

Tanzania National Coffee Sustainability Curriculum



Coffee Extension Materials: Trainer's Manual and Lesson Plans
Second Edition, 2023

The Joint Coffee Stakeholders of Tanzania

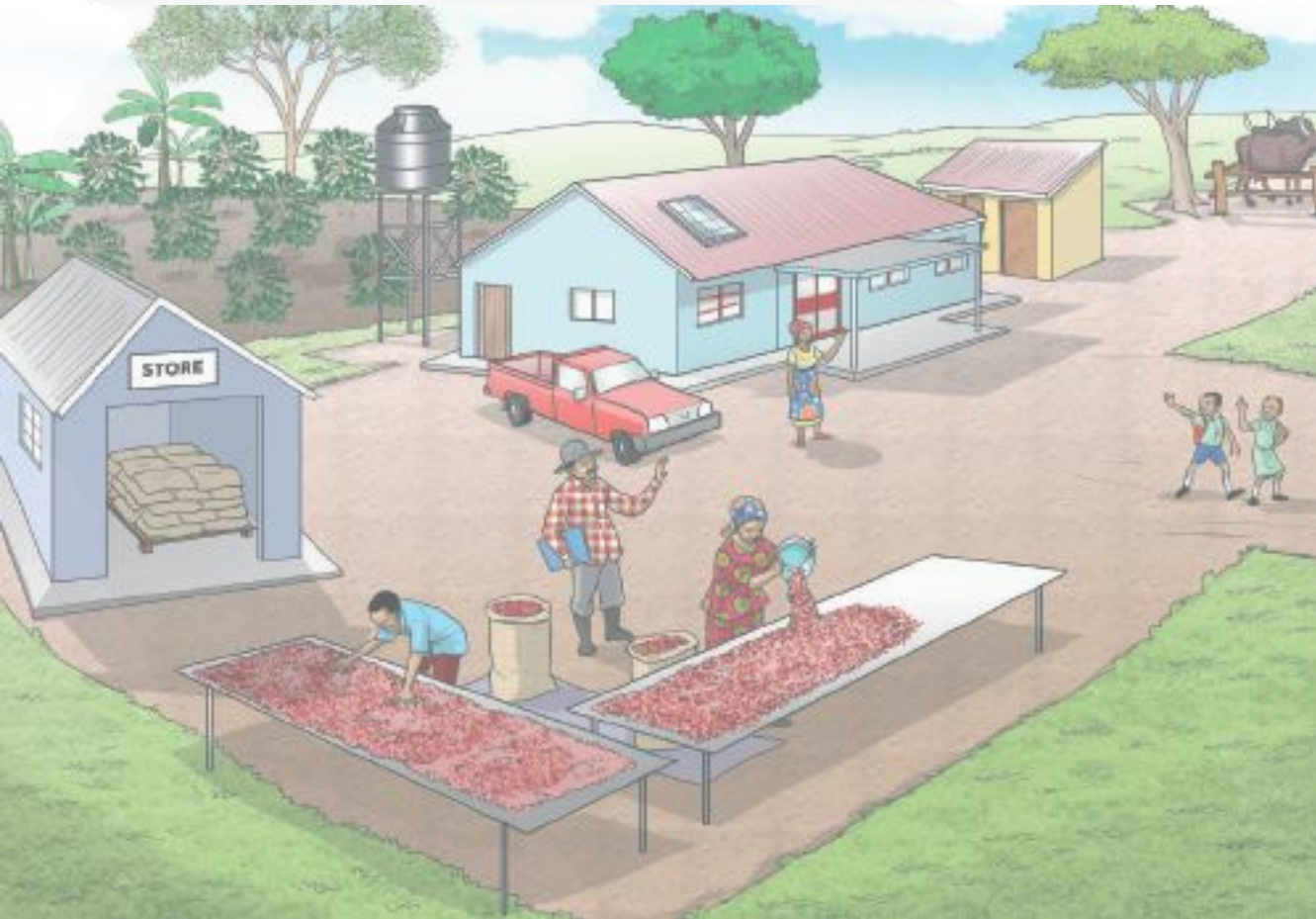




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Tanzania National Coffee Sustainability Curriculum



Preface

This second edition of the Tanzania National Coffee Sustainability Extension Training Manual has been developed through the implementation of joint projects with partners both from the private and public sector led by the Tanzania Coffee Board (TCB).

The aim of this manual is to strengthen the delivery of extension services to coffee farmers by supporting the national institutions in setting and maintaining minimum standards for delivering extension services to coffee farmers, resulting in higher productivity, increased coffee quality and better livelihoods for farmers.

This manual has been developed in a consultative process by harmonising extension materials which have been used by the institutions delivering extension services to coffee farmers and also incorporating stakeholders' suggestions on what was missing in the first edition. Furthermore, the development of the manual considered the current dynamics around the coffee sector locally and globally, including climate change, population growth, and growing niche markets for specialty coffee to suit consumers' tastes and preferences, as emphasised in the Tanzania Coffee Industry Development Strategy.

I would like to thank the P4F through the Global Coffee Platform for the financial support, the sustainable coffee sector committee for their inputs, and the sustainable coffee working group for their tireless efforts spent reviewing the draft and contributing to the development of this manual.

Each topic in the curriculum has been developed together with a lesson plan to guide the trainer on areas of focus when training the farmers. The manual has also been enriched with case studies and examples to facilitate the learning process. Together with this manual, posters have been developed with illustrations to further the training process.

It is my hope that this manual, along with its lesson plans, will serve the Tanzanian coffee sector by enhancing the delivery of extension services, hence supporting efforts to achieve the anticipated objectives sustainably.



Director General

Tanzania Coffee Board

2023

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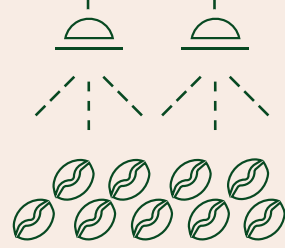
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LIST OF ABBREVIATIONS

| | |
|--------|--|
| AFA | Agriculture and Food Authority |
| AMCOS | Agricultural Marketing Cooperative Society |
| CAMGEW | Cameroon Gender and Environment Watch |
| CBD | Coffee Berry Disease |
| CLR | Coffee Leaf Rust |
| cm | Centimetre |
| CPU | Central Processing Unit |
| CWD | Coffee Wilt Disease |
| GAPs | Good Agricultural Practices |
| GCP | Global Coffee Platform |
| GMP | Good Management Practices |
| Ha | Hectares |
| ICO | International Coffee Organisation |
| ISFM | Integrated Soil Fertility Management |
| kg | Kilogramme |
| LGAs | Local Government Authorities |
| m | Metre |
| MASL | Metres above sea level |
| MDF | Market Development Facility |
| MoA | Ministry of Agriculture |
| MT | Metric tons |
| NEMC | National Environmental Management Council |
| NGOs | Non-governmental Organisations |
| PCBs | Private Coffee Buyers |
| PPEs | Personal Protective Equipment |
| SACCOs | Savings and Credit Co-operative Society |
| TaCRI | Tanzania Coffee Research Institute |

| | |
|----------|---|
| TANTRADE | The Tanzania Trade Development Authority |
| TCB | Tanzania Coffee Board |
| TPHPA | Tanzania Plant Health Pesticide Authority |
| TZS | Tanzanian Shilling |
| ULV | Ultra-low volume |
| USD | United States Dollars |
| VSS | Voluntary Sustainability Standards |
| WCSB | White Coffee Stem Borer |
| WHO | World Health Organization |



This topic introduces coffee as a crop that has international economic value as a commodity and a source of employment. A coffee farmer's main objective should be to produce high volumes of the best quality coffee that can fetch the best possible price which will generate sufficient income to meet the family's needs. The most important issues affecting the production of Arabica and Robusta coffee varieties, such as the ecological, economic, and legislative factors, can be addressed through sustainable coffee farming. Using this concept, trainers can help farmers avoid or manage these factors and grow coffee sustainably to meet national and global market demand.

1.1.1 Coffee Around the World

Coffee is one of the most popular beverages in the world, and demand for it is steadily increasing. Brazil is the largest coffee producer in the world followed by Vietnam, Colombia, and Indonesia. However, according to the International Coffee Organisation (ICO), of the 56 coffee producing countries in the world, 25 of them are in Africa. Global coffee production in 2020-2021 was estimated at a total of 169.6 million 60kg bags; 18.7 million of which came from the African continent, meaning that Africa produces about 11% of the world's supply of coffee, an amount that stayed stable between 2019-2020 and 2020-2021.

The current world demand for coffee is estimated to increase. According to WCR (2021), world coffee consumption has increased by 1.9%, from 9,847,800 metric tons recorded in coffee year 2019/20 to 10,035,600 metric tons in coffee year 2020/21. This demand increase is a result of an increase in the population consuming coffee in coffee-producing countries, emerging economies, and a stronger interest in specialty coffee produced sustainably and in product innovations in developed countries. Due to the increasing demand for coffee, farmers must embark on coffee farming as a business.

1.1.2 Coffee in Africa

The five largest coffee-producing countries in Africa are Ethiopia (with 7.7 million bags, corresponding to 41% of the total coffee produced in Africa), followed by Uganda (with 4.9 million bags, or 26% of the total produced), then Cote d'Ivoire (with 2.2 million bags or 12% of the total), then Tanzania in fourth place (with 900 thousand bags or 5% of the total), and finally Kenya (with 844 thousand bags, or approximately 4% of the total production in Africa). The other coffee-producing countries in Africa have an estimated combined production of 2.2 million bags, which is 12% of the total production.

1.1.3 Coffee Production in Tanzania

Tanzania produces both Arabica and Robusta, the two types of coffee grown commercially in the world. Arabica coffee grows in high altitude areas ranging from 1,000 to 2,500 meters above sea level (MASL) which receive between 1,500 and 2,000 millimeters of rainfall per year (Wrigley, 1988; Cambrony, 1992). Arabica's ideal temperature ranges from 15-25oC, while absolute minimum temperatures should not be lower than 4-5oC and absolute maximum temperatures should not exceed 30-31oC. Due to its distinct body and flavor, Arabica is normally used to blend with other coffees like ordinary mild, hard Arabica, and Robusta; thus, the demand for Tanzanian Arabica coffee is always higher than the supply.

Meanwhile, Robusta coffee is cross-pollinated and grows at much lower altitudes than Arabica at about 900 MASL, and prefers optimal rainfall between 1,500 and 3,000 millimeters, and mean temperatures of 24 to 30oC (Wrigley, 1988; TCB, 2012). Robusta coffee contributes an average of 30% of the total coffee produced in Tanzania.

Illustration 1 indicates that the regions in Tanzania which grow Arabica coffee include Kilimanjaro, Arusha, Mbeya, Songwe, Ruvuma, Tanga, Iringa, Morogoro, Kigoma, Manyara, Mwanza, Katavi, Njombe and Mara. Robusta coffee is mainly grown in Kagera Region under the shade of banana plants. Other regions suitable for Robusta coffee production include Morogoro, Mwanza, Geita, Tanga and Mara (TCB, 2021).



Illustration 1: Tanzania coffee growing areas/districts and new potential areas for expansion

Tanzania accounts for roughly 6% of the Colombian Mild group production. About 90% of the total coffee production in Tanzania comes from about 320,000 coffee smallholder farmers with an average of 200 coffee trees and farm sizes of 0.5-2 acres. The remaining 10% of coffee is produced by 101 registered coffee estates. According to the Tanzania District Coffee Profile (2018-2019), about 191,500 hectares are under coffee production in 52 growing districts. The profile also indicates that the country has a huge potential land of about 741,895 hectares for coffee production expansion in both the current districts growing the crop and others not doing so (TCB, 2021). The trend of Tanzanian coffee production has been increasing at a mean rate of 73,206 tons annually from the assumed baseline of 43,288 tons. The absolute minimum of 32,489.00 tons was recorded in 2003/04 while the absolute maximum of 73,027.01 tons was produced in 2020/21. This makes the country rank 4th among the 25 coffee producing countries in Africa.

Coffee production in Tanzania
has been increasing...



...from
43,288 tons
to
73,206 tons
annually



This makes the country rank

4th among the **25**
coffee producing
countries in
Africa.



1.2.1 Actors in the Tanzanian Coffee Value Chain

An effective coffee industry coordination and management system requires a streamlined process. This process will include effective modalities for planning, regulation, and monitoring and evaluation in relation to enterprise financing, production, processing, marketing, marketing infrastructure, capacity development and policy development for decision making.

Table 1: Coffee Stakeholders' Councils, member composition and their functions

| Council/Forum | Chairperson | Member Composition |
|---|------------------------------------|---|
| National Coffee Stakeholders' Executive Council | Minister – Ministry of Agriculture | Representatives from public and private sector institutions with the major focus on agriculture |
| Regional Coffee Stakeholders' Executive Council | Regional Commissioner (RC) | Representatives from public and private sector institutions with the major focus on agriculture |
| District Coffee Stakeholders' Executive Council | District Commissioner (DC) | Representatives from public and private sector institutions with the major focus on agriculture |

The Tanzanian coffee sector allows a range of supply chain actors to operate in parallel. The actors in the coffee value chain are described as follows:

1.2.1.1 Institutional Arrangements

Coffee industry stakeholders in Tanzania constitute innovative system actors which include the following: Ministry of Agriculture (MoA), Tanzania Coffee Board (TCB), input suppliers, Tanzania Coffee Research Institute (TaCRI), Local Government Authorities (LGAs), traders, farmers, Agricultural Marketing Cooperative Society (AMCOS), processors, The Tanzania Trade Development Authority (TANTRADE), non-governmental organisations (NGOs), policy makers, Development Partners, vocational training centres, extension services, and information and financial institutions. Engaging and linking these stakeholders is crucial in influencing the flow of information, knowledge and resources, and the innovative behaviour of individuals and choice of enterprises.

Coffee growers and farmer organisations: Coffee growers and their organisations are central to the Coffee Industry Development Strategy to attain economic, environmental, and social sustainability under a supportive policy and institutional framework. Farmers under a supportive policy and institutional framework are encouraged to adopt improved good agricultural practices including improved coffee varieties to ensure farm productivity is improved, farming profitability increases, and living conditions are improved.

Private sector traders/exporters/millers/roasters: The private sector is essential for improving the coffee sector by supporting farmers through cooperatives and groups. The government encourages private sector companies (traders/exporters/millers/roasters etc.) to play a part in the implementation of shared functions under public private partnerships and increase efficiency of the value chain actors.

Ministry of Agriculture: The Ministry supervises the sector; delivers quality agriculture and cooperative services; provides a conducive environments to stakeholders; and builds the capacity of local government authorities in order to facilitate the private sector to contribute effectively for sustainable agricultural production and cooperative development.

Tanzania Coffee Board (TCB): The role of TCB, among others, is to regulate the coffee industry in Tanzania and advise the Government of the United Republic of Tanzania on all matters related to the growing, processing and marketing of coffee within and outside the country.

Tanzania Coffee Research Institute (TaCRI): The objective of TaCRI is to rejuvenate the Tanzania coffee industry by placing new emphasis on the role of stakeholder-led and client demand-driven research for development.

Local Government Authorities (LGAs): Local government authorities are established under the constitution of the United Republic of Tanzania of 1977, Articles 145 and 146. The LGAs are mandated to maintain law, order and good governance; promote the economic and social welfare of the people in their jurisdiction; and ensure effective and equitable delivery of quality services to the people.

Non-governmental Organisations (NGOs): Several NGOs have extensive access to expertise, funds and dedicated resources to assist in the implantation of shared functions directly contributing to the coffee sector strategy. They can provide expertise when needed and support implementation in several dimensions of the coffee sector.

Table 2: Key Coffee Stakeholders and Their Roles

| Name of the Stakeholder | Roles |
|-------------------------|---|
| Ministry of Agriculture | <ul style="list-style-type: none"> • Supervises the sector • Acts as liaison between the sector and the legislature and provides legal and policy guidance • Formulates rules and regulations related to the coffee industry |
| Tanzania Coffee Board | <ul style="list-style-type: none"> • Advises the government on policies and strategies for the development of the coffee industry, and regulates the industry • Issues various licences and permits • Collects and disseminates statistics • Runs the coffee auctions |

| Name of the Stakeholder | Roles |
|--|---|
| Tanzania Cooperatives Development Commission | <ul style="list-style-type: none"> Oversees and regulates the cooperative unions. Provides policy guidance and operational framework that is geared towards restructuring cooperatives |
| Tanzania Coffee Association | <ul style="list-style-type: none"> Forms a forum for dispute resolution. Membership consists of licensed coffee traders, processors, cooperative unions and exporters. |
| Tanzania Coffee Growers Association (TCGA) | <ul style="list-style-type: none"> Promotes the interest of large coffee farmers and coffee estates |
| Agricultural Market Cooperative Societies (AMCOS) | <ul style="list-style-type: none"> Village-based associations whose membership consist of individual farmers Often acts as agents of buyers Perform other commercial and non-commercial activities |
| Cooperative Unions | <ul style="list-style-type: none"> Association of primary societies who buy, store and process coffee in their own facilities. They also compete with private traders in achieving their objectives. |
| Ministry of Land, Housing, and Human Settlement Development | <ul style="list-style-type: none"> Formulates policies related to investment in coffee, particularly land availability and allocation. |
| Ministry of Industry, Trade and Investments | <ul style="list-style-type: none"> Sets policies related to coffee trade and marketing |
| President's Office Regional Administration, Local Government, Civil Service, Good Governance | <ul style="list-style-type: none"> Liaises with the district authority, specifically the department of agriculture, for implementation of various agricultural activities related with the coffee industry. |
| District Executive Directors (DED) and District Agricultural officer | <ul style="list-style-type: none"> Contribution of coffee to local community development Potential of coffee industry to local community development Analysis of the targets which are over ambitious Identification of the potentials to be undertaken Infrastructure relating to coffee and its importance |
| Tanzania Coffee Research Institute (TaCRI) | <ul style="list-style-type: none"> Develops improved coffee technology and innovation development Advises the government on coffee research policy |

| Name of the Stakeholder | Roles |
|---|--|
| Financial institutions (CRDB Bank; Tanzania Agricultural Development Bank (TADB); EXIM Bank; NMB Bank; Tanzania Investment Bank; Kilimanjaro Cooperative Bank) | <ul style="list-style-type: none"> These are financial institutions that have undertaken issues related to financing the coffee industry – making available funds for coffee investment |
| Coffee processors including roasters and millers | <ul style="list-style-type: none"> Mainly buying, processing and exporting coffee |
| Warehouse Operators | <ul style="list-style-type: none"> Operation of warehouse receipt system Coffee curing plants owned by farmers cooperatives Curing plants owned by private operators |
| Coffee traders (Private coffee buyers; exporters) | <ul style="list-style-type: none"> Problems and opportunities |
| Exporters | <ul style="list-style-type: none"> Problems and potentials |
| Development Partners (World Bank) | <ul style="list-style-type: none"> Provides funding for investment in coffee |
| Development Partners (European Union) | <ul style="list-style-type: none"> Provides funding of coffee and its priorities |
| Development Partners (Gates Foundation) | <ul style="list-style-type: none"> Provides funding opportunities |

1.2.1.2 Coffee Industry Governance

Tanzania Coffee Industry Regulations, 2013 (G. N. No. 385 of 2013), contains a variety of rules relative to the coffee industry in Tanzania including the growing and processing of coffee beans and the trade in coffee. They also provide information with respect to quality control, contract farming, husbandry related to coffee growing and a stakeholders' forum, and other participation mechanisms. To ensure all these are carried out in a smooth way, an annual stakeholders meeting composed of key stakeholders (as shown in figure 1.2) from the coffee industry was introduced to plan and put forward any resolution of disputes for implementation of the shared functions.

1.2.1.3 Multi-Stakeholder Framework for Implementation of the Strategy

The main Strategy implementation agencies will be TCB, TaCRI, LGAs, NGOs, AMCOS, TANTRADE, Farmers and the Private Sector. These institutions will work together to conduct coffee production campaigns aimed at increasing coffee volumes for export by focusing on production and productivity, quality and value addition, market development and intelligence, and institutional development and accountability. There will be coffee platforms at national, regional and district levels to coordinate in addressing key challenges of the industry. The national level platform will operate through a National Steering Committee comprising a multi-stakeholder group representative of the central Government, public institutions, local government, private sector associations, farmers' organisations and development partners. Progress of the platform will be reviewed, and key milestones agreed and shared at an Annual National Coffee Stakeholders' Conference. Therefore, the implementation of the Strategy with the ambitious target of increasing production from the current 62,925 metric tons to 200,000 metric tons will require a harmonized multi-sectoral engagement (shown in Illustration 2) to support and drive the transformation of Tanzania's coffee industry.

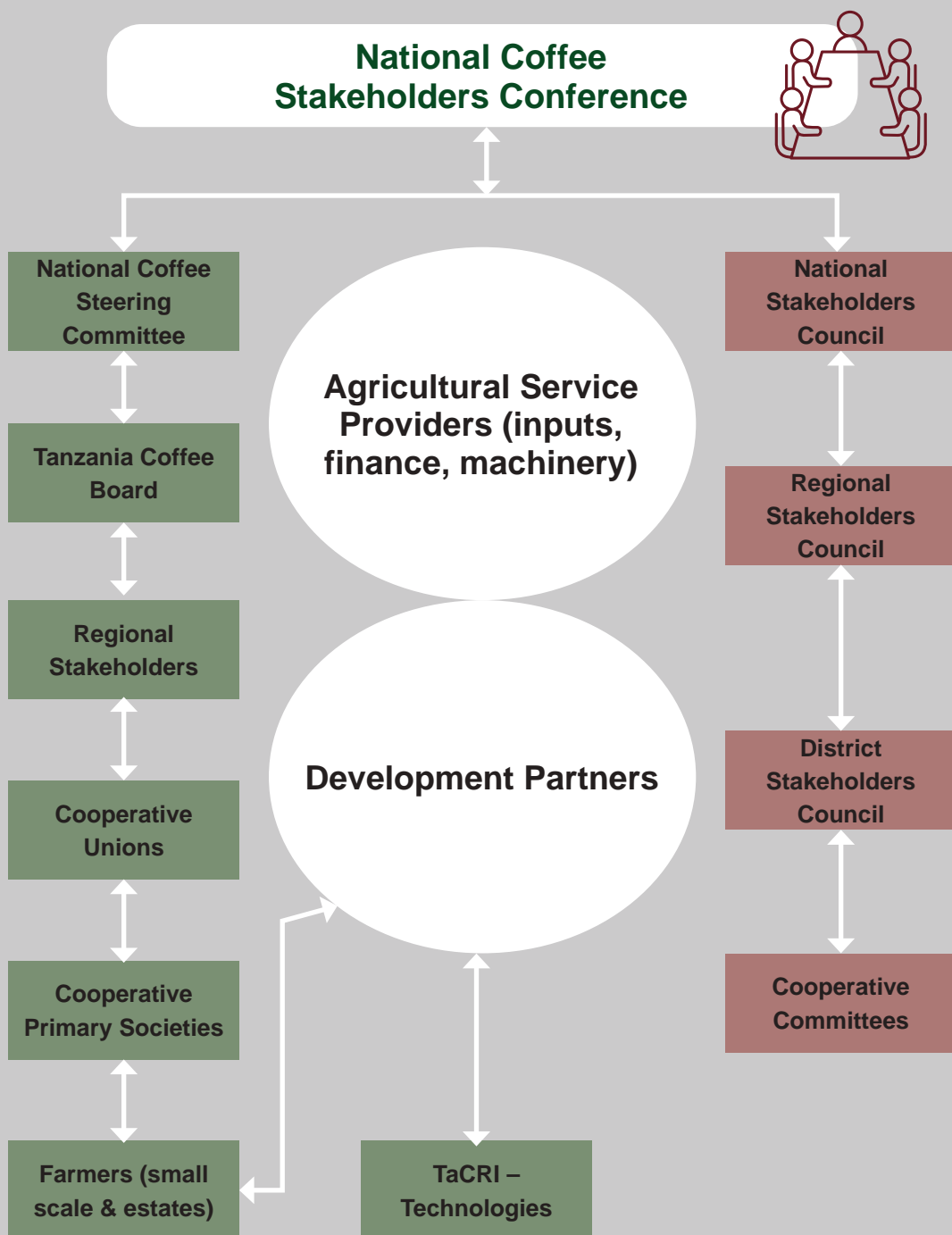


Illustration 2: Multi-Stakeholder Framework of the Coffee Industry in Tanzania

Topic 1.1 Lesson Plan

Lesson Objectives:

- Understand coffee as a crop of domestic and international economic value
- Understand the institutions and stakeholders in the coffee value chain in Tanzania

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)
- Posters

Key Points to Share:

- Coffee is a product of great economic value worldwide, and small-holder farmers are an important factor in its value chain.
- Sustainable coffee production is becoming increasingly important and covers standards that affect production, marketing, and consumption.
- Sustainable coffee production systems address economic, social, and environmental issues.
- Coffee production must follow certain procedures and standards that are set and regulated by established authorities.
- The Tanzanian coffee sector allows a range of supply chain actors to operate in parallel.
- Coffee industry stakeholders in Tanzania constitute innovative system actors which include the following: MoA, TCB, input suppliers, TaCRI, LGAs, traders, farmers, AMCOS, processors, TANTRADE, NGOs, policy makers, Development Partners, vocational training centers, extension services, and information and financial institutions.

| Topic | Topic Objectives | Training Activities |
|--|---|---|
| 1.1 Sustainable Coffee Production | <ul style="list-style-type: none"> • Discuss the origin of the world's coffee supply • Discuss the characteristics of Arabica and Robusta coffee • Discuss the amount of coffee produced in Tanzania each year | <p>Lecture and Discussion Introduce the information in Topic 1.1. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them.</p> <p>Experience Sharing Participants share how they became involved in coffee production. They should share if they produce Arabica, Robusta, or both.</p> <p>Group Discussion As a group, discuss the importance of Tanzanian coffee producers for the world's supply of coffee. Discuss the different characteristics of Arabica and Robusta coffee.</p> |
| 1.2 The Coffee Value Chain in Tanzania | <ul style="list-style-type: none"> • Clarify the different actors in the coffee value chain and their roles | <p>Lecture and Discussion Introduce the information in Topic 1.2. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them.</p> <p>Group Discussion Discuss what interactions small-holder coffee farmers have with different coffee institutions in their area. Then discuss the relevance each institution has for coffee production and marketing.</p> <p>Creating Resources Help participants create a list of representatives (names, contacts, offices) for the main coffee institutions in your area.</p> |

CHAPTER TWO

This chapter discusses the most important factors for growing coffee in an economical, environmental and socially sustainable manner. Tanzania's vast and varying landscape provides appropriate altitude, climate, and soil suitable for the cultivation of both good-quality Arabica and Robusta coffee (TaCRI, 2011).

Arabica coffee prefers well drained, friable, loamy and clay soils with a depth of more than 1.5m, and a pH in the range between 4.5 and 6.5 (Robinson, 1964; Cambrony, 1992). Robusta coffee prefers deep soil (over 100cm deep), with good texture and structure, over 2.6% organic matter and a pH of between 4.5 and 7.0. When starting a coffee farm, farmers should seek advice from their local agricultural officer about whether their land is suitable for coffee farming. They should also seek advice on which types (Arabica or Robusta) and varieties of coffee to grow.

Like any other crop, coffee plants need good climatic conditions (rainfall and temperature), good soil texture, and a range of nutrients to grow healthy and productive. Coffee plants also need a lot of care to ensure sufficient nutrients and water, and protection from insect pests and diseases (Agriculture and Food Authority (AFA), 2022; TaCRI, 2011; Uganda Coffee Training Manual, 2014). Farmers must be prepared to invest skills and attention to care for their crops so it can provide an income that meets their economic needs. This chapter contains tips on how to ensure farmers establish a coffee farm depending on the local conditions.

Because of its economic value, coffee is a regulated crop, and farmers should familiarize themselves with the rules and regulations of growing, processing, and marketing it to meet certain criteria and standards set by regulators (Global Coffee Platform (GCP), 2022; TCB, 2021). Trainers must draw farmers' attention to understand the topics in this chapter for him/her to invest properly in coffee farming and get good crop production at reasonable costs.



2.1.1 A Land Assessment

To benefit from coffee farming, farmers should understand their land ("know your farm") and how their land's specific characteristics affect their production. The following factors should be considered during coffee farm establishment.

Soil fertility: Soil fertility is a most important factor for plant growth, and knowledge of its pH, texture, and good drainage (structure) are extremely important. The soil suitable for coffee must have sufficient nutrients and in the right proportions for the plant to grow. It is vital to know your coffee farm's soil pH because it determines the availability of nutrients for plant growth. The soil must allow water and air to penetrate so that the plant's roots can absorb available nutrients. The coffee plant should be able to extend its root system deep into the soil to exploit nutrients and soil moisture.

Terrain: The terrain includes an assessment of the land's slope and its steepness and determines whether contour terraces will be needed to prevent soil erosion and harvest rainwater.

Water: Water is absolutely essential for plant growth. Adequate rainfall must be well-distributed with some months of light rains, as well as some months of heavier rains. Arabica coffee requires an optimal range of 800 to 2500 whereas Robusta requires 1200 to 3000mm per year of rainfall. If no streams or rivers cross the farm, rainwater should be harvested and stored in the soil through terraces cut along the contours. Alternatively, holes can be dug on flat land between coffee rows to trap and sink rainwater. Shade trees and ground cover help to conserve humidity on the farm and make it available to coffee plants for a longer period of time.

Shade: Shade determines how much sunlight and air reaches the plants. Coffee trees are agro-forestry plants and farms should have moderate shade to regulate the farm environment for ideal growing conditions. The recommended shade trees also act as wind breakers, reduce the impact of heavy rain, add nutrients to the soil and regulate temperature.

Altitude: Arabica grows well in high-altitude areas ranging from 1,000 to 2,500 MASL and Robusta grows well in medium-altitude areas ranging from 800 to 1,500 MASL. Shade trees also help to mitigate climate change.

