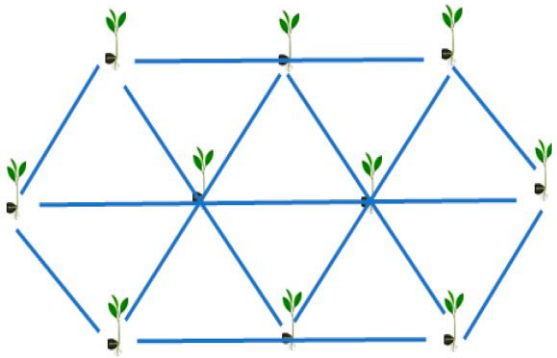
Lining is recommended at a spacing of 3 by 3 metres helps to optimize land use, facilitate husbandry practices, increase yield per unit area and increase income. Lining out is achieved using sisal or nylon ropes marked with the required spacing.

4.2.1 Benefits of proper lining and staking are:

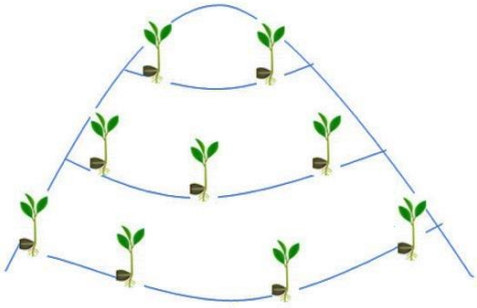
- the lines in the orchard are uniform and in straight rows
- all trees will have equal area for growth and bearing
- the land is well utilised with higher production field maintenance is easier.



Square



Triangular



Hilly

Figure 5: Illustration of field layout for cocoa: Line orientation lie from east to the west.

4.2.2 Spacing for permanent shade and cocoa plants

- Establish shade quickly to protect the soil from sun, rain, and weeds.
- Prepare approximately 7.5m (24ft) wide beds with drains between them.
- Install permanent shade pickets in the center of each bed at 18.3m (60ft) intervals, as shown in figure 6.
- Line up cocoa plants with spacing of 3m x 3m, placing pickets accordingly, as illustrated in figure 7.

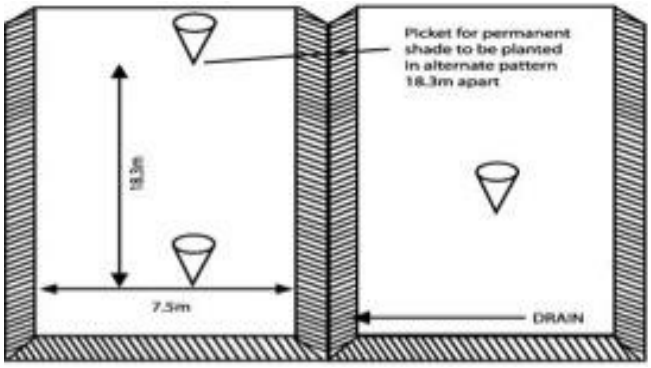


Figure 6: Pickets for permanent shade in the centre of the beds 18.3m (60ft)

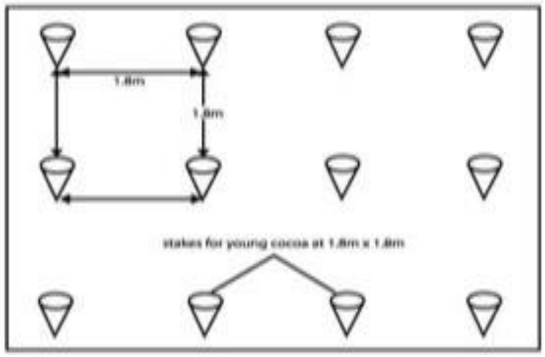
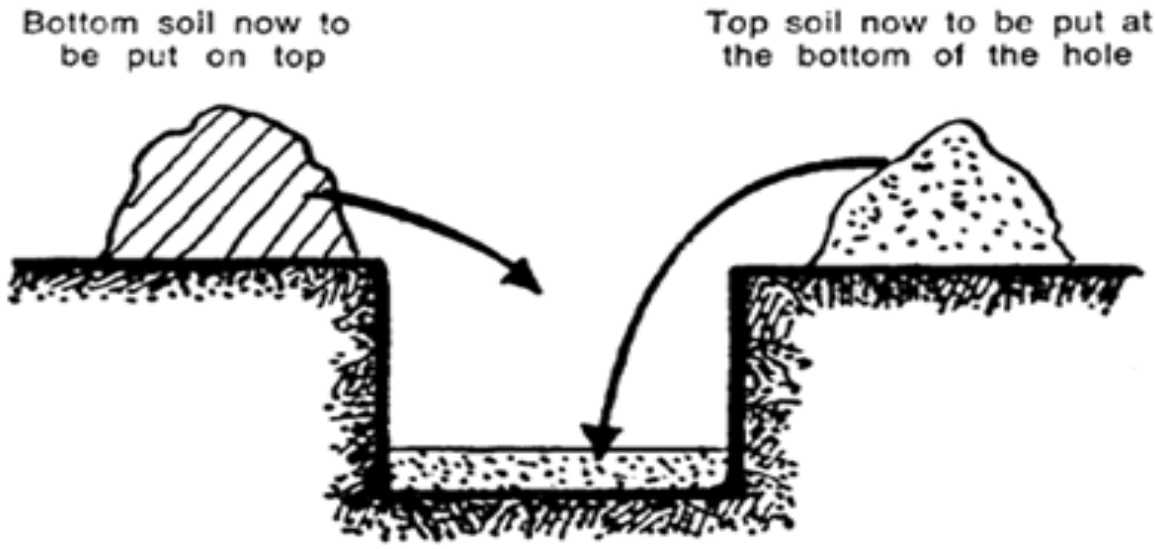


Figure 7: Illustrating the distance between the cocoa plants of 3m x 3m

4.3 DIGGING HOLES AND BACKFILLING

- Dig planting holes at pegged points at a size of 2 ft by 2ft.
- Separate the top soil from the sub-soil Top soil should be put on the upper side of the hole guided by the slope.
- Mix top soil with manure (I basin of manure) to improve the soil nutrient level and structure for proper plant growth and increased plant vigor.
- Back-fill the hole with the mixture (of soil and manure) up to the flat level of the hole. At least one basin full of manure when mixed with soil is ideal.
- Mark-off the middle of the hole with a peg.