2.1.2 Land Preparation

Establishing a new coffee farm, either by clearing new land or rehabilitating an old unproductive farm, requires the land to be cleared, ploughed, harrowed, measured, and laid out. This should be done during the dry season, using a tractor or hand hoe, depending on the farmer's capacity. Land must always be prepared to the required standards as follows:

1. If the farm will be used for mixed purposes, plan the area for all required uses such as a family house, livestock, coffee farm plot, other crops, and shade trees.
2. Locate an area for compost processing and dig the composting pit (this should be a shady spot).
3. Remove all unwanted plants away from the field (shrubs, weeds, unwanted trees, old coffee stumps, etc.).
4. Unless diseased, never burn vegetation as it is a valuable resource which can be used as firewood or to make compost. Hand picking perennial weeds is required. Burning also has a negative impact on the ozone layer.
5. Build contour terraces, bands, grass strips and cut-off drains to prevent soil erosion.
6. Measure the size of the coffee farm plot to estimate the number of trees to plant.
7. Plan for ridges and furrows for rainwater harvesting and soil erosion control.



Illustration 3: The Family Clearing the Land for Planting

2.1.3 Field Layout

After the land has been cleared, plan for farming systems you need to adopt (i.e., pure stand or coffee and banana intercropping) (TaCRI, 2016).

For coffee and banana (or other shade vegetation) intercropping, plant holes for the coffee and banana/shade vegetation following these guidelines:

1. Determine the terrain of the land so you can plan necessary terracing.
 - Consult the Agricultural Officer of your area to make sure the land is terraced according to the required standards.
 - Good terracing will trap rainwater and store it in the soil for longer periods as well as prevent soil erosion.
2. Determine the direction of the sun. For the ideal proportion of shading, all coffee lines should be parallel to the path of the sun across the sky. This regulates the proportion of light on the soil and plants, regulates soil temperature, regulates microbial activities and their population, and allows constant root development.
3. Identify where shade trees will be planted, or which existing shade trees should be left standing.
 - Spacing between shade trees depends on the type of tree used; this will range between 10 to 20 meters.
4. If intercropping with banana, identify where these will be planted.
 - Bananas should be planted with a distance of 10 metres between the banana lines and with the banana in the row is 2.5 to 3 metres.
 - Spacing between the banana trees along the banana line should be at least 5 metres apart.
5. After the field has been laid out, estimate the number of coffee seedlings required.
 - Coffee seedlings should be obtained from a registered nursery multiplying coffee seedlings certified by TaCRI to ensure the purity of the variety and to avoid diseases.
6. Use string to align the coffee lines and set pegs for holes.
 - If planting Arabica coffee, and depending on the variety selected, TaCRI recommends a spacing of:
 - 2 meters by 2.5 meters, or 1.5 meters by 2 meters between coffee rows for compact varieties. The average plant population per hectare is 2,000 to 3,333, respectively.
 - 2 meters by 2.74 meters, or 2.74 meters by 2.74 meters between coffee rows is recommended for tall varieties. The average plant population per hectare is 1,825 to 1,330, respectively.

- 2.74 meters by 2.74 meters between coffee rows is recommended for traditional varieties. The average plant population per hectare is 1,330.
- If planting Robusta coffee, and depending on the variety selected, TaCRI recommends a spacing of:
 - 3 meters by 3 meters between coffee rows for an average plant population per hectare of 1,111 because Robusta coffee trees are generally taller and bushier and require more distance between individual trees.

Table 3: Spacing and Yield Potential of Improved and Traditional Arabica and Robusta Coffee Varieties

| Type | Varieties | Spacing (m) | Plant Population | | Yield (kg) | |
|---------|------------------|-------------|------------------|------|------------|------|
| | | | Ha | Acre | Ha | Acre |
| Arabica | Improved Tall | 2.5 x 2 | 2000 | 810 | 2800 | 900 |
| | | 2.74 x 2.74 | 1332 | 539 | 1500 | 600 |
| | Improved Compact | 2 x 1.5 | 3333 | 1013 | 4800 | 1900 |
| | | 2 x 2 | 2500 | 1351 | 6000 | 2500 |
| | *Traditional | 2.74 x 2.74 | 1332 | 539 | 1500 | 1200 |
| Robusta | Improved | 3 x 3 | 1110 | 450 | 2300 | 900 |
| | *Traditional | 3 x 3 | 1110 | 450 | 2000 | 800 |

KEY

Tall Varieties = N39-1, N39-2, N39-3, N39-4, N39-5, N39-6, N39-7, N39-8, N39-9, N39-10, N39-11, N39-12, KP423-1, KP423-2, KP423-3

Compact varieties = TaCRI 1F, TaCRI 3F, TaCRI 4F, TaCRI 6F

Traditional = N39 and KP423

Improved Robusta varieties = Maruku1, Maruku2, Bukoba1, Muleba1

*Yields obtained from traditional varieties with heavy application of fungicides sprays

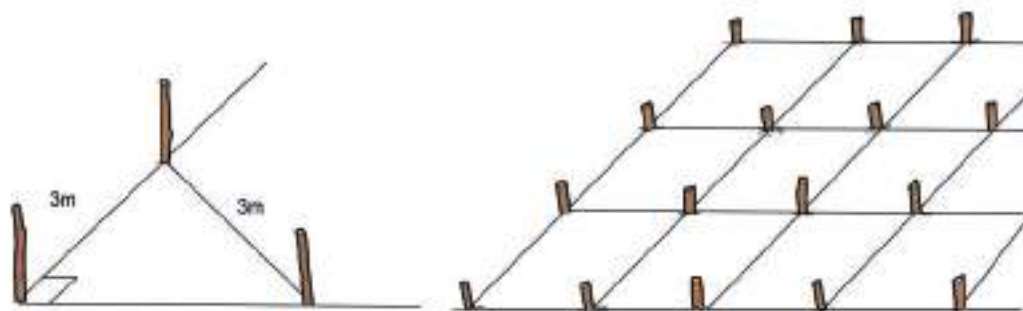


Illustration 4: Pegging Holes for Planting

2.1.4 Preparing the Planting Holes

The planting holes must be prepared well, at least two months before the rainy season in areas where the source of water for planting is primarily rainfall to let the planting holes settle (TaCRI, 2011, 2016).

1. Holes should be dug during the dry season and must be 60cm deep, 60cm wide, and 60cm long.
 - Heap the topsoil (the first 30cm of soil) on one side of the hole (uphill side).
 - Heap the subsoil (the next 30cm of soil) on the other side of the hole (downhill side).
 - This should be done because the topsoil and subsoil will be mixed separately to ensure the deep nutrients are brought to where the roots of young coffee plants can easily reach them.
2. At least one month before the coffee seedlings are planted:
 - Mix the topsoil from the hole with 100g of DAP/TSP/Rock Phosphate and well-decomposed farmyard manure or compost. Use a 20-liter container as a measuring container.
 - Fill each hole with 1 to 2 containers of the topsoil mixture, depending on the soil needs and the availability of material, then cover with subsoil.
3. Place a peg on the covered hole and leave it for at least one month before planting the coffee seedlings in the rainy season.

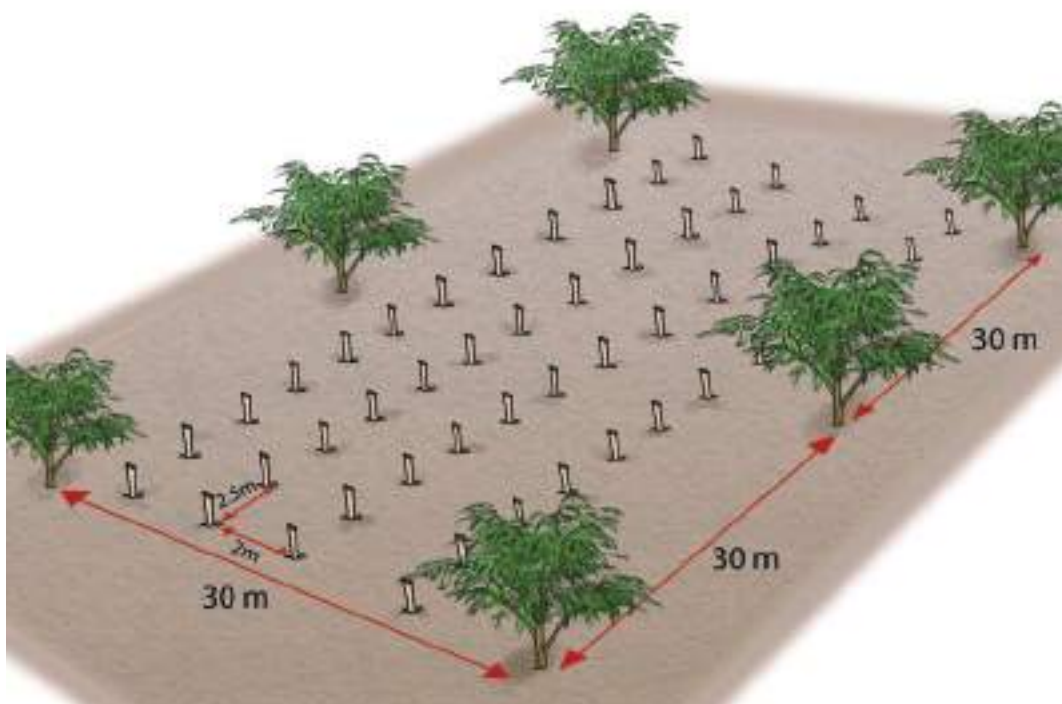


Illustration 5: Prepared, Pegged Holes

2.1.5 Coffee Seedling Selection for Planting

The first and second generation Arabica Hybrid tall varieties and Robusta coffee (shown in Table 4) are multiplied through vegetative propagation methods. Vegetative propagation is a method of producing planting materials using plant vegetative parts instead of seeds. The materials produced vegetatively are genetically identical to the mother plant. Vegetative propagation of coffee can be done by rooting of cuttings, grafting, top-working and micro propagation of tissue culture. The tissue culture is another method for coffee seedlings multiplication in Tanzania and now it is working for research purposes (Kilambo et al., 2015). The Arabica Hybrid compact varieties are multiplied through seeds.

Farmers should carefully research the availability of seedlings in their area and get advice from extension officers when selecting coffee seedlings. The seedlings should be collected from a registered coffee nursery by TCB or TaCRI nurseries so as to ensure that the varieties are genuine, and their quality is up to standard (Jeremiah et al., 2018).

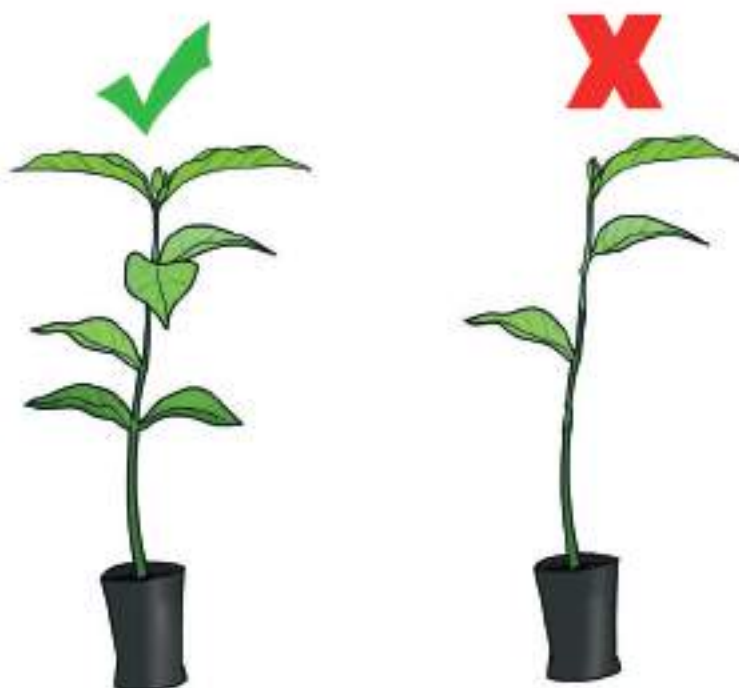


Illustration 6: Good and Bad Seedlings

Important Note: When selecting seedlings for planting, remember:

1. Always choose the variety which suits your area.
2. Only plant healthy seedlings. A poor choice of seedlings will lead to weak coffee plants and low productivity.
3. Consider planting improved varieties which grow faster, leading to an early harvest.
4. Consider planting improved varieties which are resistant to some (not all!) coffee diseases and pests.

Table 4: List of Coffee Varieties Grown by Farmers in Tanzania

| Name of coffee varieties | Descriptions | Bean size (AA+A%) | Class | Cup quality | Yield (Kg/ha) |
|--------------------------|---|-------------------|-------|-------------|---------------|
| N39-1 | Arabica Hybrid tall varieties first generation September 2005 | 77 | 4++ | Good | 2058 |
| N39-2 | | 77 | 4++ | Good | 2708 |
| N39-3 | | 74 | 5+ | Good | 2763 |
| N39-4 | | 80 | 4+ | Good | 1961 |
| N39-5 | | 62 | 5+ | Good | 2633 |
| N39-6 | | 72 | 4+ | Good | 2891 |
| N39-7 | | 72 | 5+ | Good | 2526 |
| KP423-1 | | 80 | 4++ | Good | 2225 |
| KP423-3 | | 77 | 5+ | Good | 1578 |
| KP423-2 | Arabica Hybrid tall varieties January 2011 | 68 | 5+ | Good | 1851 |
| Maruku2 | Robusta coffee varieties released in January 2011 | 90 | 4 | Good | 3900 |
| Bukoba1 | | 91 | 5 | Good | 780 |
| Maruku1 | | 98 | 5 | Good | 2400 |
| Muleba1 | | 94 | 6 | Good | 2400 |
| N39-8 | Arabica Hybrid tall varieties Second generation January 2012 | 76 | 4+ | Good | 2000 |
| N39-9 | | 68 | 4+ | Good | 2700 |
| N39-10 | | 71 | 4 | Good | 2400 |
| N39-11 | | 68 | 4+ | Good | 2700 |
| N39-12 | | 79 | 4 | Good | 2400 |
| TaCRI 1F | Arabica Hybrid compact varieties December 2013 | 69 | 4+ | Good | 6000 |
| TaCRI 3F | | 64 | 4+ | Good | 5050 |
| TaCRI 4F | | 74 | 4+ | Good | 4800 |
| TaCRI 6F | | 68 | 5 | Good | 6000 |
| N39 | Traditional Arabica coffee varieties | 57 | 4+ | Good | 1000 |
| KP423 | | | | Good | 1000 |
| MS | Traditional Robusta | | | Good | 1000 |

Source: Kilambo *et al.* (2015)

2.1.6 Planting the Coffee Seedlings

Coffee seedlings should be planted at the beginning of the long rains (Agriculture and Food Authority (AFA), 2022; TaCRI, 2011, 2016; Uganda Coffee Training Manual, 2014). It is advised to first plant shade trees or banana in the new coffee field to provide shade to the young coffee seedlings. If the shade trees were not yet planted, farmers are advised to plant crops that can be plowed under for green manure. This will protect coffee seedlings from strong winds and rains, as well as strong radiation from the sun. The soil around the coffee seedling must also be mulched to maintain moisture and reduce splashing of mud onto the new coffee plants when it rains.

Make sure coffee seedlings are planted well, otherwise their roots will not develop properly and the coffee tree will be weak and unproductive. Follow these steps when planting:

1. Pull out the polythene tube sheath. Check the main tap root to ensure it is straight, and if it is too long, cut it to avoid bending.
2. Hold the plant firmly in position in the hole while the soil is filled around it. First compact the soil around the main tap root, then fill in the rest of the soil and compact at the surface.
3. Irrigate at least 5L of water then put mulching around the plant to protect it from the sun and maintain soil moisture.



Illustration 7: Incorrect and Correct Planting

2.1.7 Mulching on a Coffee Farm

Mulching is very important because it helps in minimizing soil erosion, reducing soil temperature, protecting the soil surface from the impact of falling rain, retaining soil moisture, adding mineral nutrients and organic matter to the soil, reducing weed growth, and increasing coffee production. Farmers are encouraged to apply mulch after planting coffee seedlings.



Illustration 8: Correct Application of Mulch Around a Coffee Tree

Topic 2.1 Lesson Plan

Lesson Objectives:

- Assess and prepare land on which to establish a new coffee farm by following basic concepts of sustainable coffee farming.

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)
- Posters
- String, measuring tape, digging implements, coffee seedlings, manure/compost, phosphate

Key Points to Share:

- Understand and apply key land assessment principles to understand the suitability of your land for growing coffee.
- Think about whether you need to make adaptations to improve certain factors on your coffee farms.
- Select improved coffee varieties to save on the costs associated with managing diseases, especially Coffee Berry Disease and Coffee Leaf Rust.
- Planting the coffee seedlings correctly will ensure a strong tree that can produce abundantly.

| Topic | Topic Objectives | Training Activities |
|-------------------------------|--|---|
| 2.1 Coffee Farm Establishment | <ul style="list-style-type: none">• Understand different factors that will affect the performance of coffee plants on the farm• Understand how to prepare the land correctly for coffee planting• Understand the importance and economic benefit of selecting good coffee varieties• Recognize how to correctly plant a coffee seedling | <p>Lecture and Discussion Introduce the information in Topic 2.1. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them.</p> <p>Cross Reference Remind farmers about the main coffee institutions discussed in Chapter 1 which can assist them in coffee production.</p> <p>Farm Mapping and Sharing Ask farmers to draw maps of their current or planned coffee farms. Then ask participants to show their drawings and describe their coffee farms according to its geographical and climatic conditions.</p> <p>Farm Visit Visit a nearby farm to compare the performance of different coffee trees growing under varying conditions (those growing in different amounts of sunlight, slope, shade, etc.). Also assess the farm's soil fertility, terrain, and water availability. Discuss whether the farm has ideal conditions for growing coffee, or which factors should be improved.</p> <p>Farm Mapping Ask farmers to draw a map of how they would plan for a new coffee farm, using the information they have just learned about field layout and spacing.</p> |

| Topic | Topic Objectives | Training Activities |
|-------|------------------|--|
| | | <p>Demonstration and Practice If a new farm is available, demonstrate hole pegging, digging and preparation. In groups, ask participants to practice what you demonstrated. Point out and discuss any mistakes farmers make.</p> <p>Nursery Visit Visit a nearby coffee seedling nursery and inquire about the characteristics of the seedlings available. Then visit a TaCRI seedling nursery if possible. As a group, decide whether either nursery has seedlings they would want to plant and why. Monitor to ensure they have made a good decision about which seedlings they would want.</p> <p>Demonstration and Practice If a new farm is available, demonstrate the planting of coffee seedlings. In groups, ask participants to practice what you demonstrated. Point out and discuss any mistakes farmers make. Make sure to water and apply mulch to complete the process.</p> |



Good Agricultural Practices (GAPs) involve activities which must be done throughout the year, at the appropriate times in line with the coffee calendar for each region. The Good Agricultural Practices (GAPs) referred to in this topic includes the eight commandments for increasing coffee productivity and production (TaCRI, 2011, 2016).

2.2.1 Weeding the Coffee Farm

The farm should be free from weeds as these compete with the coffee tree for nutrients and water (Agriculture and Food Authority (AFA), 2022; TaCRI, 2011, 2016; Uganda Coffee Training Manual, 2014). Weeds also harbor pests and can be vectors for disease.

Weeding can be done by hand by uprooting the weeds from the soil, or by cutting the vegetative part of the weed and leaving in the root. If weeding is done using a hoe, it must be carried out carefully with minimum disturbance to prevent damage to the coffee plant's root systems. Therefore, light digging to remove weeds is recommended before the end of the rainy season. Weeds should be removed before they seed to reduce regrowth. Cut or uprooted weeds should be left on the ground around the coffee trees as mulch or to make compost on the farm.

Weeds on a coffee farm can also be suppressed by using recommended herbicides. These must be applied in the recommended rates (liters per number of trees) and concentrations (ratio of herbicide concentrate to water). However, this practice is not encouraged since herbicides can be harmful to environmental and human health. If not careful applied, they can harm coffee plants, especially young ones.



Illustration 9: Weeding with a Hoe



Illustration 10: Weeding with a Sickle

2.2.2 Control of Coffee Pests and Diseases

Like many other commercial crops, the coffee plants are also susceptible to many pests and diseases. Pests and diseases can cause considerable damage to the coffee plant and crop, and greatly reduce the income that farmers can earn from their coffee farm. Regular scouting of the farm to identify pests and diseases at an early stage can greatly reduce the cost and effort of remedy. Moreover, if pests and diseases are allowed to infest the farm, the damage might be irreparable.

When using agro-chemicals to manage insect pests and diseases, farmers must take the necessary precautions to safeguard their health and that of their families and neighbours, as well as avoid poisoning the environment around them (water bodies, soil, animals, and other plants).

Thereafter, farmers must ensure good harvesting and good primary processing practices and demand good storage and marketing from their sales agents or farmer associations so that their coffee can maintain its quality up to the point of sale. The common pests and diseases of the coffee plants are described in Topic 2.4 of this chapter.

2.2.3 Fertiliser Applications

The type and amounts of fertiliser applied depends on the plant growth stage and the type of soil that the coffee grows in (Agriculture and Food Authority (AFA), 2022; TaCRI, 2011, 2016; Uganda Coffee Training Manual, 2014). This requires the farmer to know the state of his/her farm and be aware of crop habits and symptoms of soil nutrient deficiencies to mitigate them (TaCRI, 2011, 2016). An agronomy extension officer should be consulted to ensure an appropriate crop nutrition program is applied (Jeremiah et al., 2018; Maro, 2014).

Table 5: Nutritional Requirements and Recommended Fertiliser for Coffee

| Recommended Fertiliser Application (g/tree) | | | | | | |
|---|-----|-----|-----|-----|------|-----|
| Year | SA | NPK | CAN | ASN | UREA | DAP |
| Year 0 | 75 | 75 | 60 | 60 | 30 | 100 |
| Year 1 | 110 | 110 | 90 | 90 | 50 | NIL |
| Year 2 | 145 | 145 | 120 | 120 | 65 | NIL |
| Year 3 | 180 | 180 | 145 | 145 | 80 | NIL |
| Year 4 | 215 | 215 | 175 | 175 | 100 | NIL |

Source: TaCRI, (2011)

Inorganic fertilisers, just like manure and compost, must be applied properly. That means applying them at the right time and in the recommended rate, depending on the soil or leaf analysis. Wrong application of fertilisers can damage the crop or cause unnecessary excessive vegetative growth and economical loss.

It is important to get a soil analysis report from accredited institutions every 2 to 3 years and leaf analysis where necessary. This will help the farmer to determine the right product formulation required to correct the soil nutrient deficiencies on the farm. The soil nutrition program can comprise of both organic and inorganic fertilisers and be applied to plants through both the soil and on the leaves (foliar fertilisers).

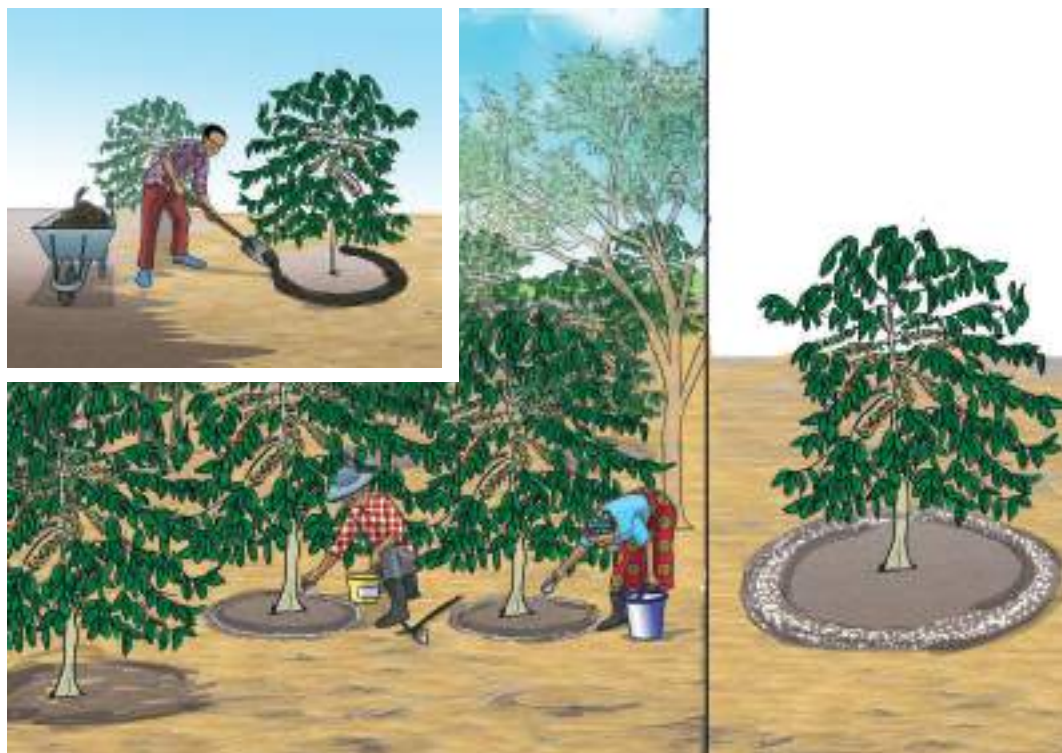


Illustration 11: Fertiliser and Manure Application

2.2.4 Soil Water Conservation

Application of mulch and contour ploughing are among the methods used for soil and water conservation. This is because it minimizes soil erosion, reduces soil temperature, protects the soil surface from the impact of falling rain, retains soil moisture, adds mineral nutrients and organic matter to the soil, reduces weed growth and increases coffee production (Maro, 2014; We Effect and Vi Agroforestry, 2014).

The recommended materials for mulching are banana trash, coffee pulp and coffee husk, maize stover, sorghum straw, Napier grass, Guinea grass, Guatemala grass and other crop residues. These materials must be dried under sunlight before mulching.

The method of mulching should be ring mulching at planting, continuing for three years for young coffee. Then for mature coffee, it should be complete inter-row mulching or alternate row mulching done every other year.

The thickness of the mulching materials ranges from 4-9 inches. The time of mulching may be before the onset of the rainy season or before the end of the rainy season, which depends upon the amount of rainfall in each area and the method of mulching used.

Mulch material should not touch the plant stem to discourage insect pests from climbing up the tree.

2.2.5 Coffee Irrigation

Irrigation is key to ensuring stable and sustainable production in coffee plantations. Supplemental irrigation is usually needed to meet the water requirements at different growth stages of the coffee. A younger crop takes less water than a fruiting mature crop. Farmers can apply any method for irrigation, depending on the availability of resources.

2.2.6 Pruning and Canopy Management of Coffee Trees

2.2.6.1 Coffee Pruning Systems

Coffee trees can be pruned in different systems. Farmers should decide whether they want to establish “free growth” or “capped”, with either single or multiple stems. The most common practice is for Arabica coffee trees to be trained as single or double stems, while Robusta coffee trees are normally managed as a multi-stem system (two to four stems).

Single stem capped or free growth: When a young coffee tree reaches a height of about 70cm, it can be capped for the first time to 50cm above the ground (this should always be done 5cm above the node and not directly at the node). A pair of suckers will grow at the node.

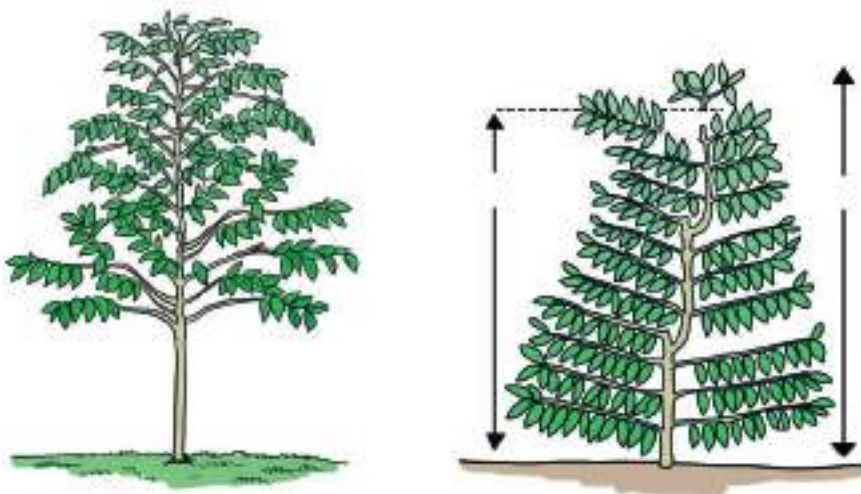


Illustration 12: Single Free Growth and Capped Growth Systems for Arabica Coffee

For single stem training (mainly Arabica varieties), select one sucker and remove the others with sharp secateurs. When the sucker reaches 15cm, the lateral branch (below the node at which the plant was first pruned) should be removed immediately to concentrate energy into the new growth.

An Arabica coffee tree can be trained to grow as a “ladder” or “free growth” (i.e., straight).

- When a main stem reaches a height of 130cm, it must be cut back to 110cm, just below the node.
- The same capping procedure must be repeated when the plant reaches 170cm, and one of the lateral branches should be removed to avoid splitting of the tree at bearing stage.

This type of canopy management gives a single permanent stem, maintained at a height of 170cm with vigorous lateral branches, which will produce yields for many years. This shape must be maintained through annual pruning and handling. All suckers should be removed from the main stem together with all secondary growth arising from 15cm of the main stem to avoid touching the ground which may create a friendly environment for mealy bug attack.

The remaining growing branches should be thinned through annual pruning, allowing not more than two horizontal shoots to grow from each node, and maintaining the umbrella-shaped tree. This shape is maintained for the entire life of the coffee plant until stumping is carried out for complete rejuvenation.

Robusta coffee trees generally grow as a thicker and more widespread canopy. When establishing the canopy for the first time, young trees are bent and pegged down towards one side. This stimulates growth of new suckers on the side of the stem that is exposed to the sun.

Alternatively, the stem can be capped (the tips removed) when the plant reaches a height of 15 to 40 centimeters (6 to 15 inches) to encourage multiple stems to grow.

Multiple stem management: For multiple stem training (practiced for both Arabica and Robusta), the first step is similar to the process for pruning of a single stem. Suckers that develop at the node are allowed to grow while the two lateral branches above it are removed immediately. Two or three suckers are selected, and all other stems must be removed from the main stem.

In this way, farmers can achieve any one of the following systems:

- capped multi-stem system
- free growing multi-stem system
- capped single-stem system
- free growing single-stem system

Depending on the productivity of the tree and overall farm management, multiple stem systems are maintained for about three to ten crop cycles, after which new growth is initiated by stumping. The shape of the tree is managed through annual pruning carried out immediately after harvest.

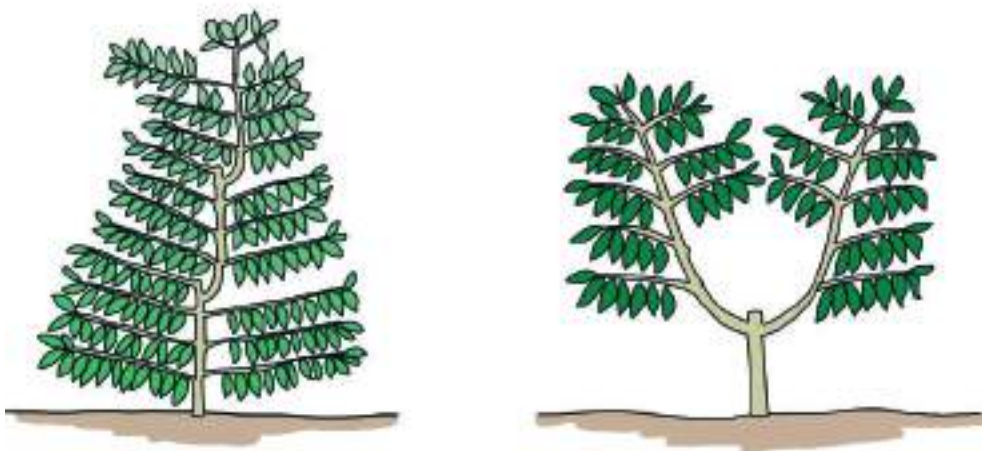


Illustration 13: Single and Multiple Stem Growth Systems in Arabica Coffee

The coffee plant must be properly pruned at the right time to encourage new growth, to remove dead and unproductive branches to allow penetration of light and air, and to manage pests and diseases. In addition, pruning gives the plant the desired shape for easy management activities such as spraying, pest and disease scouting, and harvesting. Pruning should be done immediately after harvesting and before flowering.

First pruning:

This is done to give the tree its basic shape.

- a. All unwanted suckers are removed after the best ones have been selected to produce a uniform and well-spaced axial shoot.
- b. All crisscrossing primaries are removed at the center of the tree, including primaries from the main stem. This opens the center of the tree and allows light and air to penetrate, which will encourage flowering in the following crop cycle.

Note:

When a tree is overbearing, the most heavily bearing branches are stripped and stems are cut to regulate nutrition uptake of the tree and ensure development of heavy beans.

If the tree has reached the desired height, it can be capped to make harvesting easier. All branches touching the ground are removed in order to avoid creating bridges for ants to climb the coffee branches, which encourages scale pest infestation.

Annual/main pruning:

This is carried out immediately after the harvest to remove:

- a. All exhausted branches that bore crops the previous season.
- b. All young suckers between primary branches are removed from the main stem(s) to manage light and air, as well as concentrate nutrients for the development of productive branches and fruit. This also encourages new growth for bearing in the next season and ensures good production year after year.
- c. All **Robusta** branches which bore crops the previous season as they will not bear crops again.

Note:

During this pruning, it is necessary to maintain a conical shape of the Arabica coffee tree. Starting from the tip of the coffee plant, primaries are cut back more at the top, and reduced as pruning continues down the stem. This achieves uniform light penetration, which encourages deep flowering and ensures that the tree is open and well-aerated.

Handling:

This is carried out to control new vegetative growth initiated by rain. This pruning is done throughout the rainy season (during fruit growth and expansion) and selects the bearing branches for that season. It also helps to control pests and diseases and facilitates the penetration of sprays.

- a. All unnecessary vegetation that has grown since the main pruning must be removed.
- b. Secondary branches growing close to the main stem (within about 6 inches) and matured secondary stems that bore in the previous seasons should be removed.

- c. All branches that grow haphazardly and towards the center of the tree should be removed.
- d. Only branches emerging from alternating nodes along the primary branches should remain, including secondary branches that are bearing during the pruning.

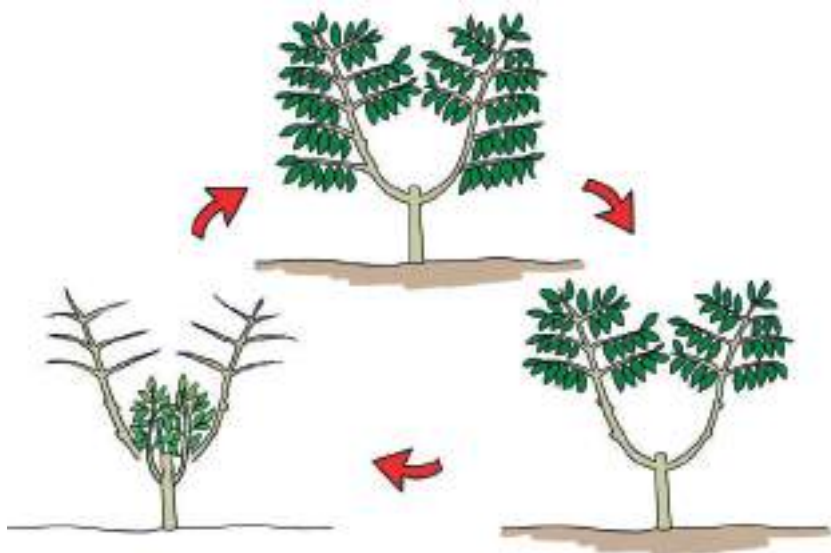


Illustration 14: Cycle for Annual Pruning in Multiple Stem Arabica

Stumping:

This is done to initiate new growth in aged coffee trees whose production has decreased and must be rejuvenated for new growth and production. This exercise should be done every seven to nine years, depending on the general health and productivity of the farm, as well as the type of coffee grown.

- a. Stumping should take into consideration the canopy system of the coffee plant, as well as the type of coffee (Arabica or Robusta).
- b. It is also important to bear in mind whether the entire farm will be stumped at once or in phases to ensure uninterrupted harvest.

Bending the Branches of Robusta Coffee Trees:

The Robusta canopy shape differs greatly from that of Arabica. When a Robusta seedling has established itself in the field (after two years), its branches are bent towards the west and fastened or weighed down to train the branches outwards. This encourages new shoots to emerge and grow upwards on the exposed branches. Free shoots should be selected to grow in the middle, and the rest removed.

When these new shoots reach a height of 30cm (1 foot) from the ground, they should also be bent outward to allow the next set of new shoots to emerge. These become the branches that will bear fruit for a few years until the tree needs to be rejuvenated by stumping.

This system of canopy management is practiced in the Kagera region and is referred to as the “Agobiada system”.

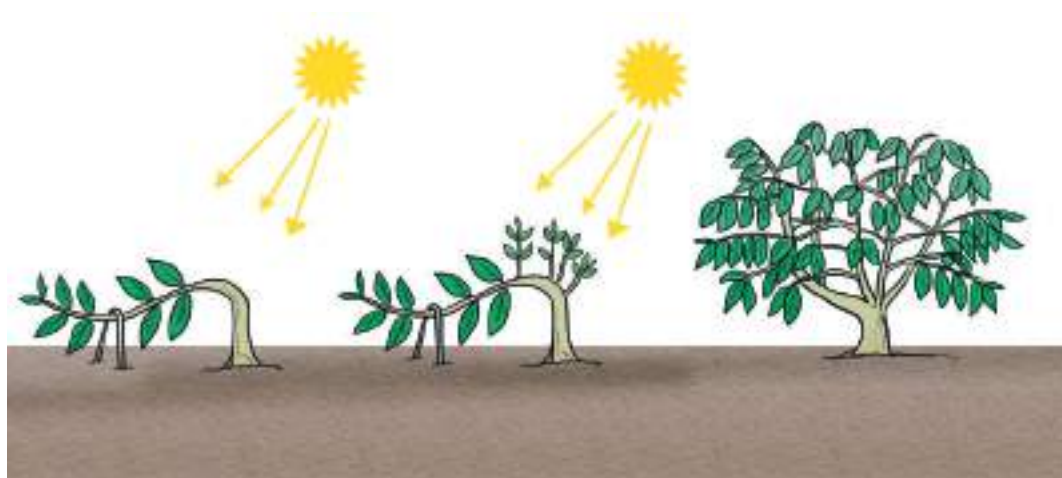


Illustration 15: Robusta Canopy Growing System

2.2.6.2 Canopy Management

Management of the coffee tree canopy is one of the most critical factors for good production and contributes significantly to promoting the development of quality coffee beans. Canopy management comprises two main types of branch removal as follows:

1. **Pruning**, which removes select branches for the purpose of managing the shape of the coffee tree.
2. **Stumping**, which removes the entire vegetative part of the tree at the main stem(s) for complete rejuvenation.

The removal of all branches and stems should be carried out with sharp secateurs or a saw to achieve clean cuts and avoid splitting the wood. Large cuts and wounds should be sealed with bituminous paint or recommended fungicides to prevent rot and disease. Branches infested with disease or pests should be burned to stop their life cycles and prevent spread to other parts of the farm. Otherwise, pruned vegetation that is not infected with disease or infested with pests can be used as mulch directly on the farm.



Illustration 16: The Coffee Canopy Must Be Managed Throughout the Year

2.2.7 Use of Recommended Shade Trees on a Coffee Farm

Coffee farmers can plant various appropriate shade trees at the recommended spacing which will contribute to reducing water stress on a coffee farm, reducing speed of wind which can destroy coffee trees, and also leaves from the shade trees can add fertility to the soil when they fall on the ground. For example, farmers should plant some trees that grow quickly so they can be used for firewood, animal fodder and timber, to help ensure that they can meet the household's economic needs. Varieties of Acacias, Albizias, Crotons, Figs and Markhamia are just a few examples of shade trees that can fulfill these needs. In addition, Acacias and Albizias have nitrogen fixing properties and therefore enrich the soil. Farmers can also plant fruit trees such as avocado, guava, and macadamia nut, among others. These trees can provide food and/or additional income for farmers. They also provide raw materials for making mulch, and the plant materials left over after pruning them can be used as fodder and firewood. New coffee farmers should consult experienced farmers on which tree species grow best in their areas.



Illustration 17: Shade Trees on a Coffee Farm

Topic 2.2 Lesson Plan

Lesson Objectives:

- Recognize what Good Agricultural Practices (GAPs) to do in order to ensure good coffee yield and quality
- Understand the need for developing and maintaining the shape and growth of coffee trees for optimal production and prevention of pests and diseases

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)
- Posters
- Pruning secateurs

Key Points to Share:

- Continuous coffee farm maintenance ensures sustainable coffee plant health and productivity, and regular income from coffee for the farming family.
- Ensure your coffee farm can retain rainwater and reduce soil erosion, such as by using terraces and trenches.
- Pruning is essential to ensure coffee tree health and productivity season after season.
- Unpruned or badly pruned coffee trees are prone to attack by pests and diseases, which lowers productivity and produces poor quality coffee.
- Pruning may be labor-intensive, but greatly determines the farmer's income from coffee each season.
- Plan for adequate shade trees which protect coffee plants and other crops from extreme weather conditions.

| Topic | Topic Objectives | Training Activities |
|--|--|--|
| 2.2 Coffee Farm Management Practices/ Good Agricultural Practices (GAPs) | <ul style="list-style-type: none">• Introduce GAPs to be carried out throughout the year in order to maintain healthy crops and improve productivity• Understand the different canopy growing systems for Arabica and Robusta coffee that can be achieved through pruning | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 2.2. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Experience Sharing Discuss which GAPs farmers carry out (and when) on a regular basis. Then identify GAPs that are less practiced and why they are not carried out as often. Discuss why some GAPs are less practiced and how this might affect the productivity of coffee farms. Advise farmers about whether they are carrying out GAPs in the correct frequency.</p> <p>Examining the Coffee Crop Calendar Examine the Coffee Crop Calendar provided at the end of Topic 2.5 with participants. Discuss when each GAP should be done in their region.</p> <p>Group Discussion Discuss how farmers can keep track of work done on their farms throughout the coffee season (introduction to record keeping), and how they cost activities carried out (introduction to Farming as a Business).</p> |

| Topic | Topic Objectives | Training Activities |
|-------|------------------|--|
| | | <p>Group Discussion Discuss which canopy growing systems are practiced by farmers in your area and why. Discuss the frequency of coffee pruning practiced by farmers in the area and whether it is done frequently enough. Discuss who in the family carries out pruning, and why.</p> <p>Problem Solving Discuss whether farmers face any challenges (labor costs, labor availability, skill of labor, etc.) with respect to pruning their coffee trees. How can these problems be solved?</p> <p>Farm Visit If possible, visit one farm that is well-pruned and one farm that is not well-pruned. Compare the plant health and productivity at both farms. Refer to any harvesting records of past years to help determine this.</p> <p>Demonstration and Practice Identify a young coffee plant that requires pruning. Demonstrate how to prune correctly. In groups, ask participants to practice what you demonstrated. Point out and discuss any mistakes farmers make.</p> <p>Demonstration and Practice Identify a Robusta coffee plant that is ready for bending. Demonstrate how to bend the plant correctly. In groups, ask participants to practice what you demonstrated. Point out and discuss any mistakes farmers make.</p> |



2.3.1 Soil Nutrition, Conservation and Management

Crops need non-mineral elements such as solar energy, carbon, oxygen, and hydrogen to grow and bear fruit. These are freely available from the surrounding environment. Crops also need mineral rich, well-drained soil with humus and adequate water so that coffee tree roots can spread into deep layers that will remain moist during the dry season. These conditions may be less available naturally on the farm, so farmers will need to ensure these conditions through good agricultural practices.

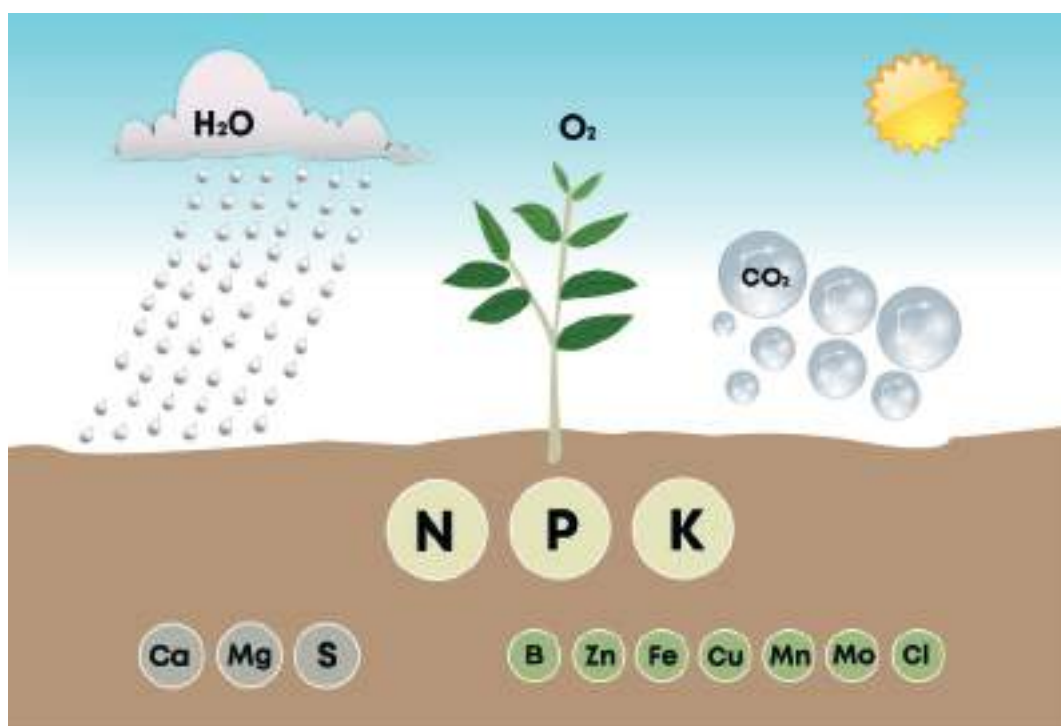


Illustration 18: Nutrient and Energy Cycle in a Coffee Plant

Apart from nutrients and soil texture, soil pH (the soil's acidity or alkalinity) determines the availability of nutrients in the soil, and soil moisture determines the ability of plants to absorb these nutrients and develop properly. Soils that are too acidic or too alkaline restrict the presence and absorption of certain nutrients, so farmers must maintain a balanced soil pH on their farms.

For optimal production, coffee trees require soil pH ranging from acidic to slightly acidic. Coffee plant growth and performance will be hindered at both extreme acidic ($\text{pH} < 4.5$) or alkaline ($\text{pH} > 7$) soil conditions, so the choice of a suitable and less acidifying nutritional program is critical. Farmers should consult their local agricultural officer to conduct soil analysis on a regular basis.

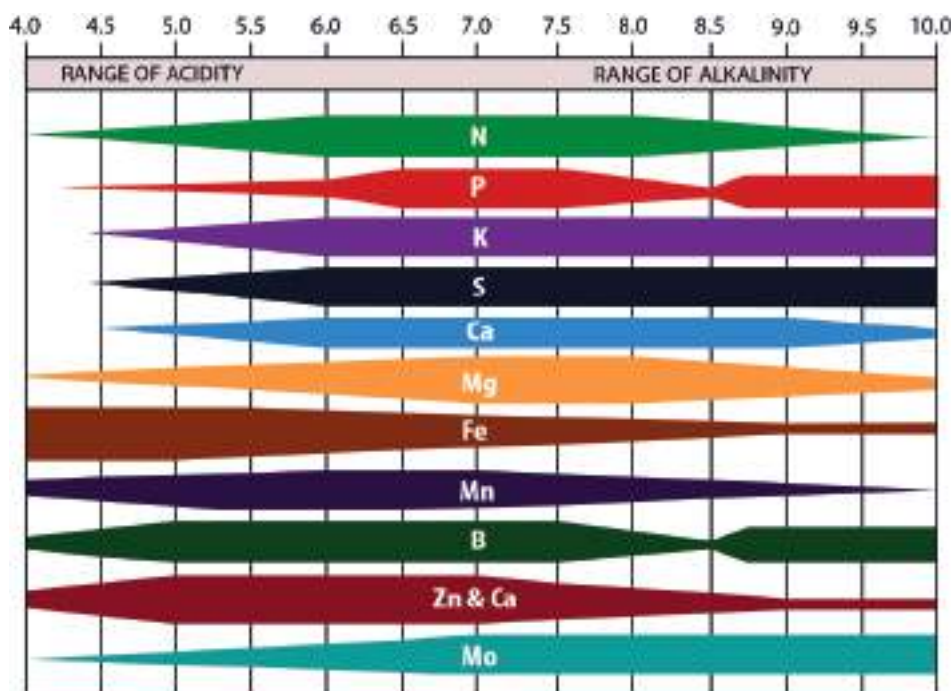


Illustration 19: pH Factors of Good Soil for Plant Growth and Production

2.3.1.1 Nutrient Requirements of Coffee Plants

Coffee is a long-term crop, and it requires soil rich in specific essential nutrients to support robust production. Different amounts of nutrients are required at different stages in its growth and production cycle. Macro-nutrients are essential in bigger quantities while micro-nutrients are only necessary in smaller volumes (TaCRI, 2011, 2016). Table 6 summarizes the most essential nutrients required by coffee plants.

Table 6: Nutrients Coffee Plants Need

| | Element | Function in coffee plant |
|-------------------------|--|---|
| Primary Macro-nutrients | Nitrogen (N): A key component of plant proteins | <ul style="list-style-type: none"> Critical in photosynthesis, cell development and division, as well as production of new tissue. |
| | Phosphorous (P): Responsible for photosynthesis | <ul style="list-style-type: none"> Responsible for converting solar energy to chemical energy in the leaf. Necessary for root and stem development and bud initiation. |
| | Potassium (K): Important for yield and quality | <ul style="list-style-type: none"> Important for respiration, photosynthesis, and water regulation of the plant. Moves sugars from leaf to fruit and is important for berry size and quality. Promotes plant vigor and increases tolerance to disease, water, or frost stress. |

| | | |
|----------------------------------|--|---|
| Secondary Macro-nutrients | Magnesium (Mg): Important for yield | <ul style="list-style-type: none"> • Important for chlorophyll formation and photosynthesis in leaves. • Involved in the uptake of potassium and water. • Repels coffee pests. |
| | Sulfur (S): Important for plant growth | <ul style="list-style-type: none"> • Important for the structure of proteins and amino acids. • Used in photosynthesis and the plant's nitrogen uptake. • Builds good resistance against diseases. • Aids good berry production and cupping quality. |
| | Calcium (Ca): Important for plant cell formation and function | <ul style="list-style-type: none"> • Stimulates growth of roots and leaves, strengthening the tree structure. • Maintains berry quality and improves tolerance to berry diseases and bacterial infections. • It offers increased resistance to stresses such as cold, heat and salinity. |
| Micro-nutrients | Boron (Bo): Important for plant development | <ul style="list-style-type: none"> • Important for metabolism of carbohydrates and break down of acids. • Important for rooting, flowering, and pollen formation. |
| | Copper (Cu): An important fungicide; promotes yields | <ul style="list-style-type: none"> • Needed to activate enzymes, regulate photosynthesis, and strengthen cell walls. |
| | Zinc (Zn): Key in plant nutrition program | <ul style="list-style-type: none"> • Involved in nitrogen and phosphorous metabolism and has major effect on yield through its influence on leaf size (for photosynthesis), flower initiation and formation, and cherry development. • It is involved in plant hormone synthesis (IAA), hence shoot growth. |
| | Iron (Fe): Influences coffee bean quality | <ul style="list-style-type: none"> • Important for the formation of plant enzymes and chlorophyll. • Aids respiration of leaves. |

| | | |
|--|-----------------|---|
| | Manganese (Mn) | <ul style="list-style-type: none"> • Activates enzymes. • Essential for respiration. • Essential for the metabolism of nitrogen and the function of chlorophyll. |
| | Silicon (Si) | <ul style="list-style-type: none"> • Helps to form strong stems and leaves. • Is an insect pest repellent. |
| | Molybdenum (Mo) | <ul style="list-style-type: none"> • Important for the plant's use of nitrates and metabolism of potassium. |

These elements are naturally available in different formulations in the air and soil for the coffee plant to absorb. However, coffee is generally considered a “heavy feeder”, meaning it requires significant amounts of macro-nutrients in varying proportions throughout its growth and production cycle.



Intensive crop farming and monoculture (growing one crop repeatedly on the same piece of land) depletes nutrients from the soil because crops draw on nutrient reserves in the soil for plant growth and the production of fruit. Therefore, a well-balanced crop nutrition program is necessary to replace nutrients back into the soil which have been used during cultivation.











2.3.1.2 Soil Nutrient Deficiencies

If the plant does not receive essential nutrients in the right amounts and proportions when it most needs them, it will show specific signs of nutrient deficiencies. These nutrient deficiencies can be validated by carrying out a soil test or leaf tissue analysis. Where soil nutrients are lacking, they can be added through fertiliser application.

Table 7 summarizes the symptoms of the most common soil nutrient deficiencies observed in coffee plants.

Table 7: Soil Nutrient Deficiencies and their Symptoms in Coffee Plants

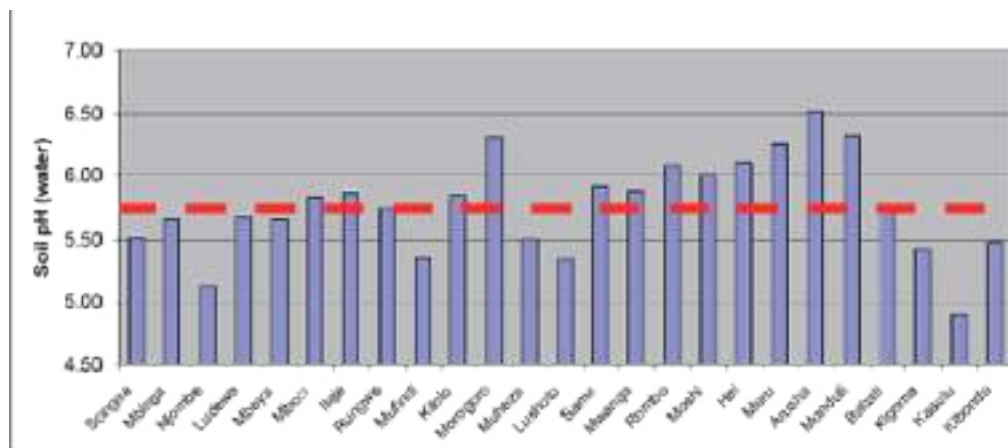
| Nutrient Deficiency | Photos for Clarification | Symptoms |
|---------------------|---|---|
| Phosphorous |  | <ul style="list-style-type: none"> • Bright coloured red, yellow, or purple leaves |
| Nitrogen |  | <ul style="list-style-type: none"> • Uniform pale green leaves with yellow to white veins • Stunted new growth • Premature leaf fall or fruit setting • Die-back if tree is bearing fruit |

| | | |
|-------------------|---|---|
| Potassium |  | <ul style="list-style-type: none"> • Brown scorches along leaf margins • Leaves curling inwards • Ragged appearance of leaves • Attack by disease • Reduced berry size and density • Producing “floaters” |
| Calcium |  | <ul style="list-style-type: none"> • Yellowing and bronzing along leaf margins, extending into the middle area of the leaf (most noticeable in young trees with an underdeveloped root system) |
| Magnesium |  | <ul style="list-style-type: none"> • Yellow-orange areas appear on leaves and between leaf veins • Leaf margins may develop a yellow-brown band starting at the base of the leaf |
| Sulfur |  | <ul style="list-style-type: none"> • Younger leaves turn faint yellow-green, starting at the band around the main stem • General growth slows down across the entire tree |
| Boron |  | <ul style="list-style-type: none"> • Mostly observed during dry weather, youngest trees turn light green and mottled, leaves are uneven and twisted • Tree grows as a fan-shaped bush due to new side shoots developing at die off points |
| Copper |  | <ul style="list-style-type: none"> • Leaves lose their green colour and die off along margins • Ribbed secondary veins on leaves • Wilting droopy young plants as leaves curve downwards, starting from the bottom of the tree |
| Iron |  | <ul style="list-style-type: none"> • Young plant leaves turn green then yellow while veins stay green. In severe cases leaves turn almost white |
| Manganese |  | <ul style="list-style-type: none"> • Pale olive-green leaves • Stripping between veins • Tree vigor, rooting and flowering is reduced |
| Molybdenum |  | <ul style="list-style-type: none"> • Bright yellow spots develop on leaf margins • Leaves become distorted and narrow and roll downwards • Older leaves are affected first |
| Zinc |  | <ul style="list-style-type: none"> • Leaves become elongated, thin, and yellow • Leaf margins can curl, which is more visible at the tips of branches |

2.3.1.3 Soil Nutrition Management

This requires farmers to develop a soil and crop nutrition program that ensures healthy coffee plants. The distribution of pH for coffee soil in Tanzania as reported by TaCRI (2016) is indicated in figure on the next page.

Table 8: Example of Soil Nutrition Program for Farmers in Mbeya Region



According to TaCRI (2016), fertiliser application for a few selected coffee growing regions are as follows:

- Morogoro, Iringa, Njombe, Ruvuma: NPK 15:9:19+3S, 80g/tree; 3 times per year, Minjingu Asilia 50g/tree/year and Foliar 20:20:20 + micronutrients, 2 times/year.
- Mbeya, Songwe: NPK 22:6:12+3S, 60g/tree; 3 times/year, Minjingu Asilia 50g/tree/year and Foliar 20:20:20 + micronutrients, 2 times/year.
- Muheza, Lushoto, Same, Mwanga, Kasulu, Kibondo: NPK 15:9:19+3S, 120g/tree, 2 times/year, Minjingu Asilia 50g/tree/year and Foliar 20:20:20 + micronutrients, 2 times/year.
- Rombo, Moshi, Hai, Meru, Arusha, Monduli, Babati, Tarime: NPK 22:6:12+3S 90g/tree, 2 times/year and Foliar 20:20:20 + micronutrients, 2 times/year.
- Bukoba, Muleba, Karagwe and Kyerwa: NPK 22:6:12+3S, 80 g/tree 3 times/year, Minjingu Asilia, 50g/tree 2 times/year and Foliar 20:20:20 + micronutrients, 2 times/year.

The table below summarises the fertiliser application programme per zone and rain season.

Table 9: Fertiliser Application Recommendations According to Region in Tanzania

| Zone | Beginning of the season | Composing the bean/ bean development | To finish |
|---------------------|---------------------------------|--|-----------------|
| Northern | October-November: NPKS/Manure | March-April: N fertiliser (CAN/ASN/Urea) | - |
| Southern | November-December: NPKS/ Manure | February: N fertiliser (CAN/ ASN/Urea) | April-May: NPKS |
| West | October-November: NPKS/ Manure | February: N fertiliser (CAN/ ASN/Urea) | April-May: NPKS |
| Lake zone - Robusta | September-October: NPKS/ Manure | March-April: N fertiliser (CAN/ASN/Urea) | - |

2.3.2 Integrated Soil Fertility Management (ISFM)

2.3.2.1 Organic Manure for Coffee Plants

Organic manure (compost, farmyard manure, and other organic substances found on and around the farm) is a good soil conditioner and greatly improves nutrient contents on the farm. It is important that coffee farmers work with compost from the very beginning and throughout their farming activities. All farmers should learn and practice compost making. This will save them the cost of fertilisers and ensure strong productive plants that are resilient to attacks from pests and diseases.