4.4 CHOOSING THE RIGHT PLANTING MATERIAL

Cocoa has four types of planting material:

1. Seeds/Beans

- Cheap
- Easy to transport
- Is seeded/ or planted in a Nursery then transplanted
- Practiced but not recommended due to low survival rate of seedlings

2. Seedlings

- Is raised from seed
- Must be raised form certified Nursery operators
- Highly recommended method
- Has a high survival rate

3. Clones: Technology still at trail stage in research level not yet disseminated
4. Grafts: Technology still at trail stage in research level not yet disseminated

4.5 PLANTING

- The best time for planting cocoa is in the longer rain season depending on the location
- Plant only well hardened cocoa seedlings with at least three pairs of leaves for better survival rates.
- Seedlings transported over long distances should be watered and arranged in a standing position in a shed area for at least a day before planting to recover from the transit shock and dehydration before planting.
- Water the seedlings heavily before transplanting. Apply a systemic insecticide if available to reduce termite and insect damage during establishment.
- Remove the seedling from polypots carefully in order not to lose too much soil from the seedlings.
- During planting, do not heap soil around the stem of the seedling above the stem collar to prevent collar rot that can kill the seedling or affect the seedling growth.
- Plant at the onset of the rains to prevent early moisture stress before the plant establishment).
- It is advisable to plant the cocoa in the evening hours reduce on the early establishment stress and increase seedling survival rates.
- Temporary shade plants (bananas, Giliricidia ssp etc.) should be planted earlier or together with the cocoa seedlings to provide shade. Recommended spacing bananas is 6Mx6M and for Gliricidia spp. 4mx4m well pruned and managed.
- Recommended shade trees for Example Maesopsis Eminii (Musizi), Albizia, Ficus, C. Africana, Grevillea should be introduced or planted prior to the cocoa establishment at 40ft x 40ft to 50ft x 50ft depending on the shade tree type. The shade trees should be routinely managed to provide adequate shade

4.5.1 Gap-fill cocoa garden

Where there is a dead or damaged seedling replace the seedling for purposes of maintaining the desired plant population.

4.6 ESTABLISHING SHADE TREES

- Young cocoa trees (0-3 years) require shade levels of about 70% (30% sunlight) and mature and old cocoa trees (4 years and beyond) need about 30- 40% shade (70% sunlight).
- Selectively prune excess branches of the temporary and permanent shade trees to allow optimum light levels for cocoa growth. Replace damage shade trees where necessary
- Plant wind breaks to protect the cocoa plants from strong winds and storms.

Figure 8: Banana plant as a shade tree- Farmers in Mayuge District

4.7 SOIL AND WATER CONSERVATION TECHNIQUES

4.7.1 Agroforestry

Integrating cocoa with other crops and trees: This helps maintain soil health, reduces the need for deforestation, and can provide additional income sources for farmers.

Figure 9: Showing Cocoa Agro-forestry

4.7.2 Planting shade trees

Shade trees benefit cocoa growth through incorporating other food crops into the system, and using trees to help manage soil erosion and improve water retention.

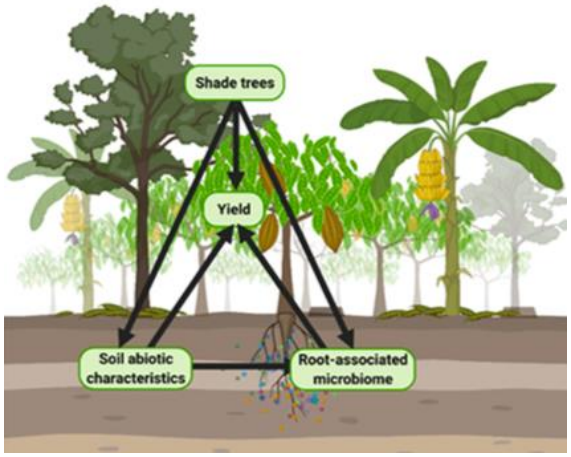


Figure 10:Cocoa Under shade
https://www.mdpi.com/2073-4395/12/1/195

4.7.3 Mulching and Cover Crops:

a) Mulching: Applying organic materials like cocoa pod husks or crop residues to the soil surface helps retain moisture, suppress weeds, and improve soil fertility.
b) Cover crops: Planting non-cocoa crops (e.g., legumes) to protect the soil surface from erosion, improve soil structure, and add nitrogen to the soil.

4.7.4 Conservation Tillage:

Minimizing soil disturbance: This helps retain soil structure, improve water infiltration, and reduce erosion.

4.7.5 Integrated Soil Fertility Management (ISFM):

- Promoting ISFM practices, which combine organic and inorganic methods, can be beneficial for long-term soil health and productivity.
- Training and Extension Services: Providing farmers with training on soil testing, fertilizer application, and other ISFM techniques is crucial for successful implementation.

Preparation and application of organic manure

Preparation of Organic Manure involves using plant and animal waste to create a natural fertilizer that improves soil fertility and promotes healthy crop growth. Types of Organic Manure are:

- Farmyard Manure (FYM) – Decomposed mixture of cattle dung, urine, litter, and leftover fodder.

- Compost Manure – Made from decomposed organic waste (kitchen waste, crop residues).
- Green Manure – Grown crops (like Sesbania, Crotalaria) ploughed back into soil.
- Vermicompost – Compost made using earthworms

4.7.6 Preparation of liquid Fermented tea manure

Figure 11: How to prepare fermented cow dung tea manure

a. Manure/fertilizer Application/ Liquid Manure

- The position of the ring in any plant is at the edge of the canopy of the respective cocoa plant.
- Dig around the cocoa plant to a depth of about 3 inches without damaging the cocoa roots
- Ring-apply the manure/fertilizer using recommended rate
- Cover the manure/fertilizer with soil to prevent vitalization and loss to soil erosion

Figure 12: The ring in a cocoa plant and liquid manure application around a cocoa plant.

Application of inorganic fertilizers

- Before fertilizer application, test the soil and apply as recommended. At 6-12 months apply 100gms of NPK 17.17.17 per tree; 13-18 months apply 100gms NPK 25.5.5 per tree; from 19-24 months apply 100gms NPK17.17.17 per tree. Use two split applications (for the 2-growing season)

4.8 PRUNING OF COCOA

Pruning is the removal of unwanted shoots and branches from the cocoa tree to improve on production and ease farm operations.

4.8.1 Forms of pruning:

There are three forms of pruning namely formation, structural and sanitary

1. Formation (or shape) pruning

Done up to 3 and 4th year. It is done to adapt the plants' habit of growth for a good plant structure. so as to increase productivity and ease of field operations.

- At the Young stage a cocoa plant has a simple form of a single, straight trunk with a crown of 3 to 5 main branches at about 1.5 metres above ground level as presented in figure 14,
- In some trees, several shoots may form on the trunk. Identify and cut off the weak shoots as illustrated in figure 15
- Sometimes the crown forms at a very low level, at less than 1 metre above ground as illustrated in figure 16. In such a case, choose a shoot which grows straight up and let it develop into a new crown.

Jorquette is the point at which the vertical stem in a cocoa tree changes into fan growth.

- This special feature on the cocoa tree makes its main stem grow in storeys.
- Under favourable conditions a cocoa seedling grows upright and starts jorquetting when it is about six months old.

Figure 13: Jorquette

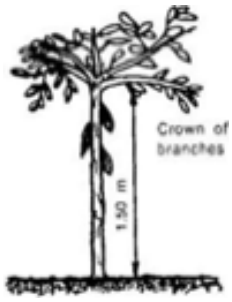


Figure 14: Jorquetting at a minimum of 1.5m (recommended)

Figure 15: With two branches in the earlier stages, you cut off the weaker one

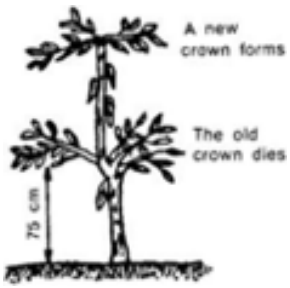


Figure 16: when Jorquetting at less than 1.5m, train the plant to jorquette at the next level

4.8.2 Structural Pruning

The main purpose of this is to encourage the continuous development of the 4-5 main branches as the main structure of the cocoa tree. It is done at every start of the rainy season. It is done when the cocoa plant is in mature stage to:

- Limit the size of the tree to one main stem and to achieve 4-5 main branches. The tree is best maintained at 4m height for easy management.
- Achieve or preserve a desired shape and plant architecture.
- Open the canopy and allow free air circulation through the cocoa tree.