Organic matter in soil improves its ability to retain water, nutrients and air, and the absorption of these by plants. Other benefits of manure and compost are:

- Nutrients are released slowly and are available to the plant over a longer period.
- It holds and prevents nutrients from leaching from the soil.
- It regulates soil temperatures by holding water and air in the soil.
- It helps maintain the soil pH for a long period.
- It can supplement what is supplied by mineral fertilisers.
- It allows better root penetration and absorption of nutrients.
- It creates a beneficial habitat for soil micro-organisms.

- It is friendly to the environment. It reduces the amount of pesticides and chemicals needed and lowers their negative impact on the farm's ecosystem.
- It may be easily available at the farm level or can be made from materials available on and around the farm, therefore reducing the cost of farming.

There are many ways of making compost. The best compost is made from a mixture of ingredients such as kitchen waste, green leafy vegetation found on and around the farm and home, animal manure, fruit waste, and any other well-decomposed organic matter.

Nutrient availability in compost depends on the sources used to make it. Therefore, it is important to ensure that many different appropriate ingredients are used to make compost, including a range of manures (cow, pig, chicken, goat, etc.), as well as leafy plants and dry matter.

In established farms, compost is applied just after harvest and pruning, and just before the short rains, as follows:

- Remove any mulch and a layer of the topsoil around the coffee tree carefully without harming the root system.
- Apply one to two 20-liter tins (debe) of compost around the tree stem and carefully replace the topsoil.
- Replace mulch around the stem at least 10cm from the stem to discourage termites. (Avoid mulch containing seeds as this will encourage growth of other plants and weeds.)
- After the first rain, remove the mulch and apply the recommended inorganic formulation fertiliser in the recommended quantities (see next section for details).
- Make sure there is sufficient moisture and replace the mulch.

2.3.2.2 Inorganic Fertiliser Application

Inorganic fertilisers provide the best-balanced plant nutrition. They are easy to use and can be applied at minimum cost. They are required in smaller volumes than organic fertilisers, and their nutrient availability to plants is much quicker and therefore more efficient for plant uptake.

Farmers should be aware that NPK fertilisers containing nitrate nitrogen work better than Urea (which contains nitrogen and ammonium that is released into the air very quickly), and foliar fertiliser because nitrate nitrogen:

- Dissolves even with minimal soil moisture, and becomes available to plants immediately
- Is less volatile (i.e., does not easily change its state or composition) and therefore remains in the soil longer
- Is more readily available to plants and contributes to higher yields, resulting in uniform berry ripening and berry size (quality)
- Is not fixed by the soil particles

- Is less immobilized by the soil particles (“immobilization” means that micro-organisms in the soil use part of the available nitrogen as their energy source)

When applying inorganic fertilisers, farmers should carefully follow the following instructions to ensure proper application and absorption by the plants, and to reduce loss of fertiliser to the air and through leaching:

- First, carefully remove mulch outward from the stem and make sure there is enough moisture in the soil.
- Remove all weeds prior to applying fertiliser, otherwise the coffee plant will compete with the weeds for these nutrients.
- Apply recommended fertiliser at the recommended rate around the plant but not too close to the stem (at least 10cm away from the stem) and as far as the canopy spread. Incorporate fertiliser into the soil and replace mulch to cover the fertiliser to avoid loss of nitrogen into the air.
- The rate of fertiliser per bush and application plan should be established based on a pre-determined yield target, soil growing conditions, age of crop and variety, rain pattern, etc.
- The recommended NPK fertiliser should contain the micro-nutrients sulphur, zinc and boron which are very low in most coffee growing areas.
- Fertilisers should be applied throughout the growing season to ensure nutrient availability at key growth stages. It is advisable to apply once prior to flowering to ensure proper fruit set. Thereafter, apply two split applications (minimum of each being 150gm/tree) of the compound fertiliser (NPK) at fruit set and fruit expansion stages, respectively
- For older trees (3-4 years for new varieties), apply one to two 20-liter containers (debe) of compost/manure per tree during the dry season (see previous section about organic manure application).
- Liming is always important in acidic soils, and 250gm per tree should be applied once a year during the short rains to prevent caking of the soil surface.
- For best results, farmers should use appropriate foliar fertilisers (see details in the next section) to provide additional nutrients when the crop is heavy and at key stages in plant growth or production cycle (i.e., pre-flowering, post-harvest recovery). Foliar fertilisers should be applied in the early morning hours of the day, early evening, or any time on a cloudy day.
- In cool climates, apply a boron-based foliar or field grade fertiliser just before flowering and zinc-based fertiliser three to four months later.
- In addition, farmers can apply a suitable natural crop bio-stimulant concentrate just before flowering to stimulate crop production to improve the yield and quality of the crop. This also improves the soil structure, infiltration, and increases multiplication of soil microbes and activities.

Important Note:

The fumes of inorganic fertiliser are acidic and therefore harmful to skin tissue. Persons applying them should wear gloves and personal protective gear for eyes, nose, and mouth.

2.3.3 Determining Soil Fertility

To monitor soil nutrient availability on the farm and develop the soil nutrition plan, farmers must have regular analysis carried out by an expert or qualified institution (TaCRI, 2011).

2.3.3.1 Soil Sampling

Soil sampling is the process used to determine the status of soil nutrients in a particular farm area. It involves collecting topsoil (the first six inches) and subsoil (the next 12 inches) after removing the top organic layer of the soil. The following steps should be taken:

- Take samples from randomly selected spaces between four trees in a coffee plot, avoiding sampling too close to the base of the trees.
- The same process is repeated at different areas and different plots. The samples are marked according to their sample location. (Accurate sampling is absolutely critical to a successful soil management plan as all recommendations are based on the samples taken and analyzed.)
- Take samples to accredited or recommended institutions for analysis in or close to your area and get updated about your soil's nutrient status.

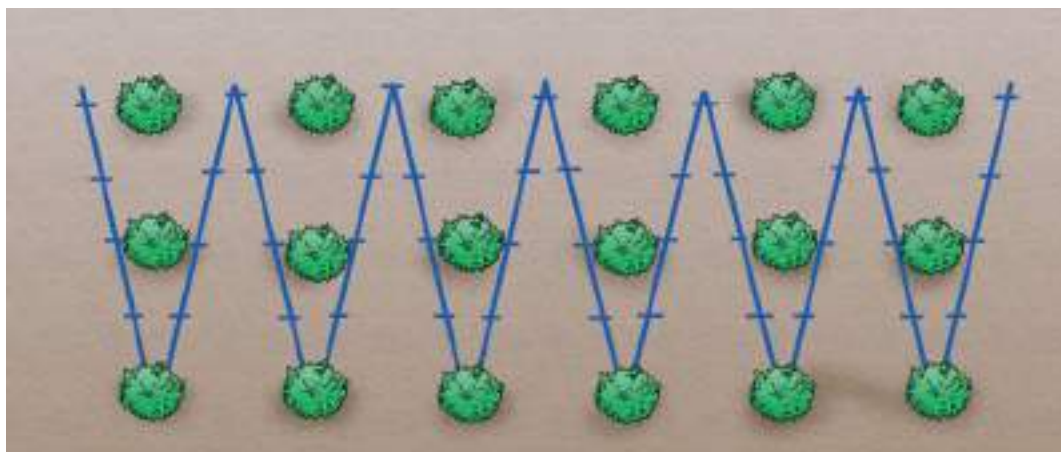


Illustration 20: Soil Sample Pattern on a Coffee Farm

2.3.3.2 Leaf Sampling

Leaf sampling is a means of detecting nutrient deficiencies using the leafy part of plants. The following steps should be taken:

- Select trees randomly on the coffee plot.
- Pick the third or fourth set of leaves from the tip of a middle branch. (Make sure there is no water stress during the sample picking.)
- Label the leaves according to the area selected and take the samples to the recommended institution on the same day.
- Get recommendations on the best fertiliser and foliar fertiliser to apply as well as the correct rates.
- Apply the recommended fertiliser by low volume sprayer, or in mist form for best results.

Soil and leaf samples obtained from the farm should be taken to a qualified and certified laboratory, where they are analyzed using specific procedures to determine the absence and availability of nutrients in the soil. The procedures described here must be followed closely to ensure correct analysis can be done. An expert must be consulted.

Topic 2.3 Lesson Plan

Lesson Objectives:

- Understand the nutritional needs of coffee plants and identify nutrient deficiency symptoms in coffee plants

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)
- Posters
- Raw materials for producing compost (farmyard manure, dry and green vegetative matter, kitchen waste and similar)
- Fertiliser application tools (fork, hoe, shovel)
- Example inorganic fertilisers to demonstrating application
- Personal protective equipment (gloves, mask, etc.) for applying inorganic fertilisers

Key Points to Share:

- Every harvest removes nutrients from the soil, so nutrients must be replaced to maintain a healthy plant and secure the next crop.
- Soil nutrient deficiencies should be assessed from time to time using soil and leaf sample analysis.
- Fertilisers should be applied following advice from a soil specialist (person or institution). Over- and under-application of fertilisers are a waste of money!
- Compost and mulch improve soil conditions and aid the conservation and uptake of nutrients, water and air for optimal growth.

| Topic | Topic Objectives | Training Activities |
|---------------------------------------|---|--|
| 2.3 Soil Fertility and Crop Nutrition | <ul style="list-style-type: none">• Understand the basic components and main nutrients of soil• Understand specific nutrient needs of coffee plants• Identify symptoms of nutrient deficiencies in coffee plants and establish cause• Emphasize the need for managing soil fertility for best plant performance• Understand different ways of improving soil fertility to increase yield and quality• Explain how to establish nutrient availability on the farm | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 2.3. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Group Discussion Discuss each soil nutrient requirement for coffee plants that is listed in Table 6. Allow participants to discuss what they know about each nutrient and its benefit for coffee.</p> <p>Farm Visit Review the symptoms of different soil nutrient deficiencies listed in Table 7. Visit a coffee farm to identify these symptoms in coffee plants. Discuss which fertilisers could be used to provide plants with the required nutrients.</p> <p>Group Discussion As a group, discuss the consequences of recognizing symptoms of soil deficiencies in coffee plants, but not making efforts to replenish the nutrients available to them. What could be the impact on crop yield and quality? What could the impact be over the long-term if soil nutrients are not replenished?</p> |

| Topic | Topic Objectives | Training Activities |
|-------|------------------|--|
| | | <p>Demonstration and Practice Making Organic Compost Demonstrate how to make an organic compost pile using materials available on coffee farms. Ask participants to help you add to the compost pile.</p> <p>Demonstration and Practice Applying Organic Fertiliser Demonstrate how to apply organic fertiliser around coffee plants. In groups, ask participants to practice what you demonstrated. Point out and discuss any mistakes farmers make.</p> <p>Demonstration and Practice Applying Inorganic Fertiliser Demonstrate how to apply inorganic fertiliser around coffee plants. In groups, ask participants to practice what you demonstrated. Point out and discuss any mistakes farmers make.</p> <p>Soil Nutrition Plan Using the information learned in this topic, help participants develop a sample soil nutrition plan for a farm. Name the soil nutrients that are lacking on the farm and then make a plan for how to replenish them, including the type of fertiliser to use and the rate/frequency of application.</p> <p>Guest Speaker If possible, ask a soil specialist or agriculture officer to demonstrate how to sample soil or leaves. Then ask them to explain the process for soil/leaf analysis and what the results can tell farmers. Then discuss the recommended course of treatment for different possible soil/leaf analysis findings.</p> |



2.4.1 Common Coffee Pests in Tanzania

Insect pests and diseases can cause considerable damage to the coffee plant and crop, and greatly reduce the income that farmers can earn from their coffee farm. Regular scouting of the farm to identify pests and diseases at an early stage can greatly reduce the cost and effort of remedy (Magina, 2011). Moreover, if pests and diseases are allowed to infest the farm, the damage might be irreparable.

When using agro-chemicals to manage pests and diseases, farmers must take the necessary precautions to safeguard their health and that of their family and neighbors, as well as avoid poisoning the environment around them (water bodies, soil, animals and other plants) (Agriculture and Food Authority (AFA), 2022; Global Coffee Platform (GCP), 2022; Magina, 2011; TaCRI, 2011, 2016; Uganda Coffee Training Manual, 2014). Sustainability standards devote additional attention to ecological production systems, water and nature conservation, and maintenance of local biodiversity and wildlife. The Global Coffee Platform (2022), helped to develop guidelines to assist farmers when using agro-chemicals to control coffee pests and diseases.

Integrated pest management (IPM) is a sustainable approach to managing insect pests and diseases on a farm. It combines biological and physical control measures which are cost-effective, safe for humans, and ecologically acceptable. These management strategies do not eradicate the pests and diseases completely, but instead they minimize their impact and keep their populations at economically acceptable levels.

This section contains information about common pests affecting coffee in Tanzania and other parts of the world. Depending on their body structure and adaptations, different pests attack different parts of the plant, from the leaves, flowers, fruit, stems, and roots (Magina, 2011). The description of each pest at various life stages as well as their symptoms on coffee plants and fruits are detailed in this section. In addition, cultural and chemical control measures and guidelines are provided for managing infestations.



Illustration 21: Regular Scouting for Pests and Diseases Reduces their Impact

2.4.1.1 White Coffee Stem Borer (WCSB)

Description: The white coffee stem borer, *Monochamus leuconatus* (Pascoe), (Coleoptera: Cerambycidae), can cause yield losses due to severe damage to trees and in some cases, substantial tree mortality. The larva bores the stem at an early stage, and in later stages can cause the coffee tree to suffer serious nutrient deficiency. Both yield and quality of coffee is affected.



Adult WCSB, *Monochamus leuconatus* (Pascoe) (left), Larva of WCSB on dissected coffee stem (right)

Symptoms: White coffee stem borer larvae feed on the coffee tree bark at the early stage and finally bore into the stem. The plant is weakened, and leaves lose their normal green colour and turn yellow (chlorosis). If not controlled, leaves wither and fall off.



Ring barking (left) and yellowing and death of coffee tree (right) caused by larvae of WCSB in the field

IPM Control:

- Observe phytosanitary practices such as clean weeding, proper spacing, pruning, and de-suckering to avoid bushiness.
- Scout and remove (kill by hand) adult beetles routinely.
- Kill or remove larvae already in the stem by inserting a wire in the tunnels. More than one larva per tree can cause severe damage on the stem by ring barking.
- Plug tunnel with cotton dipped in kerosene or a concentrated recommended chemical (like Chlorpyrifos 480 EC).
- Prune shade trees and coffee canopy to increase light penetration (beetles are attracted to light).
- Ensure sufficient coffee crop nutrition to compensate nutrient depletion caused by the pest.
- Protect the plant from leaf diseases to reduce pest attraction to the field.
- Scrub the stem just after harvest using a gunny sack or maize cob to remove the dry bar. This reduces the egg laying sites, removes eggs and larvae.
- Trace, uproot and burn heavily damaged trees before the rains.
- Animal fat can be used to attract ants into the tunnels to kill the larvae.

Chemical Control:

- Stems can be sprayed up to a height of 90cm above the ground with chemicals like Chlorpyrifos 480 EC (700ml in 20L of water), Deltamethrin 25 EC (750ml in 20L of water) and Fipronil 50 EC (20ml in 20L of water) before the onset of the rain (repeat the treatment twice a year).
- Also, banding the stem 90cm above the ground with a mixture of engine oil and Chlorpyrifos 480 EC has been shown to manage the pest infestation.

2.4.1.2 Yellow Headed Borer

Description: The yellow headed borer, *Dirphya nigricornis* (Olivier), (Coleoptera: Cerambycidae), is found in both Arabica and Robusta. The adult larvae are brownish with a yellowish head. The pests eat the center part of the plant (pith) and interfere with the movement of minerals in the plant, finally causing the direct loss of the crop.



Adult yellow headed borer, *Dirphya nigricornis* (Olivier)

Symptoms:

- Wilting of primary and secondary branches starting from the tips.
- Adult larvae burrow or perforate branches or young coffee plants.
- Adults are yellow headed with shining, blue-coloured wings. They are active during sunny days and lay their eggs on growing tender tips.
- Frays appearing on the outside of branches/stems can be clearly seen on weed-free farms.
- Broken branches are seen in severe infestations.



Coffee stem (left) and branch (right) showing damage caused by yellow headed borer



Larva of yellow headed borer, *Dirphya nigricornis* (Olivier)

IPM Control:

- Scout the farm to check for symptoms of the pest.
- Use a wire to remove the larva, and pierce to kill it.
- Cut the wilted primaries before the larvae reach the vertical stem. Check the branches for larva and burn it if found.
- Close the holes with clay soil to control the larva stage.
- Closely monitor for appearance of adults and carefully handpick.
- Cooking oil or animal fats can be smeared on the coffee stem to attract ants that kill the borer in the tunnel.
- Apply botanical products like Neem, tobacco and Datura.

Chemical Control:

- Enlarge the pest holes and apply a small quantity of diluted chemicals such as Chlorpyrifos 480 EC (700 ml in 20L of water) or Deltermethrin 25 EC (750 ml in 20L of water).

2.4.1.3 Black Borer

Description: The black borer, *Apate monacha* (Fabricius) & *A. indistinctus* (Murray), (Coleoptera: Bostrychidae), is a minor pest for both Arabica and Robusta coffee. It attacks only a few trees in a coffee plantation.

Symptoms:

- The adult beetle makes a clean-cut, circular, fairly straight tunnel about 6mm in diameter, obliquely upwards in the main stem.
- Tunnelling into the stems of host plants produces galleries and external holes.
- Attacked trees are normally found with sawdust-like fragments which are seen at the base of the tree, wherever the beetle is actively boring.
- Damage is usually most severe on young plantations and among nursery trees.
- Stems may be completely excavated, resulting in the death of young trees, or reduced growth of older trees.
- Larvae live in the wood of dead trees and do not usually cause economic damage.
- Both larvae and adults burrow in coffee stems and branches.

An exit hole
caused by a
beetle of black
borer, *Apate
monochus*



IPM Control:

- Observe phytosanitary practices such as clean weeding, proper spacing, pruning, and de-suckering to avoid bushiness.
- Clean away the saw dust-like frass from the base of the tree.
- Kill larvae of the pest by pushing a spring wire (i.e., a bicycle spoke) up the hole.
- Encourage natural enemies (predators) to attack the larvae and pupae of the pest.

Chemical Control:

- Plug cotton wool soaked in concentrated Profenofos 25 EC and Dursban 480 EC and push up in the tunnel thus killing the beetles through suffocation.
- Put chlorobenzene in the tunnel and plug the entrance with wet clay soil.

2.4.1.4 Variegated Grasshoppers

Description: The variegated grasshopper, *Zonocerus spp.* (*Z. elegans* Thun., *Z. variegatus* L.) (Orthoptera: Pyrgomorphidae), is an important polyphagous pest which feeds on numerous food and cash crops, warranting urgent management or control. Economic damage is caused when *Z. variegatus* attacks vegetables and other cash crops such as citrus, banana and coffee.



Adult variegated grasshopper, *Zonocerus spp*

Symptoms:

- The leaves of seedlings are eaten, leaving ragged edges.
- Dead heart and frass are visible in fruits and growing points of the plant.
- Nymphs and adults, which are both gregarious and sluggish, may be found on the leaves of the crop.

IPM Control:

- Dig up egg pods for desiccation at the soil surface to cause large reductions in populations.
- Identify egg-laying sites which are the areas where the swarm sits. Collect the egg pods and crush them.
- Manually pick grasshoppers up and kill them when still low in numbers. They can serve as chicken and human food.
- Shake aggregating young grasshoppers off the plant stems and collect them into a bag or net and crush them.

- Collected grasshoppers can be crushed in water. The crushed-grasshopper-water mixture is a repellent for grasshoppers and can be sprayed over the plants using a normal knapsack sprayer.
- Spores of the fungus *Metarhizium flavoviride* mixed with kerosene and peanut oil and sprayed on the plant can kill 70-95% of field populations.

Chemical Control:

- Apply chlorpyrifos-based products (Chlorpyrifos 45EC, PyrinexCS, and others), usually at a rate of 8ml in 20L of water but double-check the product label. This works well only on young grasshoppers.
- Pyrethroid insecticides like Deltamethrin-based products (Pali 250WP, Profenofos, Forte, Keshet 2.5EC and others) can be used as flat sprays.
- Apply Diazinon-based products like Diazon 30 EC, usually at a rate of 80ml in 1L of water but double-check the product label. Also use organophosphate for contact, stomach, and respiratory action on insect pests.

2.4.1.5 Systates Weevil

Description: The Systates weevil, *Systates pollinosus* (Gerst) & other *Systates* spp., (Coleoptera: Curculionidae), is a minor pest of Arabica and Robusta coffee.

Symptoms:

The adult beetle feeds on the edges of leaves at night, producing characteristic indentations or irregular-shaped notches on leaf margins.



Adult systates weevil, *Systates pollinosus*



Coffee leaves damaged, caused by *systates* weevil

IPM Control:

- Collect the adults and kill them by putting them in a jar of soapy water.

Chemical Control:

- Apply recommended pesticides such as Karate at a rate of 20ml in 20L of water; Permethrin (500 EC) at a rate of 20ml in 20L of water; or Chlorpyrifos 480 EC. Apply early in the morning or late in the evening.

2.4.1.6 Yellow Tea Mite

Description: The yellow tea mite, *Hemitarsonemus latus* (Banks), (Acarina: Tarsonemidae), is a minor pest of Arabica coffee. It prefers the underside of leaves and normally prefers new leaves, shoots, tender parts, flowers, and fruits. Severe infestation of coffee berries causes fruit fall and reduced yields. This pest also affects other crops such as tea, cotton, avocado, sweet and chili peppers, papaw, lemon, cucumber, cruciferous crops, leguminous crops, and mango.



Adult yellow tea mite,
Hemitarsonemus
latus

Symptoms:

- They are detected mainly by their damage on the plant parts like fruits, growing points, leaves, and stems.
- Pest feeding produces the damaging effect of necrosis/discolouration of the tissues and therefore deformation of tender parts of the coffee plant.
- Younger leaves turn a narrow shape during growth and edges are usually curled.
- There are twisted or crumbled leaves.
- Failure of plant internodes and leaves to elongate becomes evident with time.
- As leaves grow older, they become rigid/corky.
- Coffee berries attacked at the tender stage looks suberized when mature.
- The plant develops russet growth (bushy growth with short internodes).
- Some coffee berries may fail to develop and remain as pinheads with no bean development.
- Symptoms will persist for long even after treatment.

Twisted leaves
indicating an
attack by yellow
tea mites



IPM Control:

- Crop nutrition is important to counterbalance the effect of pest attack.
- Shade trees balance the coffee crop ecosystem for pest predator population build-up.
- Irrigation should be done overhead in warm weather (it is basically washing of the pests).

Chemical Control:

- Apply sulphur sprays like *Thiovit* or *Kumulus*, or sulfur dust like *Sulfolac*, etc.



Moth and larva of coffee berry moth and its damage symptoms to the coffee berries

2.4.1.7 Coffee Berry Moth

Description: The moth causes premature falling of berries. Sometimes the berry may remain on the tree for harvest, but moth infestation affects the quality and the flavor of the cup gotten from these berries. Adults lay eggs near the green berries which hatch in approximately six days (Magina, 2011; TaCRI, 2016). Mature larvae bore into the berries and eat the developing beans. The pests pupate in between the leaves after 6 to 42 days, depending on climatic conditions. Crop yield and quality are greatly affected.

Symptoms:

- The larva bores into the expanding and larger berries near the stalk, joining the berries together with a silk web before boring the second berry.
- One or more berries appear brown and clustered together, as well as dry and hollow. This symptom is sometimes mistaken as coffee berry disease (CBD).

- Caterpillars hatched in young berries can be seen boring the tips of green branches and can cause considerable damage.
- Sometimes buds and flowers may also be attacked.

IPM Control:

- Scouting is advised during major flowering, as serious destruction normally occurs 6-10 weeks after flowering and continues until berry maturity (at which point the pest requires chemical control).
- Weed control and minimum shading can also hinder the population.
- Botanical/natural pesticides should be applied early as it is insufficient in a serious infestation that is caught later.
- Strip and bury attacked and webbed berries.

Chemical Control:

- Check trees and if buds, flowers, and young berries are infested, immediately spray the recommended pesticide (Chlorpyrifos 480 EC at the rate of 1.5L/ha.) and repeat 5-6 weeks later.
- Products such as Profenofos and Diptrex can be used in case of an epidemic, but care should be taken as they are highly concentrated products that are very dangerous to a wide range of benefactors, especially bees, which are important for pollination. However, once the larva enters the berry, it cannot be reached by any of these products.

2.4.1.8 Antestia Bug

Description: Antestia bug, *Antestiopsis* spp, (Hemiptera: Pentatomidae), is a major pest in Arabica, but they do not affect Robusta (Magina, 2011; TaCRI, 2016). The nymphs and adults pierce young berries and flower buds during feeding, which causes failure to flower and berries to turn black. White eggs are usually laid on the underside of the leaves, sometimes on the plant stem and berries. This pest causes wounding of the cherries. They are more active in hot, dry weather than in cool weather. They live for about 3-4 months. If not controlled, it can result in 10 to 32% loss. The development of the coffee cherry is affected, and beans develop cracks and most become “floaters”.



Adult Antestia bug,
Antestiopsis spp

Symptoms:

- Attacked buds turn back and fail to flower.
- Abortion of the young berries.
- Mature nymphs feed on mature and green berries, green shoots, and flower buds.
- At processing, “floaters” are noticed.

Nymph
attacking coffee
cherries in the
field



Floater beans (left) and the characteristic longitudinal brown stripes (“zebra beans”) on cherries (right), both signs of attack by *Antestia* bugs

IPM Control:

- Regular scouting for the pest, as even a low population (1-2 bugs/tree) can cause serious economic losses.
- Regular and proper pruning, allowing the coffee tree to remain open so that light penetration and air circulation creates unfavorable conditions for the pest.

- Repeated scouting at morning hours just after pruning, at flowering, during the berry development and until maturity. If the trees can be shaken and adults can be observed falling in at least 10 trees out of 50, insecticide spraying may be justified.
- Apply 18 kg of fresh *Tephrosia* leaves per 15 litres of water. Then add 5g liquid soap into the solution



Tephrosia vogelii
flesh extracts for
management of
Antestia bugs

Chemical Control:

- Apply chemicals like Fenitrothion 50% EC (1L /ha), Profenofos 750 EC (1L /ha), Chlorpyrifos 480EC (750ml/ha), Permethrin 50 EC (750 ml/ha), Deltermethrin 25 EC (240 ml/ha), or Pyrethrum 6% EC (750 ml/ha) when an average population (nymphs and adults Antestia) are two or three per tree.

2.4.1.9 Kenyan Mealybugs/Common Coffee Mealybug

Description: Kenyan mealybugs, *Planococcus kenyae* (Le Pelley), (Hemiptera: Pseudococcidae), also called “sucking insect pests”, suck the sap from the coffee plant’s organs, leaves, flowers, bark, berries or any other part of both Robusta and Arabica coffee plants that they occupy. They normally affect the outer part of the plant, leading to poor growth, and facilitate infestation of fungal disease. If uncontrolled, the pest can kill a plant.



Adult mealy bugs, *Planococcus kenyae*, attacking a coffee leaf in the field

Symptoms:

- Evidence of the pest includes the presence of honeydew and soot mold on leaves, dead branches, and the wilting and shedding of leaves.
- White wax colonies are usually found on the bark, the underside of the leaves, and between the clusters of the berries or flower buds.
- Pests are also found on young roots near the main root where the soil is loose around the trunk.



White masses (left) and black soot (right) on suckers, leaves and midrib of coffee indicating the presence of mealy bugs

IPM Control:

- Planting material should be free from the pest and sourced from known recommended stations or certified centers.
- Banding the plant stems with a piece of cloth dipped in a recommended insecticide to prevent ants which scare the natural enemies such as ladybird beetles.
- Apply cow urine fermented for 24 hours in a ratio of 1:4 (urine:water) to the infected parts of the coffee tree.
- Remove and destroy weeds, which can harbor the pest.
- Maintain the optimum shade ratio.
- Adherence to GAPs reduces or keeps populations below economically damaging levels. This will encourage their natural enemies to multiply rather than destroying them through chemicals. GAPs also boost plant health which compensates for the damage caused by the pest and secures a good yield and crop quality.

Chemical Control:

- The bug is best controlled indirectly by banding the tree trunk at least 30cm wide with recommended insecticides such as Chlorpyrifos 480 EC 700 ml in 20L of water and Deltamethrin 720ml in 20L of water.
- Wrap the main stem just below the first primary branches with a piece of cloth soaked with a concentrated solution of recommended insecticides.
- Apply various oils (e.g., white oil/D-C-Tron Plus) or grease and soap washes, which work by suffocating the mealybugs.

2.4.1.10 Coffee Green Scale

Description: Coffee Green scale, *Coccus alpinus* (De Lotto), (Hemiptera: Coccidae), adults and nymphs suck the sap from the green berries, shoots and green leaves leading to severe leaf fall and retardation of plant growth. Severe cases can cause plant death, especially young trees. Established trees can also die if control measures are not taken. This pest attacks mainly Arabica coffee.



Green scale, *Coccus* spp., attacking a tender stem (left) and green scale, *Coccus* spp., attacking a tender branch (right)

Symptoms:

- Black ants climbing an infested tree.
- The upper part of the leaves affected by the scales are covered with sticky, transparent honey dew and often a black (sooty) mold growing on the honeydew.