4.8.3 Sanitary pruning

This includes removal of:

- Excess branches in the canopy that give a crowded appearance.
- Thin and unproductive branches in the canopy.
- Remove any damaged or dried branches.
- Unwanted chupons that develop in the canopy.
- Remove any parasitic plants and epiphytes. Notes
- Light and regular pruning is preferred but delay severe pruning.
- During pruning, the branches of a cocoa tree should be cut in a slanting manner as presented in figure 14 to allow water to drip off the cut surfaces and thus prevent fungal growth.

- Cut the identified branches and suckers with care to avoid damaging the flower cushions.
- Use a pruning sow as presented in figure 17 for cutting brunches.

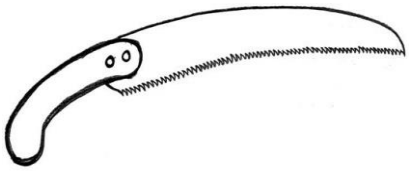


Figure 17: Pruning Saw

Figure 18:Showing a clean-cut during pruning

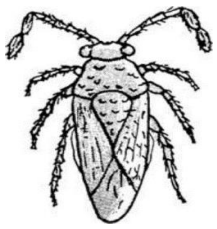
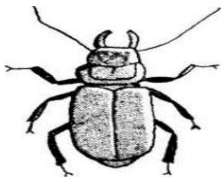
CHAPTER FIVE: PEST AND DISEASE MANAGEMENT

5.1 MANAGEMENT OF COCOA PESTS

Cocoa is attacked by major and minor insect pests. The most common pests are the sucking insects namely; capsids, aphids, scales and mealy bug. Major ones are Cocoa mirids, Stink bugs and cocoa stem borers. The minor pests are leaf defoliators/skeletonizes, termites, grasshoppers, aphids, pod borers, and psyllids. Other pests include rodents such as the African giant pouched rats and mice.

Table 5: Pests, Symptoms and Management Practices

5.2 COMMON PESTS OF COCOA

Pest	Damage caused	Management / miricides.
cocoa mirids (Capsids) 	Damage on seedlings Damage on pods /cherelles and shoots by sucking the sa. p Cause feeding puncture marks on pods.	Plant tolerant hybrids Remove alternate host plants Inspect broken canopies for mirids and lensions on fresh chupons Use appropriate pesticides
Stem borer  Stink or Shield bugs	Young larvae bore into the stems of mature plants damaging the stems of mature plants Yellow brown pods and turning to black	Sealed holes with wooden plugs or cotton wool Apply recommended pestcides Apropriate insecticides Field hygiene

5.3 COMMON DISEASES OF COCOA

Cocoa verticillium wilt

A soil borne fungal disease. The fungal spores enter the trees through the root injuries and move up to the leaves. The disease kills the tree progressively starting from the end of the branches until each branch dries up one after the other. Eventually the whole tree dries. Dried leaves stay on the branches hanging on the tree without dropping. It should however be noted that the trees prone to this disease are mainly those experiencing water stress, without adequate shade, and those where weeding is done by use of hoes.

Cocoa verticillium wilt

Symptoms of verticillium wilt

- Drying of the leaves from the tips and leaf margins.
- Diseased auxiliary buds on the main stem die off with time
- A fire scorched appearance of the plant.

Management of verticillium wilt

- Use of clean planting tools and disinfecting the tools using recommended chemicals including sodium hypochlorite (jik) during pruning and cocoa pod harvestings
- Removal of diseased branches.
- Uprooting and burning the entire tree to prevent further spread.
- Digging trenches 60 cm wide and 60 cm deep around affected trees may prevent further spread.
- There is currently no chemical control of the disease but good field management is recommended

5.3.1 Black pod disease

This disease attacks cocoa pods in gardens that are over shaded especially during heavy rains. It results in rotting of the pods and in advanced stages. It can also attack the stems causing stem canker. The disease tends to disappear when the rains stop.

Farmers are advised to remove all affected pods and dispose them away from the garden.

Symptoms Black pod disease

- Infection occurs usually at either end of the pod, causing dead spots.
- Cocoa pod turns black with a sharp line between diseased and healthy host tissue.
- The beans inside are partially or wholly destroyed.
- Young pods or cherelles and young leaves are also attacked.
- It can cause flower and stem cankers as well as seedling blight.
- Yield and bean quality losses result.

Figure 19: Symptoms Black pod disease

Control and management of pod rot

- Cultural control measures
  - Maintain the recommended spacing (3m X 3m)
  - Prune
  - Remove infected pods
  - Reduce levels of shading to reduce canopy humidity
- Chemical control measures
- Use recommended fungicides following recommended dosage and interval spray on a rainy day)
- Weeding
- Recommended types of resistant cocoa
- Construct and maintain effective drainage system
- Remove and destroy infected pods

5.4 INTEGRATED PEST AND DISEASE MANAGEMENT

Integrated Pest Management (IPM) is a comprehensive approach to pest control that combines various management strategies and practices to minimize the impact of pests on cocoa plants while reducing risks to human health and the environment. This method is particularly crucial in cocoa cultivation, where pests can significantly affect yield and quality.

5.4.1 Key Components of Integrated Pest Management

Understanding Pests and Diseases: Cocoa plants are susceptible to a variety of pests and diseases, including insects like the tea mosquito bug, mealybugs and diseases such as black pod disease. The following management practices need to be followed;

i. Cultural Practices: Implementing good agricultural practices can help prevent pest outbreaks. This includes:

- Crop sanitation: Regularly removing debris, weeds, and infected plant material from the farm.
- Pruning: Properly pruning cocoa trees enhances air circulation and sunlight penetration, which helps reduce humidity levels that favor fungal growth.
- Soil health management: Using organic amendments like compost improves soil fertility and plant resilience against pests

Biological Control: Utilizing natural predators or parasites can effectively manage pest populations without chemical inputs. For instance, introducing beneficial insects that prey on harmful pests can help maintain ecological balance

ii. Monitoring and Early Detection: Regular monitoring of cocoa plantations for signs of pest activity is vital. Farmers should be trained to identify early symptoms of pest infestations or diseases so that timely interventions can be made

iii. Chemical Control as a Last Resort: When non-chemical methods are insufficient, carefully selected pesticides may be used as a last resort. The use of pesticides should follow strict guidelines to minimize environmental impact, including rotating active ingredients to prevent resistance development.

iv. Education and Training: Continuous education for farmers about IPM practices is crucial for successful implementation. Training programs should focus on identifying pests, understanding their life cycles, and applying IPM strategies effectively. Knowledge sharing among farmers can also enhance community resilience against pest outbreaks.

CHAPTER SIX: SAFE HANDLING AND USE OF AGRO-CHEMICALS

Safe handling and use of agrochemicals involve protective measures like wearing gloves, masks, and eye protection, reading and following label instructions, proper mixing and application techniques, and safe disposal of excess chemicals and containers. It's crucial to understand the potential risks and hazards associated with different agrochemicals to ensure the safety of yourself, others, and the environment.

Figure 20: fully protected farmer ready for spraying

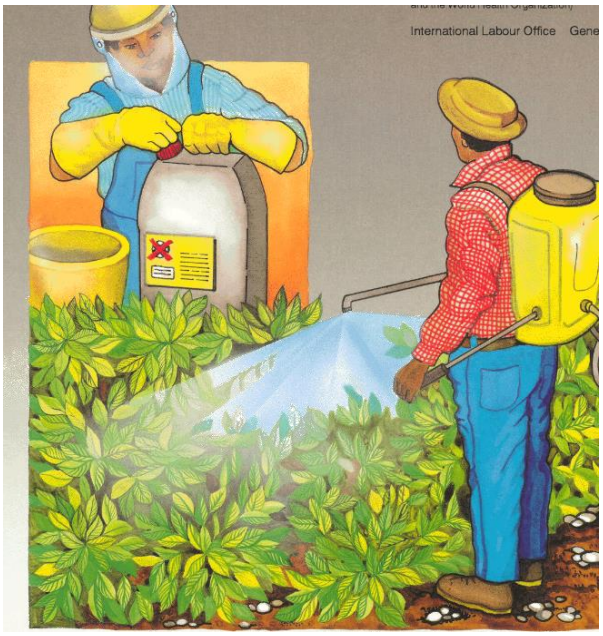


Figure 21:Do not spraying while talking to a colleague

6.1 PERSONAL PROTECTION:

- **Protective Clothing:**
  Wear appropriate clothing, including gloves, masks, and eye protection, depending on the type of agrochemical and the task being performed.
- **Gloves:**
  Gloves, especially those made of materials like nitrile or latex, should be worn to protect the skin from absorption and irritation.
- **Masks/Respirators:**
  Use masks or respirators when handling dusts, powders, or spraying chemicals that can be inhaled.
- **Eye Protection:**
  Goggles or face shields are essential to prevent chemicals from splashing into the eyes.

- **Long Sleeves and Pants:**
  Cover exposed skin with long sleeves and pants to minimize contact with agrochemicals.
- **Footwear:**
  Wear closed-toe shoes or boots to protect feet.

6.2 LABEL INSTRUCTIONS:

- Always read and understand the label before handling any agrochemical product. The label provides crucial information about the chemical's properties, hazards, safe use instructions, and first aid procedures.
- **Follow Instructions:**
  Follow all instructions on the label precisely, including dosage rates, mixing procedures, application methods, and safe disposal instructions.

Always follow instruction

6.3 MIXING AND APPLICATION:

- **Proper Mixing:**
  Mix agrochemicals according to the label instructions, using the correct amounts of water or other diluting agents.
- **Application Techniques:**
  Use appropriate application equipment and techniques to ensure accurate and even application, minimizing drift and exposure.
- **Avoid Drift:**
  Be mindful of wind conditions and other factors that can cause drift, which can lead to off-target exposure.

6.4 SAFE STORAGE AND DISPOSAL:

- **Secure Storage:** Store agrochemicals in a cool, dry, and well-ventilated area, away from children, pets, and food.
- **Safe Containers:** Store agrochemicals in their original, properly sealed containers.
- **Disposal:** Dispose of excess agrochemicals and empty containers according to local regulations and label instructions.

- **Triple Rinse:** Triple rinse empty containers and dispose of the rinse water safely.

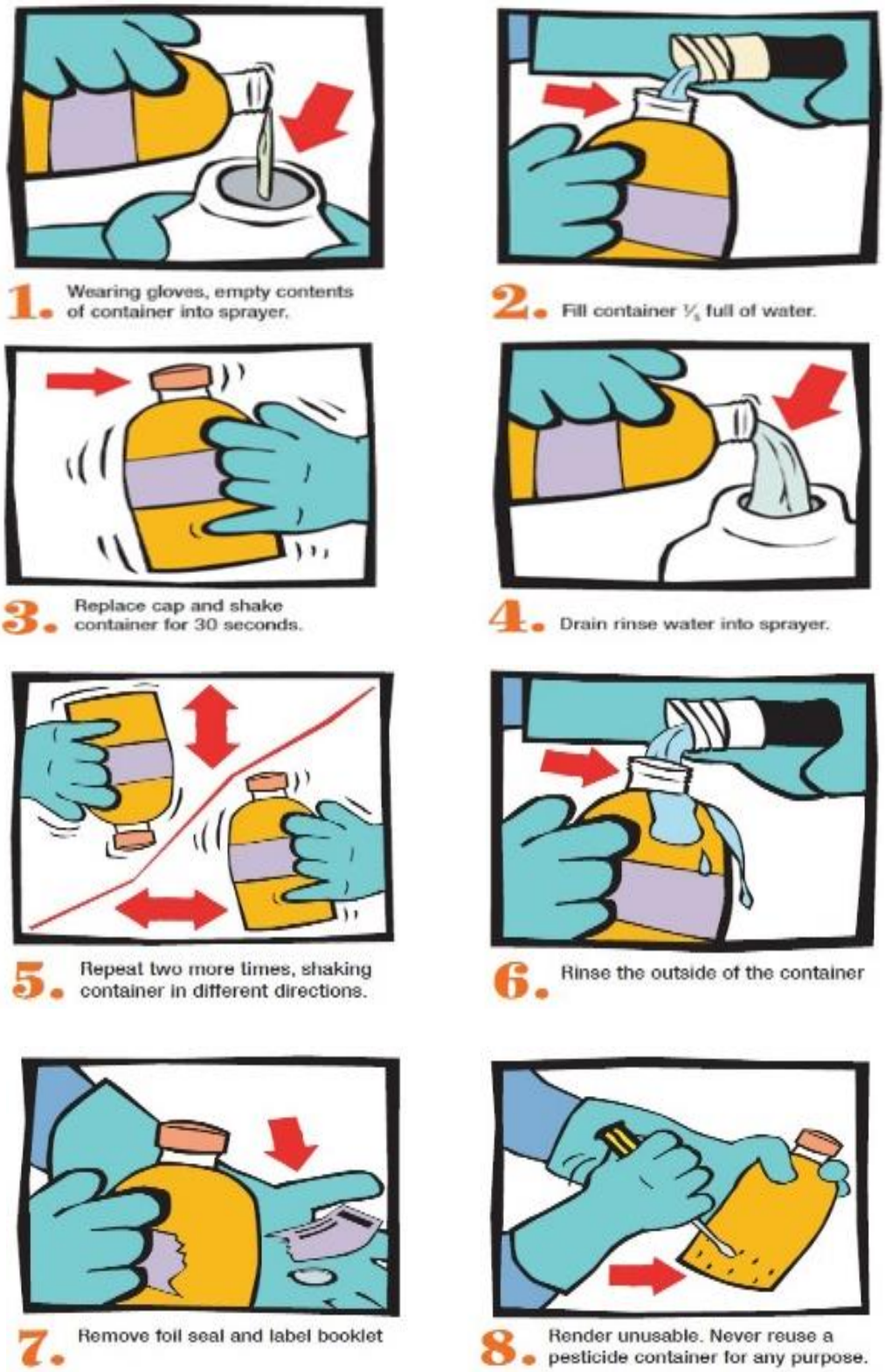


Figure 22: Steps in safe disposal of Pesticide containers.