Green scale (left) and soot mold (right), indicating presence of green scale attack

IPM Control:

- Planting material should be free from the pest and sourced from a known recommended research station or certified centers.
- Banding the plant stems with a piece of cloth dipped in a recommended insecticide to prevent ants, which deter the pest's natural enemies such as ladybird beetles.
- Remove and destroy weeds which can harbor the pest.
- Maintain the optimum ratio of shade.
- Limit and stop ants from climbing into the tree by removing unwanted suckers and branches which touch the ground.
- Adopt GAPs to increase yield as the unaffected healthy plants can help compensate for the damage caused to some plants by the pest.
- Predators and beneficial parasites such as wasps, fungi, and several species of ladybird play an important role in controlling the pest.
- Apply calcium carbonate (baking soda) and ashes on the ground around the stem to keep ants away and allow the natural enemy population to grow and clean up the infestation.

Chemical Control:

- Band at least 15cm of the lower part of the stem with recommended insecticide such as Chlorpyrifos 480 EC (700 ml in 20L of water), Deltermethrine 25 EC (750 ml in 20L of water), or Profenofos 720EC (1L/ ha).

2.4.1.11 Coffee Leaf Miner

Description: Coffee leaf miner, *Leucoptera* spp., (Lepidoptera: Lyonetiidae), is one of

the most serious coffee insect pests which primarily attack leaves of Arabica, but also Robusta. The pest is more active during hot weather conditions. Adults lay eggs under the leaves and once eggs are hatched, the larvae enter the leaves and cause tremendous damage to the plant. The result is a reduction of the photosynthetic area and the eventual falling of leaves, lowering productivity.



Adult leaf miner,
Leucoptera spp.

Symptoms:

- Irregular brown blotches on leaf surface.
- The blotch mine is inhibited by several small, white, flattened caterpillars.
- Mined leaves become brown and shed prematurely, reducing the photosynthesis activities of the plant.
- The infected leaf bends and cracks, releasing small larvae that enter a fresh leaf.



Whiteish lesions (left) and brown blotches (center), caused by caterpillars of leaf miner and leaf miner larvae (right)

IPM Control:

- Scouting during the dry season and short rains.
- Apply mulch to decompose leaves with spores and larvae faster.
- Prune and keep the coffee tree open, but moderate shade is necessary.
- Keep the coffee plant healthy.
- Keep the farm free from weeds.

- Overhead irrigation (if available) reduces the pest's pressure.
- Leaf miners are partly controlled by parasitic wasps and other beneficial insect pests, mainly in the larva and pupa stages. There are 26 known parasites of coffee leaf miner that can control their population.
- Some mite species also feed on leaf miner pupa during dry weather. However, these can also be parasitic insect pests to coffee plants if their population is too high.
- Natural pesticides such as tobacco, cow urine and water at a ratio of 1:4 can be applied.

Chemical Control:

- Use recommended chemicals such as Profenofos 720EC (1L/ ha), Chlorpyrifos 480 EC (2L/ha), or Profenofos 2.5% (250ml/ha). It is advised to use Profenofos once every three crop seasons to build up the surviving predator population.
- Recommended products should be applied when an average of 35 moths per mature plant are counted. Care should be taken as the application must be applied once a week, just after active flying adults are noticed, and just before the larvae enter the leaves.

2.4.1.12 Coffee Berry Borer

Description: Coffee berry borer, *Hypothenemus hampei* (Ferrari), (Coleoptera: Scolytidae), is the major pest in Robusta and Arabica grown in low and medium altitudes (Magina, 2011; TaCRI, 2016). In Tanzania the infestation is in lower and medium altitude Arabica coffee growing areas. Adult females and larvae cause damage by feeding inside the berries at all developing stages, causing bean rot. The female bores the bean and lays eggs in the tunnel until the next generation of the coffee berry borer hatches. Their invasion causes premature falling of cherries. Damaged fruit that remains on the plant is harvested as red cherry but has poor flavor, affecting production and causing poor cup quality. If no control measures are applied, the crop loss may range between 50-100%.

Adult coffee
berry borer,
Hypothenemus
hampei (Ferrari)



Symptoms:

- Early, large, matured berries are infested.
- One or more holes are seen near the apex of the berry where adults and larvae enter the bean.
- It attacks the berry from pinhead stage to maturity stage of coffee, including expansion, filling and even ripening. If the berry falls down, the feeding still continues to maturity of the pest.
- A grey or brown powder substance is deposited through the tunnel by active insect pests in the berry.
- The bored berries may be attacked by fungus or bacteria, causing the berry to dry up and turn black before falling.



Bored berries in the field with coffee berry borer



Damaged coffee beans in the store from coffee berry borers

IPM Control:

The pest prefers a cool, moist climate and shade. Cultural practices are the most effective measures for reducing the berry borer impact. These are:

- Pick the early red berries regularly at least every two weeks to reduce more breeding of the pest.
- Remove leftover berries and off-season crop immediately prior to the next flowering, to avoid carry-over of the pest to the next season.
- Prune regularly to reduce shade preferred by the pest and maintain the field free from weeds.
- Collect affected berries and burn to prevent larvae from developing in fallen berries.
- Observe the bored immature and matured berries. Pick and burn them.
- Apply mulch to encourage conducive conditions for natural enemies.
- Follow regulations to ban the movement of coffee from infested area to the unaffected areas.

- Properly dry coffee to the recommended moisture content level.
- Use alcohol traps in farms. Mixtures of any alcoholic beverage at the ratio of 1:1 (ethanol and methanol, Methylated spirit and water ratio 1:1) have been effective in trapping the pest in coffee and other crops.
- Various pathogens help in reducing coffee berry borer pressure, but in case of higher population, traps are most effective and can completely eradicate the pest if the farm is isolated.



Alcohol trap designed for trapping adult coffee berry borers in the field



Cepharonomia stephanoderis (left) and *Prorops nasuta* (right), parasitoids identified as natural enemies of coffee berry borers in coffee farms in the Kilimanjaro region



Chemical Control:

- The best control using chemicals is practiced after scouting and observation of heavy infestation, otherwise traps have proven very effective, cheaper, and easily available.
- Most of the recommended old chemical products are now banned if the infestation is too severe.
- Spray (Chlorpyrifos 480 EC 750 ml/ha, Cypermethrin 515 EC 20 ml in 20 L of water) after the main crop, twice at three-week intervals.
- Application should be before insect pests enter into the berries.

2.4.1.13 Black Coffee Twig Borer

Description: The black coffee twig borer, *Xylosandrus compactus*, (Coleoptera: Curculionidae: Scolytidae), is a pest which affects Arabica and Robusta coffee.

Adult black coffee twig borer, *Xylosandrus compactus*



Symptoms:

- Beetles bore into the wood of unhealthy, stressed coffee plants caused by drought, pruning, recent transplanting or dying trees.
- Wilting is observed on the terminal leaves of the branch infested by the pest.
- When you cut the damaged trees, you will see laid eggs and different stages of larva development in the pith of branches and stems.
- Wilting, necrosis, and defoliation is observed in branches.
- Symptoms may be mistaken as coffee wilt disease.
- Infested twigs don't bear berries, leading to a loss in income.
- The pest causes death of the stem and leaves beyond the tunnel entrance.



Different development stages of black coffee twig borers in the branch of coffee



Wilting of leaves (left) and a hole on the branch caused by black coffee twig borer in the field



IPM Control:

- Observe phytosanitary practices such as clean weeding, proper spacing, pruning, and de-suckering to avoid bushiness.
- Remove twigs/suckers on the lower portion of the coffee canopy.
- Cut and burn or bury the infested materials on the alternative hosts.

Chemical Control:

- Apply pesticides like imidacloprid (Imaxi/confidor/kohinor). You can use a tank mixture for the following ratio: (4 ml/L of imidacloprid + 6 ml/L of tebuconazole, twice per month at a high infestation area or once a month at a low infestation area).
- Chlorpyrifos, Permethrin, and Chlorpyrifos + cypermethrin are also reported to give good control.

2.4.1.14 Thrips

Description: Thrips is one of the most damaging insect pests, with a wide range of host plants worldwide. It is more serious during the prolonged dry weather conditions (Magina, 2011; TaCRI, 2016). It is a minor pest, but it can cause severe damage to the Arabica and Robusta coffee plants. Damage is caused by nymphs and adult thrips feeding on the sap from the cells on the underside of the young berries and leaves, causing defoliation. In such a case, it hinders photosynthetic activities of the plant and sometimes can cause dieback. It affects the size, the quality (grades) and general productivity.

Symptoms:

- Small dark/brown spots or silvery spots are observed on the underside of the damaged leaves and berries.
- Fast moving adults (small in size) are observed moving on cherries and leaves where they pierce the cell and suck the sap. This is observed under severe attack.
- Infested leaves become distorted, crinkled, or mottled.
- Infected coffee appears silvery in colour on the underside of the leaves as light is reflected from the attacked cells.

IPM Control:

- As the pupae pupate in the soil, mulching can reduce the thrips' population while enhancing natural enemies.
- Irrigate to increase moisture to initiate new leaf growth. If possible, overhead irrigation reduces the thrips' population. They are more active during the hot weather.
- Thrips are attacked by parasitic species and some fairy flies. It is advised to avoid the use of quick knockdown products (such as cypemethrins) that reduce the number of useful insect pests drastically.

Chemical Control:

- Most of the recommended products in Tanzania for thrips control are no longer produced.
- The most effective current products for thrips control are Spinosad, Biotrine, Spinotoram, and Bacillus thuringiensis.
- Sulphur-based products (e.g., Kumulus), mixed with DC-tron, can also control thrips efficiently.

2.4.1.15 Root-Knot Nematodes

Description: Nematodes, (*Meloidogyne* spp.), are small, worm-like animals that are very common in soil. This pest attacks crops such as bananas, a wide range of vegetables and coffee plants. It is difficult to notice it at the early stages because the symptoms start

appearing as nutrient deficiency. When these nematodes develop inside the roots of the plant, the infested roots swell and distort to form galls. Once the plant is infested by nematodes, the nutrient absorption from the soil is minimized and affects productivity.

Symptoms:

- Leaves yellow and fall along lines of trees (often mistaken for water and mineral uptake deficiencies).
- Heavily infested trees may die and can be easily uprooted.
- Galling on roots, swollen roots, and root hairs.

IPM Control:

- Plant nematode-free materials.
- Plant nematode-resistant varieties (e.g., Robusta) as root stock.
- Maintain biodiversity in the farm system (encourage beneficial soil organisms).
- Increase mulching and manuring.
- Remove affected trees and destroy by burning.

2.4.2 Major Coffee Diseases

As with all living things, coffee plants can also suffer from diseases caused by fungus, virus and bacteria in the air or introduced to the plant by humans or animals. Injury to the plant caused by strong winds and rains, or due to incorrect pruning or stumping, exposes the plant to attack by disease transmitters.

There are two major diseases of concern in Arabica coffee, namely Coffee Berry Disease (CBD), and Leaf Rust. Both are important to control because they can result in reduced yield and quality of the coffee crop, hence reduced income.

Robusta coffee is mainly affected by Coffee Wilt Disease (CWD), which is also called Fusaria. There is no known cure for CWD, and it is therefore very important to ensure prevention to avoid complete loss of the crop.

2.4.2.1 Coffee Berry Disease (CBD)

Description: CBD is caused by a fungus (*Colletotrichum kahawae*) which attacks both Arabica and Robusta coffee varieties. It can affect up to 90% of the coffee crop if not controlled. It is the most severe of all Arabica coffee diseases and occurs especially in higher altitudes with low temperatures, and humid conditions.

Symptoms:

Symptoms of CBD are small, sunken dark patches on expanding berries, which subsequently may cover the whole berry. The infected berries may fall or remain on the

tree with a dark colour. CBD may also affect flowers and young leaves, leaving them shrunk and with dark patches.

2.4.2.2 Coffee Leaf Rust (CLR)

Description: CLR is also caused by a fungus (*Hemileia vastatrix*). Spores are spread by wind and rains, but birds and human activities can also act as secondary vectors. If not controlled, the tree will lose its leaves, which affects the production of food and the development of cherries which can cause dieback of the coffee plant.

Symptoms:

CLR affects leaves, which eventually fall prematurely. Yellow spots appear on the underside of leaves, which enlarge to form circular lesions with orange pustules.

Control of CBD and CLR:

- Plant disease-resistant varieties which are not susceptible to either CBD or CLR.
- On farms planted with old varieties, which are susceptible to CBD and CLR, control and prevention is done in two ways:
 - Good Agricultural Practices (GAPs), especially proper pruning, cleaning the old skin on the coffee plant stems, and timely weeding all help reduce incidence of both CLR and CBD.
 - Farmers should only use fungicides that are recommended and approved by research institutes and authorities. Broad spectrum systemic or translating products are most effective for both diseases.

2.4.2.3 Coffee Wilt Disease (CWD)

Description: CWD, also called Fusaria, is a fungal disease largely affecting Robusta coffee varieties. The fungus lives deep in the plant biomass and soil, making it difficult to target with fungicides. No effective cure for CWD is available currently and affected trees eventually die, affecting the entire crop. For this reason, this disease is also called “Coffee AIDS”. It is therefore very important to prevent contamination from regions where CWD exists to those where it is not present.

Symptoms:

- Leaves turn yellow, fold, and curl inward. They dry up completely,
- Branches may turn blackish-brown or black and eventually dry up.
- The bark of the trunk, especially near the base of the tree, may become swollen and develop vertical or spiral cracks; the wood underneath the bark takes on a blue-black colour.
- Berries turn red prematurely and appear to ripen early.

Control of CWD:

- The amounts and types of fungicides needed to completely control the fungus would be uneconomic for both large farms and smallholder farmers and would also have serious environmental impacts if they were applied.
- The only means of controlling CWD is through strong regulations and quarantine measures that limit its spread. This can be done to help control the disease spread at the level of the farm, but also help the spread from regions where it is present to regions where it does not exist. Farmers should be educated and help spread information about the dangers of CWD, especially in zones bordering regions that are affected.
- Farmers must keenly scout for symptoms and take immediate measures as soon as they speculate that they have identified the disease. The local agricultural office should be consulted. Trees in and near affected areas should be uprooted and burned on the spot to destroy the fungus and its spores, which may have affected all parts of the plant. Do not move the uprooted trees to other parts of the farm as this may help to spread the fungus.
- Care for trees (pruning and weeding) very carefully as any damage caused to the tree creates wounds through which the fungus can attack.
- Mulching and compost enhance the plant's vigor and resistance to all insect pests and diseases, but only bring temporary relief to infected trees.

Note:

- Effective control depends mainly on the timing and the right choice of the fungicide used, which should be applied according to prevailing weather conditions, and the stage of the berry development.
- Farmers should monitor and keep records of spraying on their farm and should observe rainfall patterns to ensure effectiveness.

2.4.2.4 Cercospora/Leaf Spot

Description: Cercospora/Leaf spot/berry spot is caused by *Cercospora coffeicola*, a fungal disease which attacks leaves and green mature berries. Warm and wet weather (hotness and coldness) result in sporadic attack of the leaves and berries.

Symptoms:

- Attacked leaves may defoliate, causing dieback.
- Immature ripening of berries.
- Lowered quality of coffee.

Control of Cercospora/Leaf Spot:

- Application of N fertilisers.
- Mulch application.
- Shade trees to help control weather fluctuation.
- Application of copper-based fungicides at half rate of CBD 2-3 times at 7 days interval.



Coffee leaves (left) and coffee berries (right), affected with cercospora/leaf spot

2.4.2.5 Fusarium Bark Disease

Description: Fusarium Bark Disease is caused by *Fusarium stilboides*, a fungal disease which occasionally kills coffee trees. Warm, wet, weather; poor soil nutrition; and mechanical damage of coffee trees results in die-back and rotting of the bark and roots.

Symptoms

- Appears in three forms in Arabica coffee: 1) storey's bark disease, 2) scaly bark, and 3) collar rot.

Control of Fusarium Bark Disease

- Uproot and burn affected plants on the spot.
- Keep soil acidity down by applying lime.
- Disinfect pruning tools.
- Maintain plant health.



Coffee plant (left) and coffee stem (right) affected with Fusarium Bark Disease in the field

2.4.3 Safe Use of Agro-chemicals

Anyone applying agro-chemicals must take necessary precautions to protect their health and the health of their family and neighbors, as well as the health of the environment (Global Coffee Platform (GCP), 2022). In addition, care must be taken to ensure the crop is not harmed by too much use of chemicals, and that the quality of the harvest is not affected by unacceptably high chemical residues (Coffee & Climate, 2021; Manson et al., 2022).

It is important that farmers seek expert advice about what products to buy and apply to ensure that the product is genuine, certified, and recognized by legal agencies or authorities, and that the product is allowed to be used in coffee farming and it is not banned by the World Health Organization (WHO) or Tanzania Plant Health Pesticide Authority (TPHPA). The following guidelines should be observed:

1. The product must be sourced from licensed dealers.
2. The product must be in its original container or package; always check the label and validity when buying.
3. Read the label carefully; if it is not clear, seek advice from the farmer trainer in your area.
4. Store the product safely, away from food, children, heat, and living spaces, preferably in a locked storage container or room.

The World Health Organization (WHO) has classified the toxicity levels of common agro-chemicals. Each class of chemical is labelled with a different coloured-label to indicate its toxicity.

Class IA and IB: Extremely and Highly Hazardous

Labels bear a symbol indicating a high degree of hazard (i.e., skull and crossbones) and a signal word or phrase (i.e., **POISON** or **TOXIC**).

Labels are **RED**.

| Common Name | Active Ingredient | Treatment of |
|------------------|-------------------|--------------|
| FENAMIPHOS 400EC | Chlorpyrifos | Nematodes |
| Phorate 10G | Organophosphate | Nematodes |

Class II: Moderately Hazardous

Labels usually bear a symbol (i.e., a cross) and a signal word (i.e., **HARMFUL**).

Labels are **YELLOW**.

| Common Name | Active Ingredient | Treatment of |
|-------------|-------------------|---|
| Durstban E4 | Chlorpyrifos | Treatment of Coffee Leaf Rust, yellow headed coffee borer and coffee berry moth |
| Decis 2.5EC | Deltamethrin | White coffee stem borer and yellow headed coffee borer |
| Selecron | Profenofos | Coffee berry moth and antestia bugs |

Class III: Slightly Hazardous

Products are slightly toxic.

Label may contain a signal word (i.e., **CAUTION**, possibly followed by: "Harmful if swallowed", "May be harmful if absorbed through the skin", "May be harmful if inhaled", or "May irritate eyes, nose, throat, and skin").

Label is **GREEN**.

| Common Name | Active Ingredient | Treatment of |
|--------------|-------------------|--------------------------|
| Spinosad | Spinosad | Thrips, leaf miners, |
| spider mites | | |
| Kumulus | Sulphur | Thrips, mites and mildew |

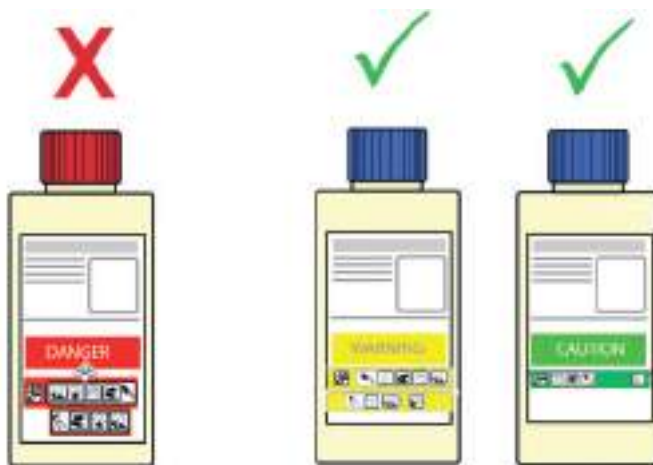


Illustration 22: Read Agro-chemical Labels Carefully

Table 10: Safe Use of Agro-chemicals

| Do's | Don'ts |
|---|---|
| While Purchasing <ul style="list-style-type: none">• Purchase pesticides/biopesticides only from registered pesticide dealers having a valid license.• Purchase only the required quantity of pesticides for a single application in a specified area.• See approved labels on the containers/packets of pesticides.• See batch number, registration number, and date of manufacture/expiry on the labels.• Purchase pesticides well packed in containers. | While Purchasing <ul style="list-style-type: none">• Do not purchase pesticides from foot path dealers or from un-licensed persons.• Do not purchase pesticides in bulk for the whole season.• Do not purchase pesticides without an approved label on the container.• Never purchase expired pesticides.• Do not purchase pesticides whose containers are leaking/loose/unsealed. |

| | |
|---|---|
| <p>During Storage</p> <ul style="list-style-type: none"> • Store the pesticides away from the house premises. • Keep pesticides in their original containers. • Pesticides/herbicides must be stored separately. • Places where pesticides are stored should be marked with warning signs. • Pesticides should be stored away from the reach of children and livestock. • Storage places for pesticides should be well protected from direct sunlight and rain | <p>During Storage</p> <ul style="list-style-type: none"> • Never store pesticide in the house premises. • Never transfer pesticides from the original to another container. • Do not store insecticides with herbicides. • Do not allow children to enter the storage place. • Pesticides should not be exposed to sunlight or rainwater. |
| <p>While Handling</p> <ul style="list-style-type: none"> • Keep pesticides separate during transportation. • Bulk pesticides should be carried tactfully to the site of application. | <p>While Handling</p> <ul style="list-style-type: none"> • Never carry/transport pesticides along with food/fodder/other edible foods. • Never carry bulk pesticides on the head, shoulder or on the back. |
| <p>While Preparing the Spray Solution</p> <ul style="list-style-type: none"> • Always use clean water. • Use protective clothing such as gloves, face masks, cap, apron, full trouser, etc. to cover the whole body. • Always protect your nose, eyes, ears, hands, etc. from spillage of the spray solution. • Read instructions on the pesticide container label carefully before use. • Prepare the solution as per requirement. • Granular pesticides should be used as such. • Avoid spilling the pesticide solution while filling the spray tank. • Always use recommended dosage of the pesticide. • No activities should be carried out which may affect your health. | <p>While Preparing the Spray Solution</p> <ul style="list-style-type: none"> • Do not use muddy or stagnant water. • Never prepare the spray solution without wearing protective clothing. • Do not allow the pesticide/its solution to fall on any body parts. • Never forget to read the instructions on the container's label for use. • Never use a spray solution 24 hours after it was first prepared. • Do not mix granules with water. • Do not smell the spray tank. • Do not use overdose of the pesticide which may affect plant health and the environment. • Do not eat, drink, smoke, or chew during the entire process of preparing, spraying and cleaning up after spraying pesticides. |

| | |
|--|---|
| <p>Selection of Equipment</p> <ul style="list-style-type: none"> • Select the right kind of equipment. • Select right sized nozzles. • Use separate sprayers for pesticides and herbicides. | <p>Selection of Equipment</p> <ul style="list-style-type: none"> • Do not use leaky or defective equipment. • Do not use defective/non-recommended nozzles. • Do not blow/clean clogged nozzles with mouth. Instead use a toothbrush. • Never use the same sprayer for both pesticides and herbicides. |
| <p>While Applying Spray Solutions</p> <ul style="list-style-type: none"> • Apply only the recommended dose and dilution. • Spray operation should be conducted on a cool and calm (not windy) day. • Spray operation should be conducted on a sunny day in general. • Use recommended sprayer for each spray. • Spray operation should be conducted in the direction of the wind, not against it. This prevents the spray from blowing back at you. • After spray operation, the sprayer and buckets should be washed with clean water using detergent/soap. • Avoid the entry of animals/workers in the field immediately after spraying. | <p>While Applying Spray Solutions</p> <ul style="list-style-type: none"> • Never apply overdose and higher concentrations than recommended. • Do not spray on hot, sunny days or in strong windy conditions. • Do not spray just before rains and immediately after the rains. • Emulsified concentrate formulations should not be used for spraying with battery operated ULV sprayer. • Do not spray against the wind direction. • Containers and buckets used for mixing pesticides should never be used for domestic purpose, even after thorough washing. • Never enter in the treated field immediately after spraying without wearing protective clothing. |
| <p>After Spray Operation</p> <ul style="list-style-type: none"> • Left over spray solutions should be disposed of at safer place such as a barren, isolated area. • The used/empty containers should be crushed with a stone/stick and buried deep in soil away from water sources. • Wash hands and face with clean water and soap before eating/smoking. • If you observe any poisoning symptoms, give First Aid, and bring the patient to a doctor. Also show the empty agro-chemical container to the doctor. | <p>After Spray Operation</p> <ul style="list-style-type: none"> • Left over spray solution should not be drained in or near ponds or water lines, etc. • Empty containers of pesticides should not be re-used for storing other articles. • Never eat/smoke before washing clothes and taking a bath. • Do not take the risk of not alerting a doctor when poisoning symptoms are noticed, as it may endanger the life of the patient. |



Illustration 23: Pregnant Women and Children Should Not Spray Agro-chemicals



Illustration 24: Bad and Good Storage of Agro-chemicals at Home

Anyone applying agro-chemicals must protect themselves from coming into direct contact with them. Fumes which enter the body through the nose and mouth, and direct contact through the skin, can harm the health of persons applying agro-chemicals.

Basic PPEs are goggles, a face mask, a long-sleeved overcoat/overall, gloves, and gumboots. These should be in place and in a good condition to limit the exposure of the spraying person to the chemical applied. The following steps should be followed:

1. First, wear personal protective equipment (PPEs) to avoid coming into contact with the chemical.
2. Add water in a sprayer until it is half full.
3. Measure the required amount of chemical concentrate and pour in the sprayer tank.
4. Agitate the tank to mix the chemical and the water together, then add more water to the recommended dilution requirement.
5. Tighten the tank cover firmly and wear on the back.
6. Always spray in the direction of the wind to avoid coming into contact with chemical drift.
7. Smoking, drinking, and eating should be avoided completely during all activities related to spraying, and the sprayer must wash their hands, equipment and protective gear before touching food or drink.
8. After spraying, clean the equipment and pour the residues in a soak-pit lined with sand, gravel, and charcoal, far from water sources and domestic animals and pets.
9. Take off PPEs and wash them at the same soak-pit. Gloves should be taken off and washed last.

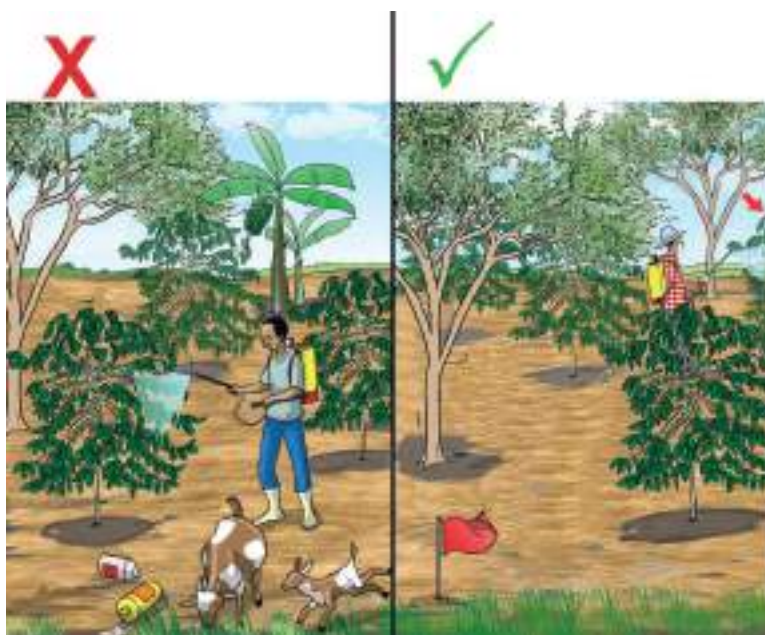


Illustration 25: Incorrect and Correct Application of Agro-chemicals

2.4.4 Determining Risk and Spraying Needs

Whether to spray and the required frequency of spraying should be determined by the risk level identified by the farmers, and based on consultations with an expert (i.e., a farmer extension officer or agricultural officer). The potential loss of crop as well as the level of infestation will also determine measures to be taken to control the disease. Table 10 provides guidelines for this.