5. Personal Hygiene:

- Wash hands thoroughly before eating, drinking, or smoking after handling agrochemicals.
- Clean the spray pump

- Bath after spraying

Figure 23: Cleaning pump and self.

6.5 DISPOSAL OF PESTICIDE EMPTY CONTAINERS

- Rinse the empty container at least three times pour the rinse back to the spray pump
- If it a metallic, puncture it or if plastic bottle, cut it several times to avoid re-use.
- Select a disposal site away from home and mark it properly '' Container disposal

CHAPTER SEVEN: HARVESTING, POST-HARVEST HANDLING, VALUE ADDITION AND MARKETING.

7.1 HARVESTING PRACTICES TO CONSIDER

7.1.1 Time of Harvest

- Cocoa pods do not ripen simultaneously, so harvesting is typically done several times a year (every 2-3 weeks) throughout the harvest season.
- Ripe pods are usually yellow or orange but they can also be purple depending on the variety.
- It is important to harvest only mature pods as the unripe will be bitter and of low quality

7.1.2 Tools for Harvesting

- Machete; This is used for cutting the pod from the cocoa tree but avoid damaging the budding area (Stem) as this is the fruiting area for the next season.
- Cocoa harvesting knife; This is a specialized tool designed to make harvesting process easier and more efficient, allowing for précised cuts.
- Collecting basket

7.1.3 Harvesting Process

- Identification of ripe pods; Framers should inspect cocoa tree regularly to identify ripe pods based on color and firmness
- Cutting the pods; the harvested pods should be cut carefully to avoid damaging the tree.
- Collecting ripe pods; Gather the harvested pods and place them in baskets to prevent bruising and damage.

7.2 POST-HARVEST HANDLING

7.2.1 Introduction

Post-harvest handling of cocoa involves removing cocoa beans from harvested pods, drying and sorting cocoa beans and grading cocoa beans.

7.2.2 Pod Breaking and Removal of Cocoa Beans

After harvesting, the healthy cocoa pods are gathered at a designated point for pod breaking to remove fresh cocoa beans. Pod breaking is done by use of a blunt cutlass, club or by knocking or hitting against another pod. The cocoa beans are scooped out by hand and the pod husk, placenta, germinated and black beans are discarded or utilized for other purposes

7.2.3 Recommended Practices in Breaking Pods

- The pod-breaking area must be clean
- Ripe pods may be broken two to three days after harvesting to reduce the pulp

juice content and improve the quality of the fermented beans.

- The correct tool must be used for pod breaking (a blunt cutlass, club or by knocking or hitting against another pod).
- Sharp cutlasses or machetes must not be used as they risk injuring the beans inside the pod, resulting in contamination by micro-organisms (bacteria, fungi, etc.) that thus affect bean quality (risk of producing OTA).
- The beans must be removed from the pod and placed immediately in a clean container (avoid use of rust metal containers).
- Poor quality beans including discoloured, diseased, broken, flattened and caked should be discarded. Avoid mixing them with good beans.

Figure 24 :Removing cocoa beans from mature pod and collected beans

7.3 FERMENTATION OF COCOA BEANS

Fermentation is done to improve on the processor ability and the quality of cocoa beans. A properly fermented and dried bean should be brown in colour when you cut the bean in half (the bean cut test). The importance of fermenting is to:

- Improve the taste, colour and flavor associated with cocoa products.
- Catalyze biochemical changes inside the cotyledons, leading to a reduction in the bitterness and astringency thus enabling the precursors of the chocolate flavor to develop.
- Kill the embryo and stop germination.
- Remove pulp/mucilage so that the beans may dry properly.
- Loosen the skin from the cotyledon thereby allowing easy and proper de-shelling during processing.
- Reduce the cocoa bean moisture content.

7.3.1 Factors Affecting Fermentation

- These include: the ripeness of pods, pod storage before breaking, quantity of beans and pulp during fermentation, type of cocoa, duration of fermentation, turning of the fermenting mass, seasonal effects/climate and diseases that affect pods.
- Over-ripening of pods can cause germination of beans. Harvesting immature, over ripe, diseased and damaged pods produces poor quality beans for fermentation.
- Pulp and beans can contain more water during the wet seasons and too much pulp affects aeration of the fermenting mass and bean acidity. Turning aerates the fermenting mass to avoid uneven temperature and oxygen distribution.
- Normally fermentation is done 4-6 days depending on the method used, weather and the variety.
- The fermentation stage of the bean is determined by the bean cut test.

7.3.2 Fermentation Methods

Cocoa is fermented by different methods which include (heap, basket, tray and box)

1. Heap fermentation

- The fresh cocoa beans are wrapped in fresh banana leaves and turned every two days until fermentation process is complete.
- Turn the beans thrice during fermentation (every after two days)
- Basket fermentation:
- Cocoa beans are placed in the basket and covered at the top with banana le
- Turn the beans every after two days until fermentation is complete.

Figure 25: Heap fermentation of cocoa beans

2. NaCORI Fermentation Box

- The NaCORI single-box is a wooden container with drainage holes, slightly raised from the ground to allow pulp to flow out and air to circulate.
- Its simple design provides a controlled and hygienic fermentation environment.

Steps of the farmentation.

- Fresh cocoa beans are placed in the box and covered with banana leaves or jute sacks.
- For the first two days, the beans remain undisturbed while natural microbes break down sugars in the pulp, producing heat and acids. The pulp drains through the holes and can be collected for other uses like juice or wine.
- On the third day, the beans are turned inside the same box to introduce oxygen and ensure even fermentation. They are then re-covered to maintain heat and moisture.
- Fermentation continues for another two to three days, during which heat and microbial activity kill the cocoa embryos and develop chocolate flavour precursors. By the fifth day, fermentation is complete.
- The final beans are evenly brown, less bitter, and aromatic.

Figure 26: NaCORI single-box cocoa fermentation system.

This system achieves about 90% fermentation in just 4–5 days, compared to 7–10 days with traditional methods, while also providing by-products that add value for farmers.

3. Storey Box Fermentation:

Three unpainted, untreated wooden boxes are arranged vertically in a ladder formation. Beans from the top box are transferred to the middle box after two days, then covered with plantain leaves or empty jute bags to promote fermentation and retain heat. After another two days, the beans are moved to the bottom box and similarly covered. This process facilitates controlled fermentation for seven days.

Figure 27: Storey fermentation boxes for fermenting cocoa

Table 6: Relationship between colour, degree of fermentation and flavour.

Colour of bean (the bean cut test)	Degree of fermentation	Flavor on roasting
Brown	Fully fermented	Strong cocoa flavor, balance of acidity, astringency and bitterness
Brown/purple	Partly fermented	Good cocoa flavor, higher acidity, astringency and bitterness
Purple	Low fermentation	Low cocoa flavour, strong acidity, astringency and bitterness

- Greyish or black Unfermented
- Absence of cocoa flavour, predominantly acid, astringent and bitter.
- Overall sour flavour

7.3.3 Drying and Sorting Cocoa Beans

- Drying is the process of reducing moisture in fermented beans from about 55% to the recommended dry cocoa bean moisture content of 7-8%.
- The beans must be turned frequently to enable uniform drying.
- Pick out germinated, flat and black beans, placenta and any foreign materials for quality control.
- Dry beans produce a 'cracking' sound after pressing them lightly in the fist.
- Fire/smoke should not be made under or close to the beans during drying as it will give the beans a bad taste/ and a smoky smell.
- A properly fermented and dried bean looks brown in color when cut in half.

7.3.4 Methods of Drying Cocoa Beans

- Drying cocoa beans can be done by sun or mechanically using driers)
- Cocoa beans should be sun or solar dried. (This gives the best quality).
- Drying beans by the roadside should be avoided to prevent contamination and post-harvest loses.
- Avoid drying cocoa beans on the bare ground.
- Drying cocoa beans using fire and or near fire must be avoided.
- Avoid drying cocoa beans on a metallic surface (the chemical reaction promotes rusting and introduces harmful heavy metals and off flavours into the cocoa beans).

7.3.5 Sorting and Grading Cocoa Beans

Grading is largely done on the basis of bean count per one hundred grams of randomly chosen sample and the number of defective beans identifies in the cut test performed.

Cocoa grades

- Grade 1 cocoa: (less than 3% slaty, mouldy and defective beans each.)
- Grade 2 cocoa: (less than 5%, 4% and 5% slaty, mouldy and defective

Figure 28: Sun drying and packing cocoa beans

7.3.6 Storage of cocoa beans

- Cocoa beans packed in sacks or jute/sisal material of non-toxic nature.
- The packed cocoa bags must be stored on wooden pallets at least 7cm above the ground in order to allow good air circulation.
- Keep the cocoa store free from vermin and other pests by fumigating
- There must be at least a passage of 60 cm between the walls and the bags and between bags of different types of cocoa in the store
- Periodic checking of the moisture content of each lot must be carried out.
- Avoid storing and transporting cocoa beans together with contaminants such as petroleum products and agro-chemical.
- Avoid storing cocoa beans in kitchen (can easily absorb the smoke).

7.4 ROASTING AND GRINDING

7.4.1 Roasting

It is crucial in chocolate making process and significantly influences flavor, aroma and texture.

- It reduces moisture content which is ideal for grinding and storage.
- It also transforms the raw bitter beans into flavorful components.
- The heat kills the microbes.
- It gives the beans a darker colour which is usually appealing in chocolate products.
- It loosens the shell making it easier to remove the shell.

7.4.2 Type of Roasters

- Drum, tray/oven, fluid, solar and hot air roasters.
- Condition during roasting.
- Temperature: 120-180 degree Celsius for 15 to 60 minutes.

7.4.3 Grinding

Grinding of cocoa beans is a critical stage in chocolate making, converts roasted cocoa nibs into cocoa paste. This process helps to release the cocoa butter contained in the nib and turns it into powder.

7.5 COCOA PRODUCTS AND BY-PRODUCTS (VALUE ADDED PRODUCTS)

Uses of cocoa and its by-products (chocolates, cocoa butter, cocoa powder, beverage, confectionary, cosmetics, ice-cream).

Products derived from cocoa waste (animal feed, potash production, wine, alcoholic beverages (local gin), jams marmalades from cocoa sweating), organic pesticides from fermented cocoa juice, pectin for pharmaceuticals.

7.5.1 Different cocoa by-products.

Cocoa Chocolate

7.6 COCOA WASTE MANAGEMENT

Cocoa management is an important aspect of sustainable cocoa production. The industry of cocoa generates various by products and waste, these include cocoa, pod, shells and fermentation waste.

Effective management of these wastes not only minimize environment impact but also provide opportunities for resource recovery, economic benefits and enhanced sustainability of the cocoa value chain.

7.7 COCOA PODS

Figure 29: Transforming cocoa pods into biochar

- Can be used as mulch, Cocoa peat, biochar production, biogas and bio energy and composting, the process of biochar making is presented in figure 27
- Cocoa pulp; Used for biogas, alcohol, wine and other fermented beverages
- Cocoa bean shells/husk; used as mulch, coca shell tea.
- Fermentation waste; Biogas, mulch, composting.

CHAPTER EIGHT: CLIMATE SMART MARKETING AND CERTIFICATION

8.1 COCOA MARKETS

Marketing includes strategies to promote coca products ranging from cocoa beans to finish goods like chocolate, butter, powder. Cocoa markets include domestic, regional, and international channels.

8.1.1 Domestic Market

- Local Processors & Chocolatiers
- Artisanal/Niche Segment:
- Retail Outlets.-supper markets

8.1.2 Regional Market

- Kenya & Rwanda,South Sudan & DRC

8.1.3 International Export(bulk Buyers)

- Europe (Netherlands, Germany, Belgium):
- Asia (Malaysia, Indonesia):
- United States:

8.1.4 Specialty & Certified Markets

- Certification Schemes require compliance with Fairtrade, Rainforest Alliance standards.
- Fine-Flavor Cocoa: require profiling and traceability systems.

8.2 STRATEGIES OF MARKETING COCOA AND 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.

8.3 MARKET REQUIREMENTS

8.3.1 Bean quality

- Uniformity: Beans should be consistent in size, shape, and color, reflecting even fermentation and drying.
- Fermentation: Properly fermented beans develop desired flavor precursors; under- or over-fermentation leads to off-flavors.

- Flavor Profile: Buyers may specify flavor notes (e.g., fruity, nutty); traceability of origin and processing for niche market demand

8.3.2 Moisture content

- Target Range: 6–7% moisture by weight at sale; too high leads to mold and quality deterioration, too low risks bean breakage.
- Measurement: Use a calibrated moisture meter on representative samples.
- Drying Protocol: Spread beans in thin layers on raised, clean drying beds; Turn every 2–3 hours until target moisture is reached and; Protect from rain and overnight humidity.

8.3.3 Foreign matter free

No extraneous material such as twigs, stones, soil, insect fragments, or other debris in the bean lot.

Removal Techniques:

- Pre-clean by hand-picking large debris immediately after pod breaking.
- Sieve & Winnow Using mesh screens and gentle airflow to separate small stones and dust.
- Execute a quality control routine by Inspecting samples from each lot before packaging

8.3.4 Grading and sorting

- Beans are graded according to size. Size Grading: into large, medium, and small. Uniform size aids even roasting. At least 1.0 gram per bean. Beans below this threshold have proportionally higher shell content and lower nib yields, which reduces processing output and chocolate quality
- Sort beans with Defects: such as remove flat, slaty, mouldy, insect-damaged, or black beans. Use Mechanical Graders with adjustable sieves for size separation or manual sorting tables with good lighting for defect identification.
- Keep records of volumes by grade and defect rates to monitor improvement.

8.3.5 Packaging

- At Primary Packaging use food-grade jute or grain-protection (polylined) sacks to maintain dryness and allow airflow.
- Labelling:
  - Lot Number / Trace Code for origin and processing details.
  - Net Weight, Harvest Date, and Farmer Group or Cooperative Name.
- Storage Conditions:
  - Cool and well-ventilated warehouses.
  - Off-floor and away from direct sunlight.