Table 11: Guidelines for Determining Risk and Spraying Needs

| Risk level | Parameters | Parameters |
|------------|--|--|
| High | Expanding berries in wet weather | <ul style="list-style-type: none">• Spray products with long residual effect at an interval of 21 days, or every 14 days in continuous rains.• For copper-based products, spray every 7 to 14 days depending on rainfall pattern. |
| Medium | Expanding crop in dry weather | <ul style="list-style-type: none">• Spray at an interval of 35 days; in case of unexpected rains, spray at a 21-day interval |
| Low | Expanded berries in relatively dry weather | <ul style="list-style-type: none">• Spray at an interval of 60 days; in case of unexpected rains, spray at a 35-day interval |

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Topic 2.4 Lesson Plan

Lesson Objectives:

- Identify the most commercially significant insect pests and diseases for coffee including their symptoms and management measures to apply
- Recognize the health and environmental impacts of commonly used agro-chemicals

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)
- Posters
- Some agro-chemical labels for discussions and demonstrations
- Personal protective equipment (PPEs) needed for applying agro-chemicals such as face mask, gloves, long-sleeved clothing and gumboots

Key Points to Share:

- Farmers must frequently scout their farms as a first step of identifying pests and diseases so they can work to control any found.
- Integrated pest management (IPM) should be the first step in controlling pests and diseases on a farm because it saves farmers resources and provides better results.
- Haphazard spraying spends money unnecessarily, causes health and environmental damage, and results in pest tolerance to agro-chemicals.
- Agro-chemicals have long-term impacts on the health of people, livestock, and the environment when exposed to them. They must be handled and applied with great care.

| Topic | Topic Objectives | Training Activities |
|-----------------------------------|---|--|
| 2.4 Control of Pests and Diseases | <ul style="list-style-type: none"> • Understand the meaning of integrated pest and disease management (IPM) and common IPM measures • Identify insect pests by looking out for symptoms and understand how to manage them when found • Identify diseases by looking out for symptoms and understand how to manage them when found • Beware of agro-chemical hazards, and protect the health of humans, animals, and the environment accordingly | <p>Lecture and Discussion Introduce the information in Topic 2.4. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them.</p> <p>Experience Sharing Ask participants to share their experiences in terms of which pests and diseases they are aware of in their region, or which have affected their own coffee crops before.</p> <p>Group Discussion As a group, discuss which integrated pest management measures they know and practice. Are they effective? If not, why?</p> <p>Group Discussion Discuss with farmers the typical reasons for applying agro-chemicals on their farms (e.g., out of habit, because they observe neighbors using them, because they get advice from an expert, etc.). Discuss whether IPM measures can ever be taken instead of using agro-chemicals. What are the benefits of using IPM instead of agro-chemicals?</p> <p>Group Discussion Discuss which of the pests in section 2.4.1 participants have encountered on their farms or in their area before. Discuss the impact of these pests on their coffee harvest from an economic perspective. Could this damage have been prevented through the application of IPM measures?</p> <p>Pest Identification If possible, visit coffee farms and the surrounding area to search and identify different types of coffee pests discussed in section 2.4.1. For each pest found, ask participants if they have ever encountered it on their farms before. Examine the plant where it was found for symptoms that it is living there. Discuss what control measures should be taken if participants find the pest on their farms.</p> |

| Topic | Topic Objectives | Training Activities |
|-------|------------------|---|
| | | <p>Disease Identification If possible, visit coffee farms and the surrounding area to search and identify coffee diseases discussed in section 2.4.2. For each disease found, ask participants if they have ever encountered it on their farms before. Examine the plant where it was found for symptoms that it is present there. Discuss what control measures should be taken if participants find the disease on their farms.</p> <p>Pest Versus Disease Symptom Discussion Start a discussion with the group about the differences between different pest symptoms and disease symptoms. Are any symptoms usually confused? How can farmers identify the correct pest/disease that is affecting their crop to ensure proper management measures are taken?</p> <p>Group Discussion Discuss with farmers where they source their agro-chemicals and whether they feel confident about the reliability of this source.</p> <p>Agro-chemical Review Ask farmers to bring the agro-chemicals they use on their farms. Help them study the labels carefully. Make sure to read all the sections (active agent, product name, registration number, health and environmental precautions, application rates, etc.). Discuss how each chemical should be applied safely.</p> <p>Group Discussion Discuss with farmers whether they have observed/experienced any negative effects of agro-chemicals on people, animals, or the environment around them. Discuss what can be done to minimize these negative effects.</p> <p>Demonstration Demonstrate how to properly dress in PPE when getting ready to apply agro-chemicals. Ensure to have all the PPE mentioned in section 2.4.3. Discuss the purpose of each PPE item and discuss the negative consequences that could result if the item is not worn. For example, if a mask is forgotten the sprayer could breathe in chemical fumes which could damage their lungs; if gumboots are not worn the sprayer could get chemicals on their skin which could enter their bloodstream and kill them, etc.</p> <p>Demonstration Demonstrate how to safely take off and wash PPE and sprayer equipment after spraying. Make sure participants know where it is safe to do this as well as how to safely do it.</p> |



2.5.1 Assessing a Coffee Farm for Rehabilitation

Coffee is a permanent cash crop. Its production cycle relies heavily on climatic conditions, which determine flowering, fruit production and harvest. However, for a coffee plant to be productive and profitable to the farmer, it must be cared for throughout the year. If not well managed, the coffee tree will grow unproductive branches that are uneconomical.

Depending on factors such as climate, land management, soil nutrients, and farming practices, a coffee plant can continuously bear fruit for more than one hundred years. But the age of the tree, soil depletion, and attack from pests and diseases affect its productivity over time. Farmers must routinely assess an established or old coffee farm and determine its state and rehabilitation needs. To do this:

1. Soil fertility should be assessed to know the types, amounts, and combinations of fertiliser required.
2. The presence of pests and diseases should be checked, and those found must be removed from the field before rehabilitation is possible.
3. The availability of water, shade, and mulching material must be ensured so that ideal conditions are created for new growth.
4. Labour must be sourced, and its costs factored in so that the farm receives all necessary attention to ensure a good quality crop that will bring profit to the farmer.

Depending on the farmer's business plan and capacity to implement it, an old coffee farm can be rehabilitated in two main ways:

1. Stumping the low-productive coffee trees
2. Grafting or pruning
3. Uprooting or removing old trees and planting new ones.

2.5.2 Methods of Farm Rehabilitation

2.5.2.1 Replanting an Old Coffee Farm with New Coffee Varieties

Coffee trees that are too woody or unproductive or have died due to age or continuous attack from pests and diseases must be replaced completely. If most coffee plants on the farm are still productive, the farmer will need to identify and remove those that should be replaced and plant new ones in their place. This is called "gap filling" (Market Development Facility (MDF), 2021; TaCRI, 2011).

If most coffee plants need replacing, the farmer may need to consider replanting the farm completely. Replanting an old coffee farm may involve land preparation, planning, and field setting. Depending on the terrain of the farm and the past cultivation practices on it, it may require installation of contours, shade trees, fertiliser and manure application, and planting of permanent companion crops.

An assessment and preparation of land to be replanted with coffee should follow procedures described in Chapter 2, Topic 2.1: Coffee Farm Establishment.

2.5.2.2 Coffee Farm Gap Filling

Gap filling is a normal process when growing a forest garden. Coffee trees are planted – some live and some die due to several factors such as drought or old age. When they die, they leave gaps that must be filled.



Illustration 26: Gap Filling

2.5.2.3 Coffee Tree Rejuvenation by Stumping

Stumping is an appropriate method for rejuvenating a coffee farm when most coffee trees on the farm are still productive and do not need to be uprooted, but they are yielding a poor crop. This method is especially important for farmers who do not have sufficient resources to plant a completely new farm. Instead, they can keep their coffee plants productive by practicing stumping (Market Development Facility (MDF), 2021; Sustainable coffee challenge, 2019; TaCRI, 2011).

Stumping removes all or most of the vegetative parts of old coffee plants, leaving just the main stem. A sharp saw should be used for this. Manure and/or compost must be applied after stumping to ensure healthy new stems develop from emerging suckers. Stumping can be done in several ways:

1. Clean Stumping

This means stumping every coffee plant on the entire farm, all at once. This method is only recommended if the farming family can sustain itself from other sources of income while the coffee plants grow back and start producing cherries again. (See Chapter 7: Coffee Farming as a Business for more information on additional income generation activities families can do on the farm.) Clean stumping of an Arabica coffee farm can be repeated every seven to nine years (five to seven years for Robusta) to ensure continuous vigorous production and removal of pests and diseases (Sustainable Coffee Challenge, 2019).

2. Staggered Stumping

This means that only part of the coffee farm is stumped at one time (for example, only every one to two rows is stumped), leaving the remaining rows to produce into the next season. After the rejuvenated trees start producing, the remaining trees are stumped in a cycle lasting two to three years. This allows the family to receive an income from at least part of the crop every year.



Illustration 27: Staggered Stumping

When stumping, farmers must ensure the following:

1. Cut the main stem 15cm from the ground. If the coffee tree was grafted, make sure to stump above the grafting joint.
2. Stump at an angle of at least 45 degrees with the slope facing away from the main stem. This allows moisture to wash off the cut and discourages the build-up of pests and diseases.

3. Leave three new sprouts on the new stem. Select sprouts according to the type of coffee grown and the desired canopy system. In nine months, these will start flowering for the first crop.

The rows in a stumped coffee farm can be planted with companion food crops like beans, groundnuts, and peas so that the family has food and some income from the sale of excess production. In addition, these crops add nitrogen to the soil and thus improve the growth of the new suckers.

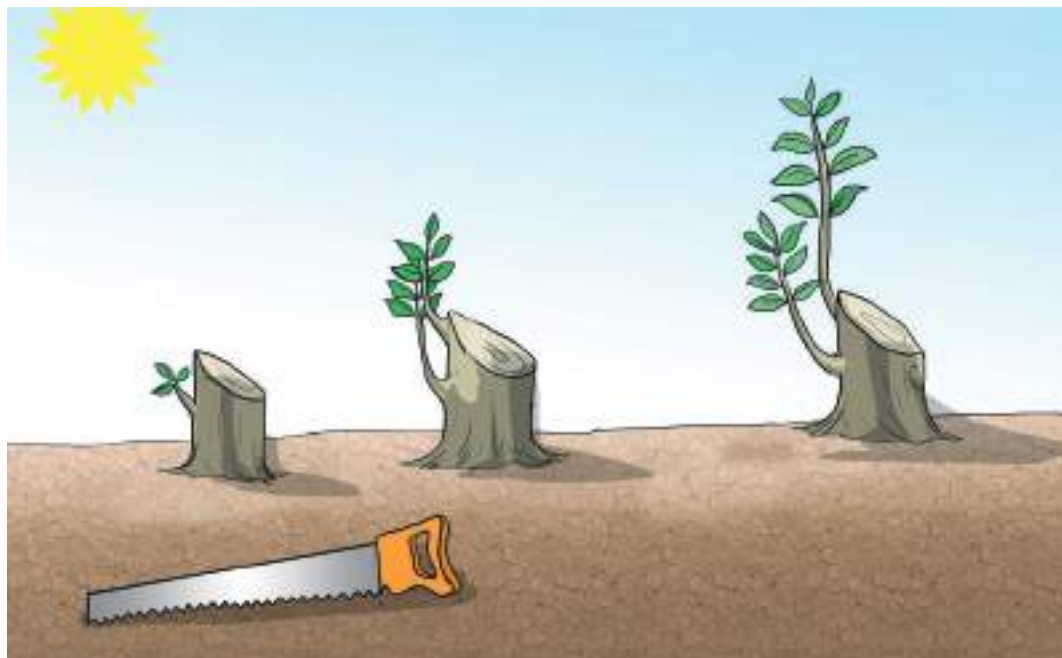


Illustration 28: Stumping an Arabica Coffee Plant

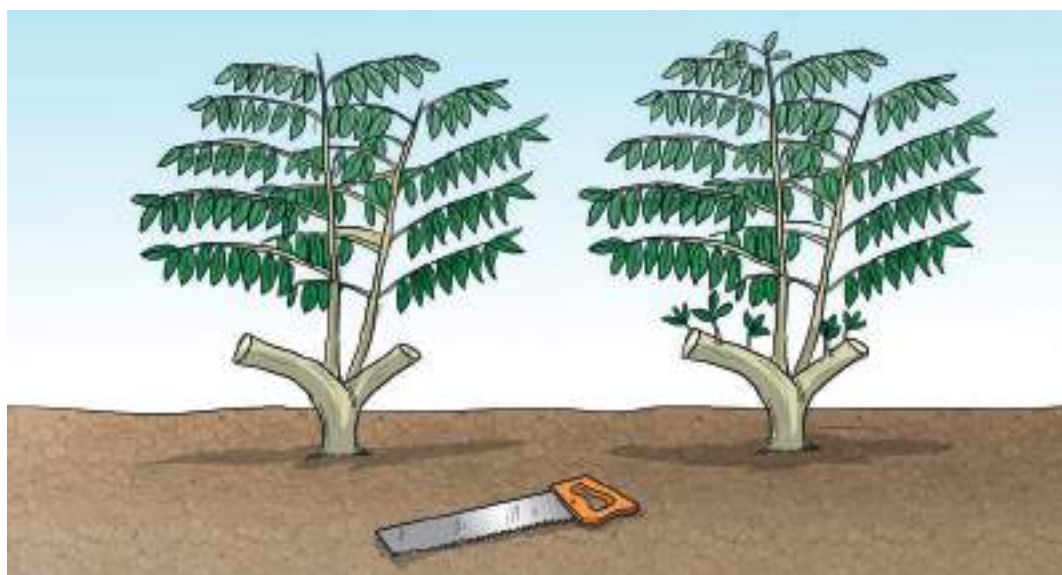


Illustration 29: Stumping a Robusta Coffee Plant

2.5.2.4 Grafting

Stumping can be followed by immediate grafting of new selected varieties which are more productive and resistant to Coffee Leaf Rust (CLR) and Coffee Berry Disease (CBD).

Grafting requires skill and preparation and should only be done by experienced farmers (TaCRI, 2011). Rejuvenating a farm in this way is therefore more expensive at the beginning but profitable in the long term as it reduces future costs to the farmer of managing pests and diseases. In addition, it can result in an earlier harvest.

However, the technology is simple to learn, and experienced farmers can do their own grafting. Women and youth should be encouraged to learn grafting skills so they can provide this service to other farmers as a means of earning an additional income. Other benefits of grafting include:

- With well-established roots, the new tree grows fast, and flowering is induced just nine months after grafting, leading to an early harvest.
- At a relatively low cost, a farmer can change from old coffee varieties to new coffee varieties within a very short time.

Only **improved varieties** should be used in grafting and replanting to improve the farmer's future management of pests and diseases.

Important Note:

Even after stumping or grafting, the coffee plant must be well taken care of. Good agricultural practices (GAPs) must be applied throughout the year for the coffee plant to grow healthy and strong.

2.5.3 References and Further Reading

Global Coffee Platform (2022). Equivalence mechanism. Ensuring schemes meet the Coffee Sustainability Reference Code

Ng'homa N. M. (2000). Kanuni za Kilimo Bora cha Kahawa Mkoani Kagera.

TaCRI. (2011). Kanuni za Kilimo Bora cha Kahawa – Kahawa ya Arabika.

TaCRI. (2011). Kanuni za Kilimo Bora cha Kahawa – Kahawa ya Robusta.

Topic 2.5 Lesson Plan

Lesson Objectives:

- Understand the rationale for rehabilitating an aged coffee farm
- Learn methods for rehabilitating an aged coffee farm

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)
- Posters
- A saw and measuring tape (or string cut to measure 30cm) for stumping demonstration

Key Points to Share:

- Farmers must link the ageing of coffee trees to the productivity and profitability of their farms.
- Field rejuvenation must be carefully considered from a long-term economic perspective. For example, loss in the first year after rejuvenation can lead to higher income in subsequent years.
- Regular rejuvenation and rehabilitation of coffee plants are necessary for the best productivity and quality.

| Topic | Topic Objectives | Training Activities |
|--------------------------------|---|--|
| 2.5 Coffee Farm Rehabilitation | <ul style="list-style-type: none"> • Determine whether an old coffee farm needs rejuvenation • Understand the economic benefits of coffee farm rejuvenation • Know at least two ways of rehabilitating an old coffee farm • Understand the benefits of coffee farm rejuvenation through grafting • Determine when to apply grafting for coffee farm rejuvenation | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 2.5. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Farm Visit Visit an old coffee farm together. Discuss whether the farm needs rejuvenation. If so, what are the indicators that it needs rejuvenation? Discuss the farmer's options for rejuvenating the farm. Then decide on the best approach (for both the short-term and long-term) that the farmer should take to rejuvenate the farm.</p> <p>Group Discussion Visit an old coffee farm that is available for replanting. Discuss whether the farm likely needs entire replanting or whether gap filling should be done. If gap filling should be done, ask participants to point out which specific trees should be replaced.</p> <p>Demonstration and Practice At the old coffee farm that is available for replanting, demonstrate how to peg, dig, and prepare a hole for a new coffee seedling. See Topic 2.1 for specific instructions on how to do this properly. In groups, ask participants to practice what you demonstrated. Point out and discuss any mistakes farmers make.</p> <p>Group Discussion Visit an old coffee farm that is available for stumping. Discuss whether the farmer should do clean stumping or staggered stumping, depending on the state of their coffee plants and family's economic needs. Discuss an appropriate rotation for staggered stumping.</p> <p>Demonstration and Practice At the old coffee farm that is available for stumping, demonstrate stumping. Follow the correct instructions depending on the type of coffee (Arabica or Robusta). In groups, ask participants to practice what you demonstrated. Point out and discuss any mistakes farmers make.</p> <p>Nursery Visit Visit a coffee tree nursery or TaCRI station to see how grafting is done. Discuss the benefits of grafting improved coffee varieties to old coffee plants.</p> <p>Group Discussion Discuss the economic benefits of the three methods for farm rejuvenation (replanting, stumping and grafting).</p> |

Table 12: Coffee Crop Calendar Per Coffee Growing Zone in Tanzania

| Zone | January | February | March | April | May | June |
|--|--|--|---|---|---|---|
| ZONE 1: Kilimanjaro Arusha Manyara Tanga Mara | <ol style="list-style-type: none"> 1. Mulching 2. Weeding 3. Harvesting 4. Pruning 5. Caring for seedlings | <ol style="list-style-type: none"> 1. Minor pruning 2. Spraying against CLR 3. Selling coffee | <ol style="list-style-type: none"> 1. Harvesting 2. Applying fertiliser and manure 3. Planting coffee seedlings 4. Spraying against CBD and CLR 5. Minor pruning | <ol style="list-style-type: none"> 1. Spraying against Coffee Stem Borer 2. Harvesting 3. Planting new coffee seedlings 4. Caring for seedlings | <ol style="list-style-type: none"> 1. Pruning 2. Harvesting 3. Mulching 4. Spraying against CBD and CLR 5. Continue planting new coffee 6. Selling coffee | <ol style="list-style-type: none"> 1. Major pruning 2. Harvesting in lower belts 3. Spraying against CBD and CLR |
| ZONE 2: Morogoro Iringa Mbeya Rukwa Ruvuma | <ol style="list-style-type: none"> 1. Control leaf miners, antestia bugs and stem borers 2. Weeding and Mulching 3. Control CLR and CBD | <ol style="list-style-type: none"> 1. Planting coffee seedlings 2. Applying fertiliser and manure | <ol style="list-style-type: none"> 1. Applying fertiliser and manure 2. Planting coffee seedlings 3. Spraying against CBD and CLR | <ol style="list-style-type: none"> 1. Planting coffee seedlings 2. Weeding 3. Applying fertiliser and manure 4. Spraying against antestia bugs | <ol style="list-style-type: none"> 1. Pruning 2. Harvesting 3. Mulching | <ol style="list-style-type: none"> 1. Spraying against CBD and CLR 2. Harvesting |
| ZONE 3: Kigoma Kagera Mwanza Ukerewe | <ol style="list-style-type: none"> 1. Mulching 2. Weeding 3. Spraying against stem borers | <ol style="list-style-type: none"> 1. Planting coffee seedlings 2. Applying fertiliser and manure 3. Spraying against stem borers | <ol style="list-style-type: none"> 1. Planting coffee seedlings 2. Spraying against CBD and CLR | | <ol style="list-style-type: none"> 1. Minor pruning 2. Mulching 3. Applying fertiliser and manure | <ol style="list-style-type: none"> 1. Harvesting in lower belts 2. Spraying against CBD and CLR |

| Zone | July | August | September | October | November | December |
|--|--|--|---|--|--|--|
| ZONE 1: Kilimanjaro Arusha Manyara Tanga Mara | <ol style="list-style-type: none"> 1. Weeding 2. Harvesting 3. Spraying against CBD and CLR | <ol style="list-style-type: none"> 1. Harvesting 2. Selling coffee 3. Weeding 4. Caring for coffee seedling nursery | <ol style="list-style-type: none"> 1. Preparing the field for planting 2. Harvesting 3. Pruning 4. Preparing holes for planting | <ol style="list-style-type: none"> 1. Preparing the farm for planting 2. Harvesting 3. Pruning 4. Preparing holes for planting | <ol style="list-style-type: none"> 1. Spraying against CBD and CLR | <ol style="list-style-type: none"> 1. Weeding 2. Harvesting |
| ZONE 2: Morogoro Iringa Mbeya Rukwa Ruvuma | <ol style="list-style-type: none"> 1. Pruning 2. Harvesting | <ol style="list-style-type: none"> 1. Harvesting 2. Selling coffee 3. Weeding 4. Preparing the farm for planting 5. Preparing compost holes 6. Pruning | <ol style="list-style-type: none"> 1. Preparing the field for planting 2. Harvesting 3. Pruning 4. Preparing holes for planting and applying farmyard manure 5. Spraying against CBD and CLR | <ol style="list-style-type: none"> 1. Preparing coffee seedling nursery 2. Harvesting 3. Pruning 4. Preparing holes for planting 5. Applying farmyard manure 6. Spraying against antestia bugs | <ol style="list-style-type: none"> 1. Spraying against CBD an CLR 2. Applying fertiliser and manure | <ol style="list-style-type: none"> 1. Spraying against CBD and CLR 2. Spraying against coffee stem borer |
| ZONE 3: Kigoma Kagera Mwanza Ukerewe | <ol style="list-style-type: none"> 1. Pruning 2. Harvesting | <ol style="list-style-type: none"> 1. Harvesting 2. Selling coffee 3. Pruning 4. Mulching | <ol style="list-style-type: none"> 1. Preparing farm for planting 2. Harvesting 3. Preparing holes for planting 4. Mulching | <ol style="list-style-type: none"> 1. Spraying against coffee stem borer | <ol style="list-style-type: none"> 1. Filling holes and planting seedlings 2. Applying fertiliser and manure | <ol style="list-style-type: none"> 1. Weeding 2. Mulching |

CBD = Coffee Berry Disease
CLR = Coffee Leaf Rust



2.6.1 Introduction of Agroforestry Practices on a Farm

The previous topics covered coffee farming practices with an emphasis on management practices. Coffee farmers can also practice other activities on their coffee farms for the purpose of income diversification, soil fertility management and/or environmental conservation. Collectively these activities are termed “agroforestry”, which means using the same unit of land for growing trees as well as growing crops and/or rearing animals.

This topic highlights some of the agroforestry interventions that can enable farmers to get better crop yields and quality so they can fulfil their economic, social, and cultural needs.

Definition of agroforestry

- Agroforestry is a farm management system in which trees are grown among different crops such as coffee. Under the canopy of shade trees, coffee is protected from extreme heat during the dry season. Additionally, during the rainy season, shade trees protect the bare ground from soil erosion (Coffee & Climate, 2021).
- Agroforestry is the practice of growing crops (including coffee) among trees and woodland.
- Agroforestry is a collective name for land use systems that combine trees with crops and/or animals on the same unit of land (Cameroon Gender and Environment Watch (CAMGEW), 2014)

2.6.1.1 Importance of Agroforestry Practices on a Farm

Coffee is an agro-forestry plant that needs moderate temperatures and adequate rainfall to grow and produce a good crop. Shade on a coffee farm creates cooler temperatures during the hot period and retains warmth when temperatures drop, maintaining ideal conditions for coffee trees to grow and produce. For better crop yields, coffee farmers must have a suitable micro-climate (humidity, sun intensity and wind) which can be created through agroforestry practices (Agriculture and Food Authority (AFA), 2022; Coffee & Climate, 2021; Morka & Terefe, 2022; TaCRI, 2011).

Agroforestry also helps farmers avoid soil erosion, get firewood, conserve water, produce green manure, provide shade, and break the wind, all of which benefits their coffee farms. Agroforestry activities also help conserve the environment and reduce the amount of carbon in the atmosphere, which have valuable benefits for society (Morka & Terefe, 2022; We Effect and Vi Agroforestry, 2014).

Farms with no shade or mulch are vulnerable to high rates of evapo-transpiration, leaving farms dry. However, by planting the correct trees and shrubs on their coffee farms, farmers can improve the quality of their farmlands, create organic fertiliser to conserve the soil, increase income generating opportunities and establish sustainable supplies of high-protein animal forage, food, fuel, medicines and building materials (Wagner et al., 2021).

2.6.1.2 Benefits of Agroforestry Practices on a Coffee Farm

- Reduce the force and direction of wind (act as a wind breaker) and the impact of strong rains and storms, hence protecting coffee berries, leaves, and flowers
- Add soil fertility by transferring deep soil nutrients to the surface through the leaf litter, making them available to plants with shorter root systems
- Improve drainage and aeration of the soil due to the tree's root systems
- Conserve soil and water, especially on sloping land, promoting long-term sustainable agriculture
- Retain moisture in the soil and air, and facilitate cloud formation
- Provide firewood, animal fodder, timber, and other household uses (tools, artifacts)
- Provide household food security and nutrition (fruits, nuts)
- Provide raw materials for making compost
- Create a healthy environment, as trees provide forage for honeybees and contribute to biodiversity
- Reduce the amount of carbon in the air, helping to battle the negative impact of global warming and climate change
- Form permanent boundaries around the farm
- Generate income from the sales of different products and byproducts from trees

Bearing these benefits in mind, care should be taken when selecting the types of trees and crops to plant on a coffee farm. The farmers should take care to select trees that will not compete directly for nutrients with the coffee and other crops on the farm (Coffee & Climate, 2021; TaCRI, 2011, 2016; We Effect and Vi Agroforestry, 2014). This is explained more in section 2.6.3.



Illustration 30: A Well-Integrated Farm with Coffee and Agro-forestry

2.6.2 Shade Management

Where trees exist on a piece of land that will be converted into a coffee farm, or when rehabilitating an old coffee farm, farmers should carefully assess which trees to keep and which to remove. If there is not enough shade on the farm, or some shade trees are old and damaged and need to be removed, farmers must plan to plant new ones.

To maintain the right amount of shade on the farm, and to control pests and diseases, shade trees must be well-managed (Tengnäs, 1994). A balance must be maintained between sufficient light, air penetration, and sufficient cover to retain humidity on the farm. In addition, correct spacing must be considered to ensure just the right amount of shade, without leading to competition for light, air, water, or nutrients with the coffee crop. This means that **shade trees must be pruned on a regular basis as well.**



Illustration 31: Shade Trees Need Management

2.6.2.1 Recommended Trees for Coffee Farms

Coffee farmers can plant various appropriate trees which can benefit their farms and improve their livelihoods. For example, farmers should plant some trees that grow quickly so they can be used for firewood, animal fodder and timber, to help ensure that they can meet their household's economic needs (Mbuya et al., 1994; TaCRI, 2011, 2016). Varieties of Acacias, Albizias, Crotons, Figs and Markhamia are just a few examples of shade trees that can fulfill these needs. In addition, Acacias and Albizias have nitrogen fixing properties and therefore enrich the soil. Farmers can also plant fruit trees such as avocado, guava, and macadamia nut, among others. These trees can provide food and/

or additional income for farmers. They also provide raw materials for making mulch, and the plant materials left over after pruning them can be used as fodder and firewood. New coffee farmers should consult experienced farmers on which tree species grow best in their areas.

Farmers should also plant permanent trees, preferably those that have a long lifespan, multiple uses, and which the local village authority does not permit to be cut (i.e., Mvule). This will ensure that the benefits of the shade trees are permanent, and the environment of the farm is sustained over the long-term. Permanent shade trees that should not be removed from the farm are:

***Cordia africana* (Mringaringa):** A small to medium-sized evergreen tree which grows 4-15m high. They are heavily branched with a spreading, umbrella-shaped or rounded crown. They are often left behind when forests are cleared for cultivation because the tree is an excellent shade tree for crops found in riverine forest and secondary bushland, transgressing into humid types of woodland. Leaf fall from these trees in the dry season is heavy, and the leaves make good mulch.

***Albizia schimperiana* (Mruka):** A medium-sized deciduous tree which grows up to 30-35m tall with a straight and cylindrical or low-branched trunk. The crown is often umbrella-shaped. These trees are planted in agroforestry systems as a shade tree and for soil conservation and improvement. Its leaves are browsed by cattle and branches are lopped off and fed to goats. These trees grow slowly, and their roots develop nitrogen fixing nodules.

***Milicia excelsa* (Mvule):** This tree occurs in deciduous, semi-deciduous or evergreen, primary or secondary forest, in gallery forest or forest islands, or as lone trees in savanna regions. It is sometimes left as a lone tree in old, cultivated areas. It is usually found at 1200-1500m altitude or even higher on Mount Kilimanjaro. It has many domestic, commercial, and medicinal uses.

***Grevillea robusta* (Meresi):** It is advisable to plant these trees as boundary trees which act as a wind breaker. If it will be planted within a coffee farm, a spacing of 15 meters between trees is recommended.



Illustration 32: Recommended Shade Trees on a Coffee Farm

2.6.3 Intercropping on a Coffee Farm

Other crops can be grown together with coffee on the farm; however, only crops that are beneficial to the coffee plant are encouraged to reduce competition for nutrients and water, which can affect coffee's productivity and yield (TaCRI, 2011, 2016).

Farmers should grow food crops as well as coffee to ensure their families have a steady food supply. Food crops can also help provide an additional income which can help them manage the risks of a failed coffee crop or coffee price fluctuations. By growing their own food, farmers can reduce their dependency on cash and cheaply ensure a well-balanced and healthy diet for their family throughout the year.

As part of food and income diversification, and to reduce farming costs, intercropping should be done in combination with rearing livestock (cows, goats, chickens, pigs). This combination is beneficial in many ways, as it allows for the recycling of nutrients on the farm, thus reducing the need to buy fertilisers, mulch, and composting materials. At the same time, produce from these different sources can be a lucrative business to the family and can help cover cash needs for school fees, medical expenses, household development and expansion, farm development and investments, and savings.

When growing other crops together with coffee, care must be taken to ensure that the right crops are grown to minimize competition for soil nutrients and water.

2.6.3.1 Competing Crops

Competing crops are all food plants that compete with the coffee trees for nutrients, water, and light. They tend to be heavy feeder crops such as tomatoes, maize, sweet peppers, melons, and pumpkins. Although they provide highly nutritious and varying food, they are discouraged on coffee farms and should be grown separately as part of the family kitchen garden.

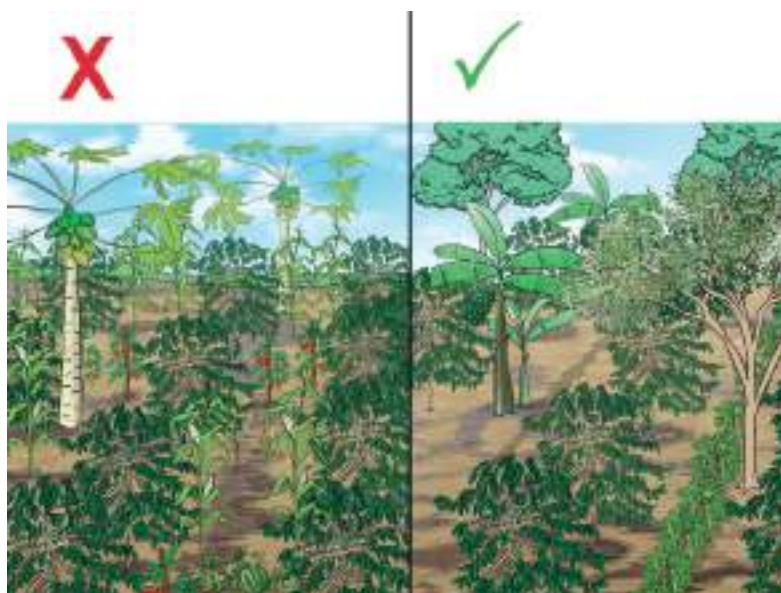


Illustration 33: Competing and Companion Crops on a Coffee Farm

2.6.3.2 Companion Crops

Companion crops are those which do not compete too much or at all with the coffee plant, either because they do not need the same nutrients and in the same quantities as coffee does, or because they have deeper or shallower root systems and therefore get their nutrients and water from a different layer of soil than coffee does. The most common companion crop recommended for intercropping on a coffee farm is banana, cover crops, shade trees and fruit trees.

2.6.3.3 Coffee and Banana Intercropping

In areas where banana is a staple food, bananas are highly recommended for intercropping with coffee as described in Table 12, and provide the following benefits:

- **Shade:** Banana trees provide acceptable shade to the coffee plants when planted in rows at the recommended spacing.
- **Food for the family:** Banana fruits are a highly nutritious food that can be consumed in many ways. The availability of a wide range of banana varieties also means that the food supply can be spread throughout the year because different banana varieties produce at different times of the year. The banana plant also tolerates a range of climatic conditions and thrives on household grey water. Surplus banana can be sold at a lucrative price on local markets and is a common cash earner for women.
- **Fodder:** Banana stems and leaves make excellent feed for household livestock, particularly cows, goats, and poultry (whose manure can be used to enhance soil fertility on the farm).
- **Mulching:** All vegetative parts of the banana plant provide the best source of mulching materials that is available at no cost to the farmer. Banana mulch also adds to soil moisture as it is very wet. It decomposes easily and quickly adds humus to the soil.

Table 13: Coffee Banana Intercropping Space and Plant Populations

| S/N | Coffee | | Banana | | Total Plant Population per Acre | |
|-----|---------------------|------------------|---------------------|------------------|---------------------------------|------------|
| | Meters between rows | Meters with rows | Meters between rows | Meters with rows | Coffee | Banana |
| 1 | 3 | 3 | 12 | 2.5 or 3.0 | 311 or 333 | 133 or 111 |
| 2 | 3 | 2.5 | 12 | 2.5 or 3.0 | 400 or 422 | 133 or 111 |
| 3 | 2.5 | 2.5 | 10 | 2.5 or 3.0 | 480 or 507 | 160 or 133 |
| 4 | 2.5 | 2.0 | 10 | 2.5 or 3.0 | 640 or 667 | 160 or 133 |
| *5 | 2.5 | 1.25 | 10 | 2.5 or 3.0 | 1,120 or 1,147 | 160 or 133 |

Sources: (TaCRI, 2011, 2016)

2.6.4 References and Further Reading

D. Hines & K. Eckman. (1993). *Indigenous Multipurpose Trees of Tanzania: Uses and Economic Benefits for People*, FAO Working Paper, Available at: <http://www.fao.org/docrep/019/x5327e/x5327e.pdf>

ICRAF. (1994). *Agroforestry Extension Manual for Kenya*.

Mbuya L.P, Msanga H.P, Ruffo C.K., Ann Birnie and Bo Tengnas (1994). *Useful Trees and Shrubs for Tanzania Identification, Propagation and Management for Agricultural and Pastoral Communities* Regional Soil Conservation Unit (RSCU) Swedish International Development Authority.

Topic 2.6 Lesson Plan

Lesson Objectives:

- Understand the importance and benefits of shade trees on a coffee farm
- Recognize which trees are recommended for planting on a coffee farm
- Recognize the importance of intercropping coffee with food crops such as banana

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)
- Posters

Key Points to Share:

- Trees have both agronomic and economic benefits.
- Shade trees planted on a coffee farm must be carefully selected to ensure their benefits and reduce competition between coffee and the selected trees/food crops.
- Farmers should farm food crops and carry out other activities to ensure food security and generate additional income.

| Topic | Topic Objectives | Training Activities |
|---|--|---|
| 2.6 Agroforestry Resource Efficiency and Nutritional Food Practices on Coffee Farms | <ul style="list-style-type: none"> • Understand the importance of agroforestry for farmer livelihoods, coffee production and environmental health • Understand the importance and benefits of shade on a coffee farm • Understand the need to manage trees for optimal shade • Identify the most suitable trees for creating shade on a coffee farm • Encourage correct intercropping and other farming activities on a coffee farm | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 2.6. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Group Discussion Discuss the various benefits (economic, nutritional, environmental, etc.) that farmers and the community get from growing non-coffee/shade trees on their farms. Make sure to discuss who in the family benefits the most from shade trees grown on the farm.</p> <p>Farm Visit Visit a few coffee farms and assess their shade availability. Compare the amount of shade to the productivity of the coffee plants. Would the plants benefit from more or less shade? How can the available shade be managed better? Also observe the moisture in the soil, and the biodiversity on the farm (insect pests, birds, small animals, diversity of plants, etc.).</p> <p>Group Discussion Discuss the types of trees that are most suitable for growing on a coffee farm in the area. How can farmers create a good mix of different types of trees which have different uses? Discuss the availability of seedlings for these trees. Discuss whether there are possibilities to grow these tree seedlings at a coffee seedling nursery.</p> <p>Farm Mapping Farmers should each draw a map of how they would ideally plant shade trees on their own coffee farms, including which trees they would plant and where. Then ask farmers to use their ideal drawings to discuss the shade trees that currently exist on their farms. What would they want to change? What would they keep the same?</p> <p>Farm Visit Visit a coffee farm and assess the suitability of the plants intercropped. Discuss a plan to help the farmer improve the intercropping by removing competing crops and introducing companion crops.</p> <p>Experience Sharing Ask participants to share what food crops they farm to help subsidize their income and/or contribute to their family's nutrition. Discuss the advantages and disadvantages of growing each crop and help the group make a list of the top three food crops they would recommend for intercropping with coffee.</p> |

CHAPTER THREE





Coffee quality is associated with good pre-harvest and post-harvest management activities referred to as the ten commandments. The post-harvest processing activities contribute to about 60% of the quality of green coffee beans. Post-harvest activities include pulping, processing, drying, hulling, cleaning, sorting, grading, storage, roasting, grinding, and cupping. This chapter details the good harvest and post-harvest activities for coffee and their impacts on coffee quality.

3.1.1 Coffee Harvesting

Coffee plants start bearing fruit referred to as cherries in clusters along its branches after 18 and 36 months of planting for improved and traditional varieties, respectively, (Agriculture and Food Authority (AFA), 2022; Craft Coffee Guru, 2023; TaCRI, 2011, 2016; Uganda Coffee Training Manual, 2014). The fruit is initially green and turns red when it is ready for harvesting.

When coffee starts to ripen, the farm must be visited frequently to monitor cherry ripening and determine the right time to pick, which is about every 10 to 14 days.

Coffee is traditionally harvested by hand in one of two ways: strip picking or selective picking.

1. **Strip picking** is exactly how it sounds – trees are harvested entirely at one time by "stripping" all the beans off the branches. Ripe cherries as well as unripe cherries are all harvested at one go. Typically, only Robusta coffee is strip-picked. Modernized machine harvest for Robusta coffee simply shakes the trees which knocks all the cherries off at one time (Uganda Training Materials for Coffee Production 2014 and Rudy, 2016).

2. **Selective picking** involves making numerous passes over coffee trees, selecting only the ripe cherries, then returning to the tree several times over a few weeks to pick the remaining cherries as they ripen. Selective picking is more expensive due to the labor involved and is only used for Arabica coffee.



Illustration 34: Correct Harvesting of Coffee

Key points to consider when harvesting coffee

- i. Pick the ripe red cherries
 - a) Farmers should measure and record the weight or volume of each harvest throughout the season so that they can monitor how much their farm produces.
 - b) This information is an important part of calculating income against expenses of the farm and determining whether the coffee farm is operating profitably.

TAARIFAYA MAVUNO

| Harvest / Mavuno | Kafuu Kina | Kafuu Kina | Kiasi kiloboru (KPS) | Kiasi kiloboru (KPS) | Bei uliyazika (TSh) |
|------------------|------------|------------|----------------------|----------------------|---------------------|
| 17/7/2022 | ✓ | | 19.5½ | 19.5½ | 2000/= |
| 21/7/2022 | ✓ | | 5 | 5 | 2000/= |
| 26/7/2022 | ✓ | | 57½ | 57½ | 2000/= |
| 29/7/2022 | | | | | |
| 20/8/2022 | ✓ | | 73 | 73 | 2000/= |
| 22/8/2022 | | ✓ | 193 | 193 | 450/= |
| 23/9/2022 | | ✓ | 183 | 181 | 450/= |
| 4/10/2022 | ✓ | | 11 | 11 | 2600/= |
| 21/10/2022 | ✓ | | 21 | 21 | 3000/= |
| 22/10/2022 | ✓ | | 23 | 21 | 3000/= |

Illustration 35: Example of Farmer Harvesting Records

- i. Sort harvested cherries for uniform ripeness.
 - a) Harvested cherries must be thoroughly sorted after picking to ensure cherries of uniform quality are processed.
 - b) Immature, over-ripe, diseased, and pest-infested cherries should be removed and processed separately as secondary grade coffee for a different market and price.
 - c) Sorting also removes stones, debris, waste from the farm and other unwanted materials.

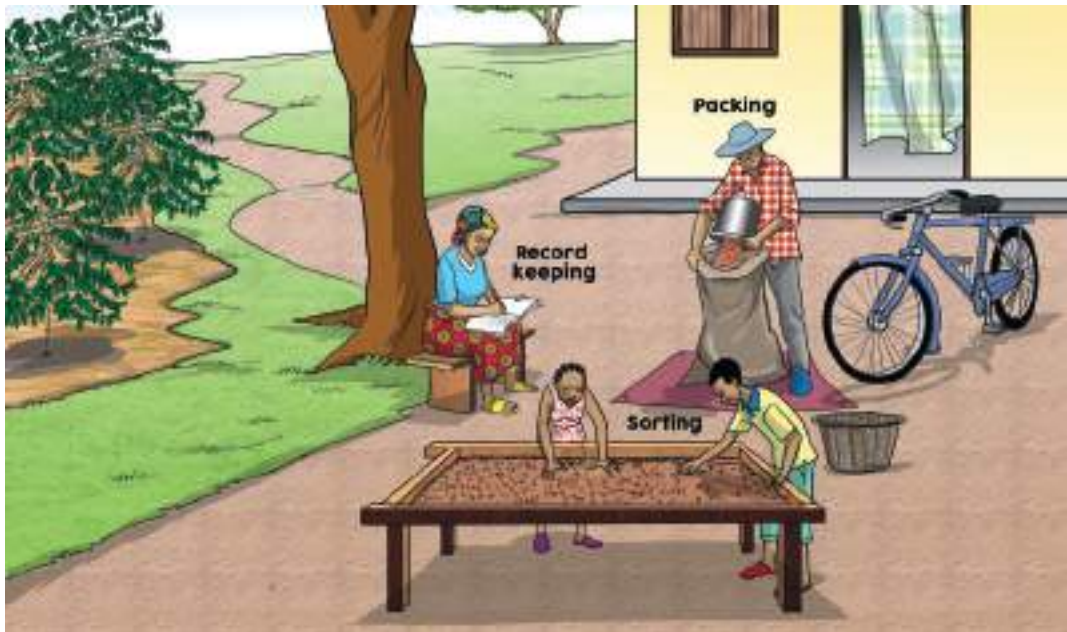


Illustration 36: Sorting, Weighing and Recording Harvested Cherries

- i. Pulp coffee the same day it is picked. Never let harvested cherries lie for more than eight hours!
 - a) Ripe harvested cherries should be stored in baskets with good ventilation off the ground until it is brought for primary processing.
 - b) It is important that the ripe cherry is not stored for more than eight hours, as fermentation begins immediately after harvesting, especially in warm conditions, which can destroy the quality of the green beans.

At the end of the season, all mature coffee left on the branches should be removed and processed separately. Pruning follows immediately after coffee has been harvested, to prepare the tree for the next production cycle.



Coffee quality is associated with pre-harvest and post-harvest management activities referred to as the ten commandments. The post-harvest processing activities contribute to about 60% of the quality of green coffee beans. Post-harvest activities include pulping, processing, drying, hulling, cleaning, sorting, grading, storage, roasting, grinding, and cupping. Coffee is mainly processed in three ways: primary processing, secondary processing and tertiary processing. This chapter details the harvest and post-harvest activities for coffee and their impacts on coffee quality.

3.2.1 Coffee Primary Processing

Primary processing of coffee is categorised in three methods such as wet processing, natural/dry processing, and honey coffee processing (TaCRI, 2011, 2016). To attain good quality, TACRI (2011 and 2016) developed guidelines required during primary coffee processing which includes ten commandments as follows:

1. Cherries must be processed in a timely manner to preserve their quality.
2. Machinery must be adjusted to ensure cherries are not damaged during processing. Avoid breaking and nipping the beans in the pulper. (Adjust the machine properly).
3. Pulp with a good supply of clean water. (Follow the instructions of the specific machine being used).
4. All bad beans should be picked out of the processed coffee and sold separately (together with other second-grade coffee such as the floaters, under or over-ripe beans). Pick out as many cherry skins (pulp) as possible from the parchment.
5. Wash the coffee thoroughly to remove skins and floaters (lighter parchment which floats on top). Where the process requires fermentation, ferment the coffee in a clean container, stirring thoroughly each morning.
6. Never mix coffee pulped on separate days into the same fermenting container! This step will not be necessary if using an eco-pulper.
7. Wash the coffee when the sticky mucilage layer is loose. Wash with plenty of clean water in the container. Separate the light beans (floating on top) from the heavy beans which sink to the bottom.
8. Make sure the pulper is clean by removing all dirt inside including left-over rotten beans, and pulp. (Rotten beans from previous processing activities are called “stinkers” and cause the worst defects in the coffee’s taste). Quality and volumes of coffee received and processed must be checked (for quality) at all stages and documented (for records).
9. Records must be kept to follow-up on payment and operation costs.

10. Waste generated (solid and liquid) must be well managed to ensure no pollution occurs.

3.2.1.1 Wet Coffee Processing (Mild or Washed Arabica)

Wet processed coffee, often called washed processed coffee, is the least natural and most heavy-handed approach to processing coffee (TaCRI, 2011). The wet processing method strives to remove the fruit and all residual pulpy plant matter from the coffee cherry, leaving only the coffee bean (Banti & Abraham, 2021).

The wet method of processing coffee has several steps and requires different equipment including home pulper or central pulper units (CPU) as described later in this section. Depending on the type of machine, it may require substantial amounts of fresh water and several people to operate (Agriculture and Food Authority (AFA), 2022; Uganda Coffee Training Manual, 2014).

After being harvested, the coffee cherries are brought to be processed/pulped the very day they are harvested. After processing, the beans are fermented in fermentation tanks for 24-36 hours, until the mucilage can be easily washed off (The skin, pulp, and sugary mucilage layers are removed from the ripe coffee cherry, leaving the parchment layer still on the bean). The cleaned coffee beans are then taken for drying either in the sunlight or using forced-air drying, to achieve a final moisture content of about 10.5%.

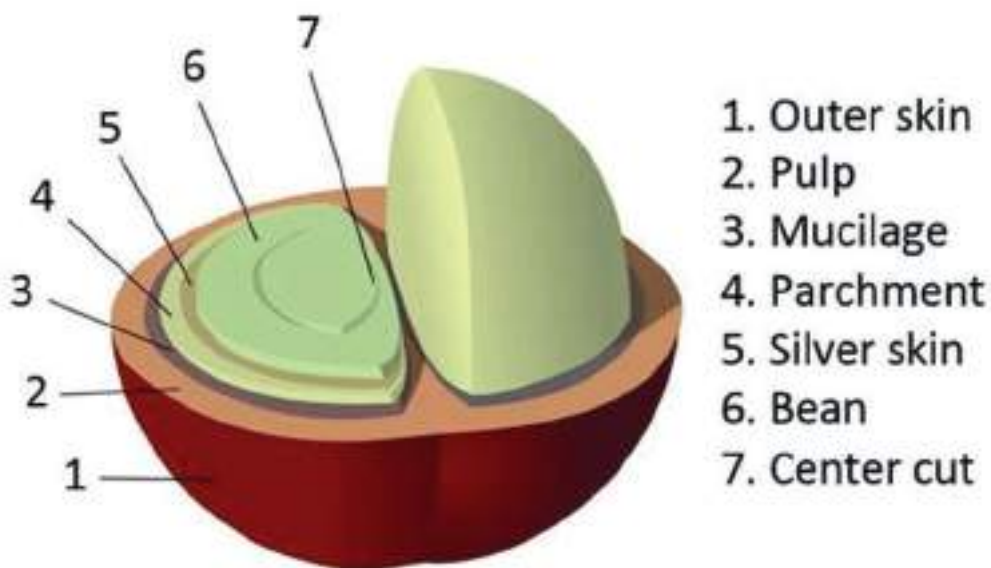


Illustration 37: Cross Section of a Coffee Cherry

3.2.1.2 Home Processing Using Hand Pulper Machine

Wet processing of Arabica coffee can be done using hand operated pulpers at home. This is not the most recommended method because coffee of different quality is produced by different farmers. Some farmers may process their coffee well while others use dirty water, do not clean the machine properly, and do not wash or ferment the pulped coffee enough. When coffee of varying qualities is bulked together for sale, the undesired characteristics of the poor-quality coffee affects the good-quality coffee, thus reducing its overall price (Ijanu et al., 2020; TaCRI, 2011).

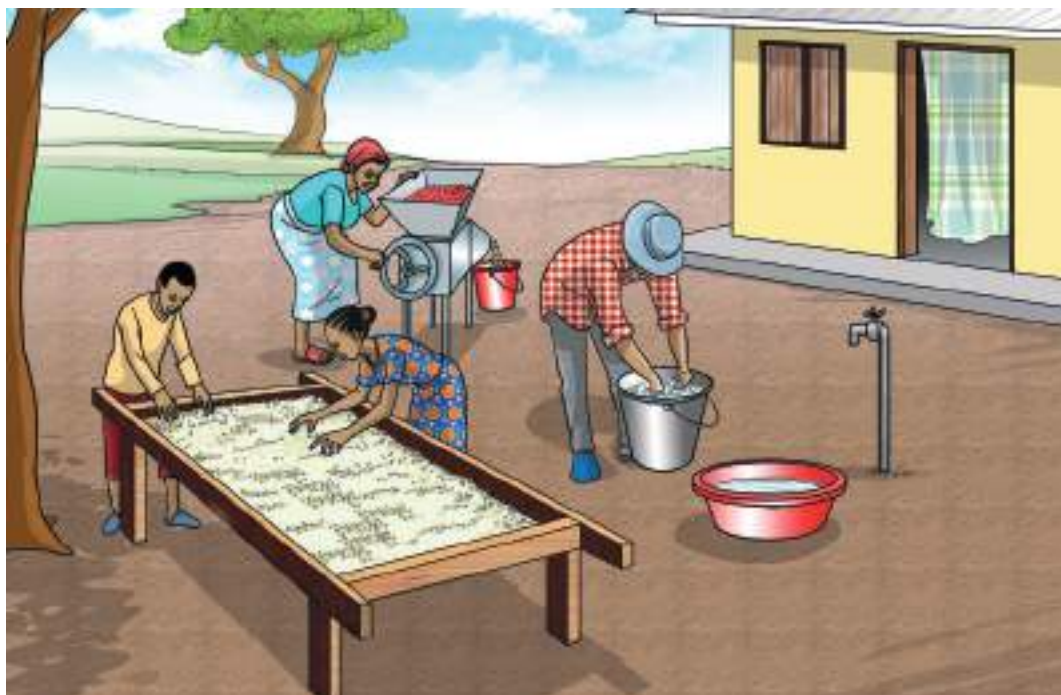


Illustration 38: Wet Coffee Processing at Home

3.2.1.3 Processing at a Central Processing Unit (CPU)

The preferred way of processing coffee using the wet method is to use a wet-mill, often at a central processing unit (CPU), where cherries from many farmers are processed collectively. The process is very similar to that of home processing; however, a wet-mill machine is bigger and therefore more efficient. Because coffee is processed together, a more uniform quality is achieved across a larger amount of coffee.

However, because it is operated by a diesel or electric motor, costs of production are higher. A CPU requires a team of people to manage the receipt of coffee brought by farmers and supervise the quality of the final product from beginning to end. This adds to the operational cost. Other costs arise due to the following requirements:

- Enough cherries must be collected to operate the machine.

- Farmers must deliver the harvested cherries to the pulping machine in good time and processing must start before the cherries ferment in their skins. (Good coordination of CPU supervisors is required).
- The pulping machine and other components must be well maintained to operate optimally and produce the best quality parchment.
- The wet method requires substantial amounts of good quality fresh water, and facilities to dry the processed coffee after fermentation.



Source: AWF/Paul Thomson

3.2.2 **Dry Coffee Processing Method**

Dry processing is a type of coffee processing that involves drying the freshly-picked coffee cherries (fruit) in the sun on large patios for a period of time while repeatedly raking and turning the drying cherries until the moisture content is between 11-12%. It takes about 10 to 14 days for the coffee to dry to this level.

Robusta is mainly processed using this method (TaCRI, 2016; Uganda Coffee Training Manual, 2014). Arabica produced in regions like Ethiopia where water is scarce continue to use this method, and because a small consumer segment (e.g. the Middle East) still pay a premium price for coffee produced in this way. In areas without good access to fresh water, it may be easier and cheaper to use the dry method.

The coffee processed through this method will have lower acidity and a heavier body.

The cup of a natural coffee holds brighter, fruitier flavours. The following guidelines are required during coffee drying:

- Parchment coffee must always be dried on raised wire trays or tables, at least one metre off the ground to avoid contamination from dust, plants, livestock, and dirt. Coffee should be dried in direct sunshine at the beginning (skin drying), after which it should be covered if the sunlight is strong. It must be turned frequently to ensure even drying.
- Cover drying coffee with rainproof material to prevent it from re-wetting and absorbing moisture at night, as this causes mould and affects the flavour of the coffee drink.
- Drying is complete when the parchment has reached a moisture level of 11-12 % as per Tanzania Coffee Regulations (2013). Farmers can measure this using a moisture metre. If no moisture metre is available, experienced farmers can use a knife or their teeth to cut the bean. The bean should be hard to bite or cut if it is properly dried (TCB, 2021).

3.2.3 Honey Coffee Processing Method

It's not about coating the beans with honey, despite what you might think! The honey process is a method in which coffee cherries are picked and sorted, and have their skins and pulps removed like other types of coffee, but they are then dried without washing off the sticky-sweet outer layer of the fruit.

Honey processed coffee, which is sometimes referred to as Pulped Natural, is somewhere in between the natural and washed processes. Unlike natural processed coffee, honey processed coffee removes some of the pulp from the cherry, allowing it to dry without washing afterward. Since some of the mucilage on the outside of the bean is left on, what remains is akin to honey. The more mucilage left, the darker the bean when it dries (honey black, gold or red). The less left, the paler the colour (honey yellow or white). Also, the more humid the climate during drying, the darker the bean will be. At the end of the process, the coffee will exhibit more body than the washed bean as well as sweeter flavours.

3.2.4 Coffee Storage for Primary and Secondary Processing

- Dried coffee must be stored in a well-ventilated and leak-proof room, on pallets at least 15 centimeters off the ground, and at least 30 centimeters away from walls and ceilings to prevent moisture that accumulates there.
- The coffee should be stored in clean and specifically approved bags, and not mixed with other products to avoid smell contamination. It should never be stored with agro-chemicals, oils, or fuels.

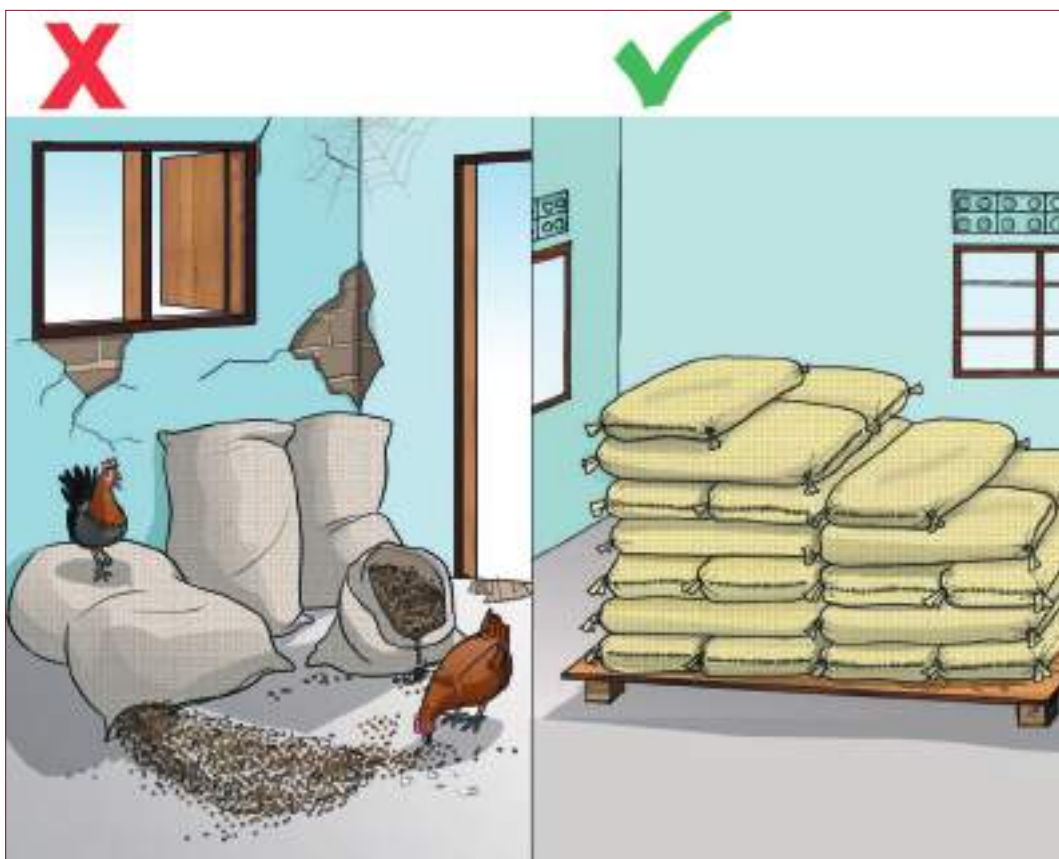


Illustration 39: Bad and Good Storage of Parchment Coffee

3.2.5 **Secondary Coffee Processing**

After primary coffee processing (wet or dry) is completed, the coffee beans are then taken to the second stage of processing known as secondary coffee processing. These final steps which are carried out at curing works involve removal of the husk or the parchment from the beans to obtain green coffee beans. These coffee beans are again packed and stored. This stage is comprised of number of stages including:

i. **Sample Testing**

The coffee received in bags is tested in samples to determine its quality, the percentage of different grades, to check for defective beans and to assess moisture content.

ii. **Re-drying**

The moisture content of the dried coffee should be 12%. However, if it is under dried, it should be dried again in open areas on concrete floors to the prescribed moisture level that facilitates easy milling and increases the shelf life of coffee.

iii. Cleaning

The coffee is passed through screens to separate it from twigs, leaves, etc. Then it is rolled on conveyor belts where a continuous stream of air flows blows the coffee beans to one side and heavy particles like stones, pebbles to the other side.

iv. Milling

This is the process of removing the dried husk or the parchment from the processed coffee. The parchment coffee, obtained from the wet processing of coffee, has the parchment and the silver skin. The parchment is removed by peeling and the silver skin is removed by polishing. This gives a clean appearance and limits the amount of chaff produced while roasting the coffee. The cherry coffee, on the other hand, is processed in a method known as hulling. The cherries are directed into a huller where the dried husk is removed.

v. Winnowing

This is done to remove all the bits of pulp and skin from the coffee. The coffee that is winnowed is called bulk coffee.

vi. Grading

The bulk coffee is graded based on size, shape and density. Various machines are used to grade the coffee like drum graders, PB (peaberry) band separators and gravity separators.

3.2.6 Tertiary Coffee Processing

The tertiary coffee processing is the final stage which involves the coffee tasting process, coffee roasting, coffee grinding and packaging.

3.2.6.1 Coffee Tasting Process

The packed coffee is repeatedly tasted to additionally check and define its taste and quality. The process is called cupping and it takes place in a special room designed to enhance it. Tasting helps people to tell where the coffee is from. The process shouldn't intimidate you; anyone can take part in it. It involves gurgling coffee to the back of your mouth and identifying which flavor it is. The process is quite similar to a wine tasting event. Some of the terms tasters use are:

- **Acidity:** Acidity describes the level of acidity of coffee. High acidity coffee is thought to be of a higher quality. Low acidity coffee is usually called sour.
- **The body and aftertaste** are other terms used to describe the coffee. The 'body' refers to how the coffee feels in the mouth – for instance, it may feel heavy or extremely light. This quality is, to some extent, constant and does not depend on individual tastes.

3.2.6.2 Coffee Roasting

Unroasted coffee is also known as green coffee and such beans have all the flavors locked in them. Roasting seeks to transform the green coffee into the aromatic brown beans you buy in your favorite stores. Roasting is carried out at temperatures of approximately 550°F during which time the green coffee beans are turned continuously to avoid burning. Green beans are first dried until they become yellow and develop a roasted smell. Once the beans register an internal temperature of 400°F, the step called 'first crack' happens during which the beans double in size and start to turn light brown. After that, as the temperature continues to rise, the colour changes to medium brown and a fragrant oil (caffeol) starts to emerge.