8.3.6 Certification

- Common Schemes:
  - Organic: No synthetic agrochemicals; follows organic farming protocols.
  - Fairtrade / Rainforest Alliance / UTZ: Social, environmental, and economic standards.
- Certification Steps:
  - Carry out a Self-Assessment and evaluate current practices against standard checklists.
  - Implement record systems (pesticide usage logs, social policies).
  - Engage accredited certifier for on-farm inspection and audit.
  - Implement annual surveillance audits and continuous improvement

CHAPTERS NINE: EXTENSION APPROACHES FOR SCALING UP CSA

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.

9.1 APPROACHES TO CSA UPSCALING

These approaches differ depending on the numbers of the farmers targeted, the contents of the training and available resources.

1. Individual/Household Approach
    - Personalized extension visits
    - Tailored advice based on household resources and needs

Examples of information disseminations:

⇒ Tailored advisory services promoting resilient cocoa varieties (e.g., drought-tolerant)
⇒ Promotion of soil and water conservation practices (e.g., mulching, Making trenches).
⇒ Support adoption of climate-informed planting calendars using seasonal forecasts.
⇒ Encouraging home-based composting and organic manure use to reduce reliance on chemical inputs.
⇒ Facilitate access to weather information via mobile platforms to guide daily farming decisions.

2. Community Based Facilitators & Lead Farmers approach

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.
This model encourages Peer-to-peer learning and eases technology transfer by observation and demonstration among farmers communities.
Examples of techniques that can be disseminated:

⇒ Train lead-farmers to champion CSA technologies such as: Conservation agriculture; Agroforestry integration with soybean (e.g., Gliricidia, Sesbania); Intercropping and crop rotation with legumes for soil fertility.
⇒ Establish on-farm climate-smart demo plots showing; Use of bio-fertilizers and rhizobium inoculants; Integrated pest management (IPM); Irrigation techniques.

3. Demonstration Plots (Demos)

⇒ On-farm demonstrations of technologies or practices
⇒ Comparative plots to show traditional vs improved methods

4. ICT-Based Extension Services

⇒ 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.

5 Private Sector Engagement

⇒ Involvement of Agro-dealers and input suppliers in farmers training

⇒ Contract farming and value chain linkages

6. Group Approach

Through formation of farmer groups or cooperatives, it allows collective learning and bargaining power and these include Farmers Field Schools, Demonstrations, Field Exchange Visits and Farmer Field Days.

7. Farmer Field Schools (FFS)

This involves a season-long training focused on experiential learning, empowering farmers through observation, experimentation and discussion. It involves participatory decision-making of all members

⇒ Facilitate farmer experimentation with:

- Soil fertility management techniques
- Variety testing
- Water harvesting systems for supplementary irrigation.

⇒ Promote adaptive research with a FFS acting as innovation hubs where farmers develop climate-smart solutions jointly with researchers and extension workers.

8. Field Exchange Visits

⇒ Farmer-to-farmer visits across regions

⇒ Sharing best practices and innovations in SLM, Cropping systems, etc

9. Farmer Field Days

⇒ Organized events to showcase technologies and practices

⇒ Participation of multiple stakeholders

10. High-Level Farmer Organizations

⇒ These are Apex organizations, cooperatives, unions

⇒ Umbrella organizations for Policy advocacy, aggregation, and group market

⇒ Extension officers can Build capacity of cooperatives and unions to access and distribute:

- Tolerant seed varieties, mechanization and irrigation equipment that cannot be afforded individually
- Group financing e.g. SACCOS,
- Market incentives for sustainably grown soybeans (e.g., Carbon Credit, Weather-index insurance and traceability permits)

⇒ Advocate for CSA policies and incentives at district and national levels.

9.2 GENDER INTEGRATION IN CSA

9.2.1 Why is Gender Integration in Agricultural Extension Important?

i. **Gender-responsive extension services**

⇒ Develop climate-smart extension messages tailored to the needs and knowledge gaps of women youth and men in cocoa 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 cocoa 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 cocoa value chain—production, processing, storage, and marketing.

⇒ Promote climate-resilient aggregation models where women can lead or co-manage collective cocoa 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.

⇒ Encourage participatory research with women to adapt soybean farming practices to their specific climate-related challenges.

vi. **Climate-smart policy advocacy with gender perspective**

⇒ Support platforms where women farmers can advocate for CSA policies, such as subsidies for climate-resilient inputs or CSA-related extension support.

⇒ Involve gender-focused CSOs and local leaders to mainstream women's climate needs
into district and national agricultural planning.

9.3 OUTCOMES OF GENDER-SMART CSA INTEGRATION

⇒ Increased Productivity and Food Security; 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.

⇒ Empowerment of Women; 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.

⇒ Sustainable Development; Ignoring gender issues in agriculture can lead to unsustainable 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, and organic fertilization—led by both women and men.

Key Aspects of Gender Integration in Agricultural Extension:

⇒ Gender Analysis; Understanding the specific roles, constraints, and needs of both women and men in agriculture is crucial for designing effective extension programs.

⇒ Inclusive Extension Services; Extension services should be accessible to all farmers, regardless of gender, ensuring that information and technologies are relevant and useful for both women and men.

⇒ Capacity Building; Extension staff need to be trained on gender issues and how to work effectively with both women and men farmers.

⇒ Targeted Interventions; Some interventions may need to be specifically targeted at women, such as providing access to credit, training, or inputs, while others should address the needs of both men and women.

⇒ Monitoring and Evaluation; It's essential to monitor the impact of extension programs on both women and men and to evaluate whether gender equality is being achieved.

⇒ Policy and Institutional Change; Gender integration requires changes in policies and institutional structures to ensure that gender equality is a priority in agricultural development.

Practices of Gender Integration in Agricultural Extension:

⇒ Hiring Women Extension Officers; Having women extension officers can improve access to information and services for women farmers, as they can better relate to

their needs and experiences.

⇒ **Training Women Farmers;** Providing women with access to training on new technologies and farming techniques can increase their productivity and incomes.

⇒ **Ensuring Access to Resources;** Ensuring that women have equal access to land, credit, and inputs can help them to participate more fully in agriculture.

⇒ **Promoting Women's Leadership;** Supporting women's participation in farmer groups and other decision-making bodies can empower them and ensure that their voices are heard.

⇒ **Using Gender-Sensitive Indicators**; Monitoring the impact of extension programs on both women and men can help to ensure that gender equality is being achieved

CHAPTER TEN: MONITORING AND RECORD KEEPING

This chapter focuses on effective monitoring and record-keeping practices for farmers and extension officers in the context of Climate-Smart Agriculture (CSA). As climate change increasingly affects farming systems, proper monitoring and record-keeping have become essential for tracking progress, adapting practices, and demonstrating outcomes. This chapter equips extension officers with the knowledge and tools needed to guide farmers in maintaining clear, simple, and practical records. Illustrated examples are included throughout this module to aid training.

10.1 IMPORTANCE OF EFFECTIVE MONITORING AND RECORD-KEEPING

⇒ Better planning and decision-making based on actual farm data.
⇒ Identification of successful practices and avoidance of repeated mistakes.
⇒ Justification for credit, input support, and project benefits.
⇒ Measurement of CSA outcomes, such as improved yields or resilience.
⇒ Early detection of problems like soil degradation or pest outbreaks

Key Indicators to Monitor S.A Activities

⇒ Climate smart agriculture indicators in regard to "CSA TIMPs" at various nodes of commodity (source of planting materials, variety verification, trenches, manure application, mulching, shade trees, bananas).

1. Resilience/adaptation indicators

⇒ Percentage of Climate resilient varieties adopted
⇒ Number of households using solar powered irrigation technologies
⇒ Number of households using energy saving techniques

2. Productivity indicators

⇒ Area under cover cropping
⇒ Area under SLM
⇒ Number of pods per tree
⇒ Percentage of certified Cocoa produced
⇒ Increment in household income
⇒ Number of farmers in cocoa production

3. Mitigation indicators

⇒ Area under agroforestry coverage
⇒ Amount of Cocoa waste valorized on the farm
⇒ Enabling environment indicators
⇒ Percentage access to CSA credit
⇒ Percentage of women and youth engaged in Cocoa production

10.2 FARM RECORDS

10.2.1 Financial records

- Invoices: document issued by the seller to the buyer demanding payment for the goods and services offered. It indicates the quantity, unit price, taxes and details of the payee.
- Payment vouchers: A document prepared to pay service providers after invoices have been received and verified receipts: It is a document issued acknowledging payment Pay in books: Documents indicating money you have paid in the bank
- Cash book: contains information of the money banked, received and spent

10.2.2 Operation Records

- These are records that contain all farm activities including fertilizer application, pest and disease control, harvesting, as part of farming as a business.
- A farmer needs to design a simple comprehensive record entry/ report which can easily be understood by all the people on the farm.
- Records must be easy to understand and written in such a way that they can easily be accessed for analysis.

10.2.3 Storage Records

- Stock card: It is a document in form of a card hanged on a batch of food product or grain indicating the quantity of stock you have at that time. You can also have stock card for all inputs at your farm. Keeping track of stock helps with identifying theft, guarding against wastage and unnecessary purchases and planning for production
- Stack Card: Card fixed to a bag stack used to keep a tally of the number and weight of bags of grain either
- added or removed from the stack.
- Goods Received Note (GRN): Document issued out to acknowledge receipt of goods
- Received Stock ledger books: Records of the stock that has been received in the store/ware house
- Outgoing stock ledger books: Records of stock that has been removed from the store

10.2.4 Marketing Records

- List of customers
- Price lists
- Details of buyers and quantities desired by the market
- Product types

10.2.5 Production records

- These include input records, labour records and records of all other inputs that are used in the production of maize.
- Input records
- An example of an input record for starting a maize farm table

Table 7: Input records

Input	Date of purchase	Expected useful life	Unit cost	Quantity	Total cost
Land					
Implements (hoes, pangas, etc.)					
Seed					
Fertilizers					
Pesticides					
Gumboots (pairs)					
Sisal rolls for marking planting holes					
Pegs for marking planting holes.					
Total expenditure on inputs					

10.2.6 Labour records

This type of record details the labour used for the various tasks on the farm. An example of labour records for a maize business

Input	Timing (e.g. March)	Duration (Days)	Amount of labour (e.g. person-hours)	Total Cost of the labour (UGX)
Land clearing				
Ploughing and harrowing				
Field marking				
Digging holes				
Planting				
Weeding				
Thinning				
Harvesting				
Transport				
Marketing				

10.2.7 Sales record

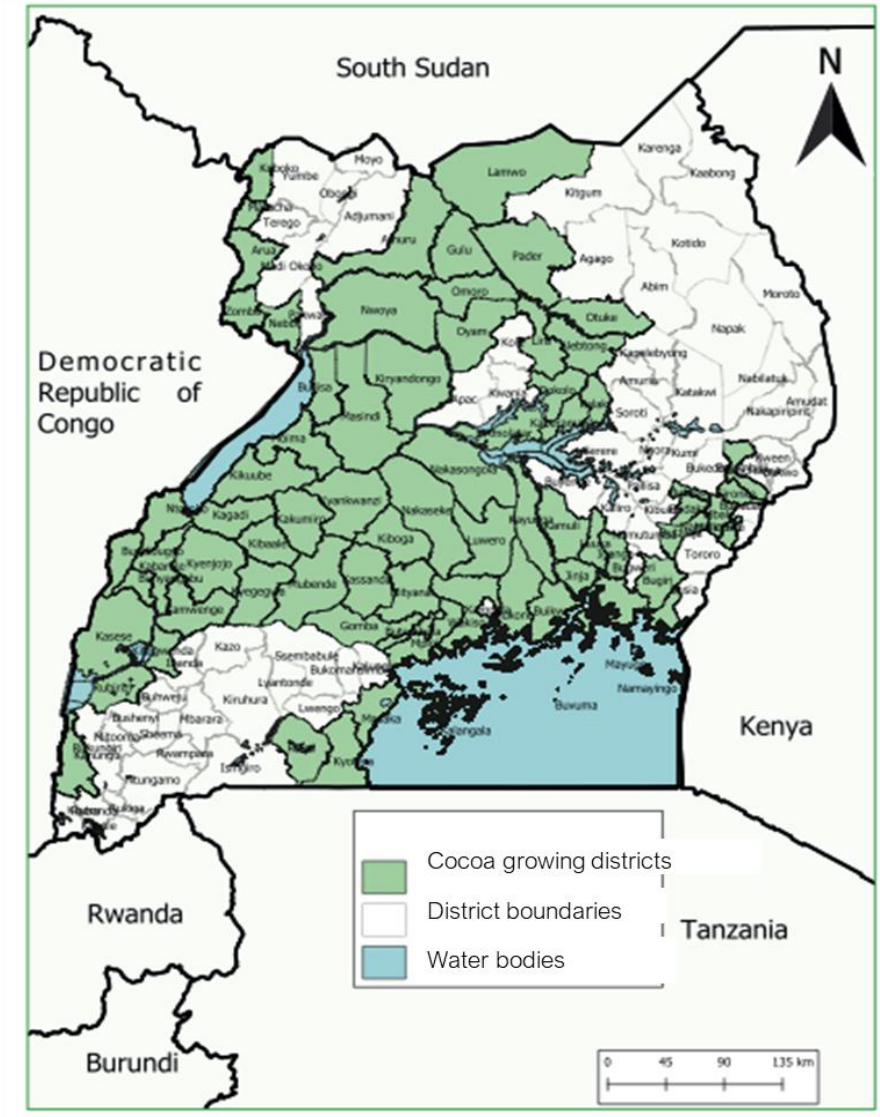
The sales record is used to capture information on the sales made. It should include the volumes of the produce sold, the date of sale, the average selling price, the type of buyers and mode payment.

An example of sales record for a maize farm

Date	Product Type	Quantity sold	Average. Price per unit sold	Type of buyer, (e.g. bicycle traders, wholesaler)	Mode of payment, e.g. cash, cheque, credit etc.

ANNEXES:

ANNEX 1: MAP OF COCOA GROWING AREAS



Disclaimer: The names and boundaries shown and the designations used on this map do not imply official endorsement or acceptance by UCDA

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