3.2.6.3 Types of Coffee Roast

There are different types of roasts – light, medium and dark – and within these roasts each has a few levels:

- Light roasts do not produce any oil on the surface of the coffee beans. Beans are light or a moderate light brown colour.
- Medium roast beans are a medium light to medium brown colour and are developed during the first crack.

Note:

Whenever possible, roasting takes place close to where the consumer is. This is because when beans are roasted, they begin to lose their good quality immediately.

Home roasting is another popular alternative. Some cafés usually offer their customers coffee roasted on site. However, to become an expert home roaster, one will need some training. It is not very expensive, and it can be learned quickly.

3.2.6.4 Coffee Grinding

The primary goal of a grind is to produce the most flavor in a cup of coffee. The type of coffee brewer used determines how fine or coarse the coffee should be ground. The type of grinding determines how fast the coffee can release its flavors. This is the reason espresso coffee is so finely ground. On the other hand, coffee prepared with filter coffee makers is coarse-grained (coarsely ground).

3.2.6.5 Packaging

Coffee packaging is very important, as any exposure to air could turn the coffee into a lump. This is especially the case for ground coffee, which can quickly lose its flavor if exposed to air. This is the reason why coffee is usually packed in airtight containers and should be resealed carefully when not in use.



3.3.1 Environmental Issues

Wet processing, especially at a wet-mill, produces notable volumes of pulp and waste water (Coffee & Climate, 2021; Global Coffee Platform (GCP), 2022). Water pollution from wet coffee processing is a significant negative externality. The mucilage and residual water are predominately organic-biological in nature; they rapidly ferment to produce organic acid, which lowers the pH eutrophication of receiving water bodies, give off malodors that affect those who produce coffee and those who live in the surrounding community, and make streams and rivers quite unsuitable for domestic use. These must be well-managed in order to prevent environmental pollution, health hazards and nuisance to the community surrounding the wet-mill.

Management of Waste from Coffee processing

The management of the wet-mill must take special steps to ensure all waste generated is contained and properly processed before releasing it into the surrounding environment. For example:

- When pulp is removed from wastewater and dried separately, it can make a valuable mulch.
- The pulped coffee husk can be used to make organic fertiliser and used by farmers surrounding coffee farms as organic fertiliser.
- Likewise, if wastewater is passed through a simple gravel, sand, and vegetation filter, it can be re-used for irrigation or let to soak into the ground to create humid soil conditions.

The National Environmental Management Council (NEMC) of Tanzania requires all industries generating waste to meet certain criteria to ensure environmental safety (URT, 2021).

3.3.2 Social Issues

The role of the coffee process industry is important to sustainable development of socio-economic natural systems in the area.

Apart from risks to coffee quality, the size and complexity of a motorized machine also poses a risk of injury. Pulping machine operators must be trained in using the machine properly, and they must take safety precautions at all times. Exposed moving parts of the machine must be guarded, to prevent potential risk of injury. All risks of fire must be mitigated, and workers must be prepared (through necessary skills and equipment) to deal with a potential outbreak of fire.

The Occupational Health and Safety Act, enforced in 2003, requires all workplaces to secure the safety, health, and welfare of persons at work. Rules and regulations about workers' safety and welfare as stipulated by Tanzanian Law must be maintained as a minimum.

Coffee processing as a step of value addition is a good opportunity for engaging women and youth in the coffee value chain. Young people may be keener and more capable of engaging as service providers in coffee as they are better equipped to keep up to

date with advances in technology and access to market intelligence. Moreover, coffee produced and marketed by women has a special market and receives extra attention and support on a global scale.

3.3.3 References and Further Reading

Agriculture Training Manual A Resource Manual for Trainers: FiBL, Research Institute of Organic Agriculture, Switzerland, www.fibl.org

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Rudy Caretti, (2016). The process of coffee production: from seed to cup. <https://www.newfoodmagazine.com/article/28006/process-coffee-production-seed-cup/>

TaCRI. (2011). *Kanuni za Kilimo Bora cha Kahawa – Kahawa ya Arabika, Moshi Women in Coffee Initiative*, <http://www.womenincoffee.org/>

Uganda Training Materials for Coffee Production (2014): Training Manual First Edition 2014

Chapter Three Lesson Plan

Lesson Objectives:

- Understand how harvesting practices impact the quality of coffee
- Understand the main aspects for ensuring coffee quality throughout primary and secondary processing
- Introduce social and environmental issues related to coffee processing

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)
- Posters
- Tins, sack, mat
- A coffee farm that is ready for harvesting
- Coffee cherries of different levels of ripeness
- Equipment for processing coffee at home (hand pulper, tins, water, drying tables etc.)

Key Points to Share:

- Harvesting cherries correctly preserves the quality of the final product.
- Uniform ripeness of harvested cherries provides batches of green coffee that have uniform quality.
- The processing of coffee must suit specific market requirements.
- Quality achieved in the field can be lost during processing, so great care must be taken to ensure proper procedures are followed to reduce this risk.
- In collective selling, it is not enough for only a few farmers to attain good quality because cross contamination spoils the entire bulk, thus reducing prices for all farmers.
- Processing, as part of value addition to coffee, can greatly benefit from the engagement of women and youth.

| Topic | Topic Objectives | Training Activities |
|-------------------------------|--|--|
| 3.1 Good Harvesting Practices | <ul style="list-style-type: none"> • Understand how to harvest coffee for best quality and price • Understand the importance of uniform ripeness and how this affects coffee quality | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 3.1. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Demonstration and Practice Visit a coffee farm that is ready for harvesting and demonstrate how to selectively hand pick only red-ripe cherries. In groups, ask participants to practice the harvesting practice you demonstrated. Point out and discuss any mistakes farmers make.</p> <p>Sorting Practice and Discussion In groups, ask participants to pour their harvested coffee cherries onto a mat. Have them remove any unwanted materials (debris, stones, etc.). Have them sort the cherries into groups according to colour (green, yellow, red, black). Discuss the importance of this sorting for quality and prices.</p> <p>Calculating Harvesting Losses After each group has sorted their coffee, examine together the proportion of each group's undesired cherries (under- and over-ripe, defected coffee, etc.). Calculate (using weight or volume), the proportion of undesired coffee to desired coffee for each group. Discuss what impact this will have on their incomes (for example if they accidentally harvested a lot of undesirable cherries, their current and future incomes will be impacted). Use this as an opportunity to reemphasize the importance of careful handpicking to reduce yield and income loss.</p> |

| Topic | Topic Objectives | Training Activities |
|-----------------------|---|---|
| 3.2 Coffee Processing | <ul style="list-style-type: none"> • Understand different ways of processing coffee depending on the type of coffee and its market requirements • Understand wet coffee processing at home and at a CPU including the factors affecting quality • Recognize the practices coffee farmers should follow after harvesting, and during processing, drying and storage to ensure quality | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 3.2. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Experiment Dissect coffee cherries of different levels of ripeness and observe how they are formed. Pay particular attention to the thickness of the skin, and the size of the bean. If the coffee has not been recently sprayed, have farmers taste the different cherries to determine sugar levels.</p> <p>Experience Sharing Ask participants to share their experiences with dry processing, wet processing, and/or the honey process. What methods and equipment did they use? What was the result? Would they change anything about their usual processing techniques or equipment?</p> <p>Group Discussion Discuss how home and at a CPU wet processing can be done including the factors affecting quality coffee during processing.</p> <p>Farm Visit Visit a farmer who does wet processing at home. Discuss what good practices he/she takes when processing. Ask the farmer to demonstrate their processing procedure.</p> <p>CPU Visit If possible, visit a CPU to see how coffee is wet processed using a wet-mill machine. Discuss each of the good practices that are taken when processing. Ask participants to identify any areas where quality might be affected during the process.</p> <p>Group Discussion Discuss the prevailing methods for drying coffee in your region, and how quality might be jeopardized by poor processing practices. What better practices should be used instead?</p> <p>Farm Visit Visit a farmer who does dry processing at home. Discuss what good practices he/she takes when processing. Ask the farmer to demonstrate their processing procedure including sorting, turning and covering the coffee.</p> |

| Topic | Topic Objectives | Training Activities |
|---|---|--|
| | | <p>Processing Center Visits Visit a secondary coffee processing center or collect different samples for demonstration. Then visit a tertiary coffee processing center or prepare different samples for demonstration. This is very vital for those interested in value addition and promotion of domestic coffee consumption.</p> <p>Storage Visit Visit a good storage room/warehouse for coffee. Ask participants to make a list of the good qualities they noted in the storage (clean, dry, coffee stored off the ground, well-ventilated, etc.)</p> <p>Experience Sharing Ask participants to share the process they use after harvesting, during processing, during drying and during storage to ensure good quality and prevent losses. Is there anything they can improve? How can improving their practices improve their incomes over the long-term?</p> |
| 3.3 Social and Environmental Aspects of Coffee Processing | <ul style="list-style-type: none"> Understand the environmental, social and sustainability issues farmers should be aware of during processing | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 3.3. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Group Discussion As a group, discuss the importance of taking care to follow environmental safety standards during coffee processing. How does this ensure coffee sector sustainability over the long-term?</p> <p>Group Discussion As a group, discuss what social issues they take into consideration when it comes to coffee processing. What do they do to ensure they, their families and their workers stay safe during processing?</p> <p>Group Discussion As a group, discuss the benefits of involving women and youth in the coffee sector, especially during processing. What advantages or skills do women and youth bring to the table?</p> |

CHAPTER FOUR





Coffee is a global commodity, and its price is determined by forces in the world market. Prices are determined by complex functions of production and demand of coffee on a global scale, which affects the price. The quality of coffee produced by farmers determines the price they can ask for it.

Producers can establish the quality of their coffee by taking samples to a TCB representative or trader in their area. When they know the quality of their coffee, farmers can gather information on prices offered by different buyers to get the best market for their coffee.

Farmers can get this information through their farmer association, TCB indicative prices, or coffee marketing service providers in their area.

4.1.1 Arabica Coffee Quality

After parchment processed through the wet method has dried to the right moisture content (11 to 12%), it is brought to a “dry mill” to have the parchment skin removed to get “green” or “clean” coffee. Normally, the husk removed comprises 18% to 21% the weight of parchment coffee (this is also called “milling loss”). The green beans are then graded according to weight and size. Defective beans are also removed at this stage. Special machines (Triage) use air to separate the lighter beans from the heavier ones. Heavier and more dense beans fall into the top grades and result in lower milling losses.

Arabica green beans are separated according to their size into grades as shown in Table 13.

Table 14: Grades of Clean Arabica Coffee

| Grade | Descriptions |
|----------|--|
| A/AA/AAA | Heavy, solid beans according to size, with A the biggest and C the smallest |
| B | |
| C | |
| PB | “Peaberry” are beans that are fully formed and heavy but in which the cherry has developed into one instead of the usual two beans |
| E | “Elephants” are mis-formed beans that have two parts closely fitting into each other and separate when the bean is roasted |
| TT/AX | Light beans removed by the air blaster, called “Triage” - TT are heavier than TEX |
| TEX | |
| HP | Defective beans which have been removed by hand picking |

The A, B, C and PB are the top-grade coffees that fetch the best prices. The rest are low grade coffees used in blending and making coffee products for which the special taste of coffee is less important.

Large heavy beans can only grow on trees that are well-nourished and cared for. Application of GAPs and consistent soil nutrition can secure good quality beans harvest after harvest. Refer to Chapter 2 for details on this.

An “outturn report” summarizes the proportions of coffee beans falling into each of these grades by weight. It determines the proportion of coffee that can be sold at better prices during marketing. The more coffee that falls into the higher grades, the better the income for the farmers.

The final stage of grading coffee is called “classification” and it involves roasting and tasting samples of the graded coffee to determine taste. This work is done by liquors and requires expert knowledge of coffee and many years of experience. Farmers can seek advice from Tanzania Coffee Board (TCB) about the quality of their coffee to enable them to seek the appropriate market for it.

4.1.2 Hard Arabica and Robusta Coffee Quality

The quality of hard Arabica and Robusta coffees is determined following criteria for the types and magnitude of defects, the colour, size, and smell of the green beans.

The Coffee Act Regulations of 2013 categorizes Robusta coffee into the following grades, whose decisions are subject to these regulations:

1. Robusta over Screen 18
2. Superior
2. Robusta Fair Average Quality (FAQ)
3. Ungraded (UG) Robusta
4. Robusta Triage

4.1.3 Defects in Coffee

Coffee defects refer to any unwanted characteristic or defect that negatively affects the taste, aroma or overall quality of coffee.

The international coffee price, particularly on the commodity market, is based partially only on the number and type of defects found in a sample of about 300 grams of coffee. But what are these defects that we can find in coffee? Can we taste them (and if so, how) in the cup? And in which coffees do we mainly find them?

Defects in coffee occur both in the field and during processing. Their presence reduces the quality of coffee, and subsequently the price that farmers can get for it. This is why every stage of coffee production is so important. The most common defects are:

4.1.3.1 Defects Caused at the Farm

If the coffee tree did not receive sufficient nutrients, or was attacked by diseases or insect pests, the coffee tree will be weak and cannot produce good fruit. Similarly, if coffee is inter-cropped with competing crops in the field or was allowed to overbear and does not receive sufficient nutrients, the berry cannot develop in size and flavor. These factors affect the appearance of the harvested coffee and the taste of the brewed coffee.



Black beans (caused by fungus attack)



Insect pest damage (caused by CBB)



Insect pest damage (caused by CBB)



Malformed bean (caused by lack of water and nutrients)



Shells (caused by variety selection or growing conditions)



Floaters (caused by improper drying and storage after harvest)

4.1.3.2 Defects Caused at Harvesting

If the coffee cherry was picked too early (under-ripe) or too late (over-ripe), the sugars and other properties will not have developed properly or be in the right proportions. Harvested coffee should not be stored more than eight hours prior to processing as this too can destroy its quality when uncontrolled fermentation starts within the berry. Harvested cherries should be transported carefully to prevent damage and contamination from dust, rain, fuel and oil fumes, which can cause the coffee to adopt a different smell, taste, or colour.

4.1.3.3 Defects Caused During Processing

The cherries may be damaged in the machine during primary processing or contaminated by rotten beans stuck in a machine that was not properly washed. Clean your machine properly before and after use.

Beans can also be damaged by poorly controlled fermentation and using dirty water. If drying coffee is re-wetted or stored before it is properly dry, it will grow mold. This affects the appearance of the bean and taste of the brewed coffee.

Stinkers are caused by bad fermentation, and when the pulping machine and fermentation vessels are not properly cleaned before they are used to process beans. Beans acquire an earthy taste when they have been dried directly on the ground, and tainted beans are those that have been affected by smells during drying, storage and transportation. Stinker, earthy and tainted beans all produce bad smells and taste in the coffee brew.



Broken / chipped beans (caused by improper setting of pulping machine)



Moldy / fungus damaged beans (caused by improper drying and storage in damp conditions)



4.2.1 Introduction to Marketing

This section introduces the concept of marketing. Marketing is a social process by which individuals, groups, and institutions satisfy their needs through the creation and exchange of products and services. Marketing means understanding the needs and wants of your customers and supplying these to them at a profit. Marketing comprises a series of services involved in moving a product from the point of production to the point of consumption.

The marketing process must be customer-oriented. It is a commercial process, which must provide goods and services at a profit to stay in business. It is a dynamic and continuous process (it is not a one-time job), and it is needed not only at the time of starting up the business but also during its diversification. The entrepreneur or agro-processor must be aware of the market's changing needs and respond accordingly.

Marketing is different from selling. While selling, a farmer enters the marketplace with little thought or knowledge about the market. However, marketing requires a more deliberate strategy whereby farmers plan what they produce based on some knowledge of what consumers want. Marketing therefore involves: 1) Identifying buyers; 2) Understanding what buyers want in terms of products and how they want to be supplied; 3) Operating a production-marketing chain that delivers the right products at the right time; and 4) Making enough profit to continue to operate.

Marketing is a series of inter-connected activities. All these activities are linked in the production-marketing chain. These activities include:

- Planning production
- Growing and harvesting
- Standardization and grading of products
- Packing, transporting, storage, processing, distribution and selling
- Financing and risk bearing
- Sending information from production area to market (e.g., products/volumes available) and from market back to producing areas (e.g., prices and supply levels, consumer preferences and changes in taste)

4.2.2 Coffee Marketing System

Different markets have different preferences. It is important that farmers research and compare different markets so that they can make the right decision about where to sell their coffee at the best price for the particular qualities they produce.

Generally, all coffee of the same grade and class is packed together (bagged) for marketing and shipment. When a farmer association does not produce sufficient quantities, their coffee is bulked with that of other producers.

Producers and exporters of coffee should therefore inform themselves of where their coffee is most desired and tailor the quality to the requirements of the buyers.



Illustration 40: Farmers Must Obtain Information about Where and How to Sell Their Coffee

4.2.2.1 Farm Gate

This channel allows a farmer to sell coffee to a licensed coffee buyer in either cherry or parchment form. This transaction must take place at a buying post established by the licensed buyer, or with their agent in the farmer's village. Farmers are strongly advised to use these buying posts as they allow healthy competition and good price discovery. Always refer to a TCB Officer in your zone for details on laws and regulations.

The value of coffee increases with every processing step it undergoes. Individual farmers or weak farmer associations may be limited to selling coffee at farm gate because they cannot afford or have access to processing facilities. But some strong individuals and farmer associations exist which get higher prices for their coffee because they can sell it in a more usable form.

Coffee sold at farm gate is sold in local currency and is therefore subject to the local economy.



Illustration 41: Farmers Selling Coffee at a Buying Post

4.2.2.2 The Coffee Auction

Decentralized Coffee Auction

The TCB, as the main agency for marketing Tanzanian coffee, organizes the National Coffee Auction, which allows international and local coffee traders to bid for coffee that they have a market for within and outside Tanzania.

The green coffee traded at the Auction is sold in United States Dollars (USD) and is subject to the reference market in New York, whereas Robusta dry cherry at the Auction is sold in Tanzanian Shilling and is subject to the reference market in London. This means that prices are determined by world supply and demand for coffee, and not controlled in Tanzania.

Suppliers of coffee to the Auction are PCBs (private coffee buyers), cooperatives/AMCOS, farmer groups and estates. Arabica and Robusta green coffee of all grades is packed in 60kg bags (prices are set for units of 50kg) according to different producers, grades, and classes for trade at the Auction every week from July to March.

Coffee producers can attend the coffee Auction in Moshi, Mbozi, Mbinga and Kagera to observe how their coffee compares to other coffee produced in the country in terms of quality and price. Farmers are encouraged to visit the Auction to observe how Tanzanian coffees are traded and learn how price and quality are interlinked. Prices at the National Coffee Auction have consistently competed with those of the world coffee market.

Registered farmer associations can sell their green coffee through the National Auction if they meet the following requirements, laid out in the Coffee Regulations of 2013. The association:

1. Must collect coffee from its members for the purpose of marketing, adding value to it, etc.
2. Must collect at least 50 tons of parchment to produce economically tradeable volumes of green coffee after hulling and grading. Moreover, significant volumes of green coffee are sent as samples to the auction and buyers.
3. Must comprise of members who have common goals, and cannot comprise of family members, and must be confirmed by the village government and District Authority that it truly is a farmer association.
4. Must obtain a permit to sell their coffee on the Auction, and its validity is only for the period specified.
5. Must have an office from which all its operations are conducted.

Farmers selling their coffee on the Auction must have a good understanding and management of financial matters. An understanding of exchange rates is important. They may need a USD account, thus increasing their administrative cost. In addition, marketing and management skills are needed to acquire the right permits and export documents, to set reserve prices, and deal with other issues at this level.

Online Coffee Auction

This is done electronically using internet whereby the buyers can buy the coffee anywhere. It does not need physical presence at the Auction area.

4.2.2.3 Direct Export

Green coffee of the best quality (i.e., grades A to C for Mild Arabica and grades FAQ to Above Screen 18 for unwashed Arabica and Robusta – refer to sections 4.11 and 4.12) can be exported directly to international buyers without being traded through the National Auction. A special Direct Export license for this must be obtained from TCB. Farmer associations that have such a market should seek advice from TCB on procedures for direct export.

Direct export requires a strong relationship between producers and their buyer. These relationships can provide long-term profitability to the farmers, and requires good organization, leadership, and communication skills to be maintained. Moreover, producers must supply consistent quality and volume to build a reputation and develop a brand for their coffee.

To protect the interest of farmers, direct export contracts must be registered by the Tanzania Coffee Board to ensure farmers receive the best market price.

Farmer associations must also arrange the logistics of exporting the coffee. This includes bagging, storage, transport, and shipping of the coffee according to international

standards and requirements by TCB and the buyer. If a marketing agent is hired, producers must ensure the after-contract services of the marketing agent safeguard the quality of coffee until it reaches the intended buyer.

Direct relationships with buyers require farmer associations to increase their marketing, communication, financial and management skills (i.e., price fixing, contract writing, negotiation, etc.). In addition, they must maintain a high level of integrity to fulfill their contractual obligations and build and sustain such marketing channels. This means, for example, that the sale must proceed even when prices at the National Auction exceed prices agreed and set in direct export contracts. Breaching such agreements ruins farmers' reputations and opportunities for dealings with direct export markets.

4.2.2.4 Specialty Coffee Market

Specialty coffee refers to the highest quality coffee available, usually involving the entire supply chain and using single origin or single estate coffee. On the 100-point Coffee Review scale, specialty coffee is described as coffee that receives 80 or more points. Specialty coffee is coffee of outstanding quality both farmed and brewed to a substantially higher level than the norm.

i. Specialty-grade Coffee

It has been reported that the 85-89.99 grade segment has dominated this market with there being a large market share in the world. However, this represents a small percentage of the total volume of coffee produced around the world. For coffee to be classified as specialty grade, it must score higher than 80 points on the Specialty Coffee Association's 100-point scale. However, alongside this, several other factors have come to be "associated" with specialty coffee and are becoming increasingly prominent. These include more of a focus on transparency and traceability in the supply chain.

ii. Certified Coffee

The coffee which is produced under a sustainability standard (i.e., Fairtrade, Utz, Rainforest Alliance, Organic, etc.) are referred to as specialty coffee. In most cases, such standards focus on fair prices for producers, social and economic improvement, environmental protection, and the rights of farmers or workers in the sector. The coffee produced under a sustainability standard might not necessarily have higher grades as described in the above sections.

iii. Niche Market

A niche combines a set of conditions that enable a single species or a single product to thrive within the greater ecological or commercial environment. Much of global coffee production consists of mainstream type coffees. However, there are many other coffees, often of limited availability, with greatly varying taste characteristics that appeal to different groups of consumers, and which sell at a premium over mainstream coffees. Simply put, where the producers or exporters of such a coffee and such a group of consumers get together, a niche market is created.

Two main factors determine whether a coffee can find a niche market: quality and availability. 'Availability' is easily understood, but 'quality' is a subjective term which means different things to different people.

4.2.3 Coffee Price Determinants

Prices for coffee, at the Auction or for direct export to international buyers, is largely determined by the uniformity of the volume of quality of the green beans.

4.2.3.1 Volume of Coffee

The amount of coffee available on the market determines the price at which producers are willing to sell or buyers are willing to pay. This is commonly referred to as supply and demand. When more coffee is available, there is more competition to sell it and prices drop. However, when supply is low, farmers can negotiate better prices with buyers as they try to meet their demand.

4.2.3.2 Quality of Coffee

Better quality coffee fetches a higher price than poor quality coffee that may be full of defects which affect its taste and smell. To obtain and preserve uniform quality from the moment the coffee leaves the farm until it is bought at the best possible price, coffee farmers must ensure good harvesting practices. Poor farming practices, harvesting and post-harvesting handling are the stages that can destroy coffee quality.

4.2.3.3 Market of the Coffee

The price of coffee can be influenced by the fluctuations in foreign currency exchange rates, which are part of the cost of marketing; development of a niche market that requires a specialty or certified coffee; the relationship between producer and buyer; and the competence of the person or agent to bargain the best price for a particular coffee quality. The volume can also help to influence price.

Chapter Four Lesson Plan

Lesson Objectives:

- Understand how the quality of both Arabica and Robusta coffee are determined from the market perspective, as well as the price implications for different grades
- Introduce the main means of marketing the coffee of Tanzanian producers

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)
- Posters
- Samples of coffee of different qualities/grades for demonstration

Key Points to Share:

- Factors determining coffee price are primarily: quality, marketing skills and market access of farmers and farmer associations.
- In case a marketing agent is used, producers must ensure that the services provided ensure quality of coffee is maintained and the best possible price is sought.

| Topic | Topic Objectives | Training Activities |
|-------------------------------|---|---|
| 4.1 Coffee Quality Assessment | <ul style="list-style-type: none"> • Understand the basic characteristics of coffee that determine its quality | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 4.1. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Group Discussion Discuss farmers' understanding of "coffee quality". What do they consider to be good or poor-quality coffee and how do they "measure" or determine this? Do farmers consume coffee themselves? What do they consider to be a good coffee brew? What should it taste like?</p> <p>Coffee Quality Demonstration Bring samples of coffee of different qualities. Show participants each sample, ask them to guess its grade and then reveal its grade. Then ask farmers to comment on which grade(s) of coffee they produce. Why do they aim to produce this grade? Who are their potential customers?</p> |

| Topic | Topic Objectives | Training Activities |
|------------------------------|--|--|
| | | <p>Guest Speaker If possible, ask a Mild Arabica coffee grader to visit the group and discuss the process of grading coffee. What advice does he/she have for farmers for ensuring that they produce the highest quality coffee they possibly can?</p> |
| 4.2 Coffee Marketing Systems | <ul style="list-style-type: none"> • Understand the basics of coffee marketing • Understand channels for selling coffee in Tanzania • Understand factors that influence how coffee prices are set | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 4.2. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Group Discussion Discuss farmers' participation in the marketing of their coffee. Who do they leave this task to and are they aware of the skills and knowledge required to market coffee?</p> <p>Experience Sharing Ask farmers to share how they usually sell their coffee. Why do they sell it via this channel? What are the advantages and disadvantages? Could they make more money selling via a different channel? What is holding them back from doing this?</p> <p>Group Discussion Discuss how farmers learn about coffee prices each season. Discuss how coffee prices change throughout a single season. Discuss how this affects profit or loss to producers of coffee. Discuss what farmers can do to overcome fluctuating coffee prices.</p> |

CHAPTER FIVE





5.1.1 Introduction

Coffee has always been connected with emotions and opinions, so the debate about socioeconomic aspects of coffee production is decades old already. One regular topic, especially in times when coffee prices are low or when there is political turmoil in coffee producing areas, is the working and living conditions of coffee farmers and workers on coffee plantations.

5.1.2 What is Sustainability?

Sustainability has been defined by some as ‘meeting the needs of the present generation without compromising the ability of future generations to meet their needs’. It can then be further defined in environmental, economic, and social dimensions with biodiversity perhaps as the key measure of environmental sustainability in the natural world (Global Coffee Platform (GCP), 2022).

Sustainability in itself, of course, does not need the guarantee of a certification or verification. Often, producers are already improving performance and efficiency significantly through the use of good agricultural practices (GAP) and/or good management practices (GMP).

Voluntary Sustainability Standards (VSS) are voluntary, private standards that require products to meet specific economic, social, and/or environmental sustainability metrics. The requirements can refer to product quality or attributes, but also to production and processing methods, as well as transportation and transparency.

VSS are mostly designed and marketed by non-governmental organisations (NGOs) or private firms and they are adopted by actors up- and down-stream of the value chain, from farmers to retailers. Certifications and labels are used to signal the successful implementation of VSS.

5.1.3 Coffee Certification

Certification guarantees (through a certificate) that specific rules and regulations of voluntary standards are met in a certain environment (i.e., individual producer, producer group, cooperative or even region).

These producers must meet certain requirements – social, economic, environmental – and certification calls for independent third-party confirmation of this status, conducted by an accredited auditor. Mostly, certifications must be renewed on an annual basis.

Roasters buying certified coffee benefit from the guarantee provided by the certificate and by using the logo and related information on their retail packaging. Certification protects both buyer and supplier, often also resulting in better marketing opportunities because there is a specific demand for certified products.

5.1.3.1 Coffee Verification

Verification also ensures that certain agreed criteria and practices are met, but does not use a certificate to market the claim to the final consumer. Instead, company standards or internal supply chain standards rely on verification processes that are not as rigid and costly as a certification process that must be conducted by appointed auditors. Instead, local third-party actors such as NGOs – or even second-party actors – may be asked to verify adherence to specific criteria. In addition, the timing between repeat verifications may be significantly less onerous than an annual re-certification process.

In the coffee sector the most prominent example of a verification scheme is the 4C Association – the Common Code for the Coffee Community. 4C offers guidelines for better coffee farming that link up with GAP and GMP, while aiming at continuous improvement. The claims 4C makes are therefore not as specific as those of certification schemes and it refrains from using an on-pack (retail) logo.

5.1.3.2 Why Certification and Verification?

The global market of certified coffee has increased due to growing dynamics of coffee consumers with different tastes and preferences. The certification and verifications standards were introduced in order to differentiate between coffee produced by following good agricultural practices only, and coffee produced along certain criteria that guard the social, environmental, and economic interests of the producers and their land (Global Coffee Platform (GCP), 2022). This is because they take into consideration specific requirements that consumers may have, such as organic production and fair price for producers.

5.1.3.3 Certification Programs

There are many certification programs with different objectives, but generally they all share the following features:

- i. Certification provides economic incentives to farmers. (Distributors pay premiums for certified coffee, giving farmers more income).
- ii. Because certification guidelines are satisfied during production, the way a coffee is produced is being certified.
- iii. Before a coffee is certified it must be verified by an inspector from an independent certification agency. Farmers or farmers' associations can pay for an inspection.
- iv. The certification process is voluntary for farmers.
- v. These producers must meet social, economic, environmental, and administrative requirements laid out by the specific standard.
- vi. Farmers must be well-organised, maintain records and practice traceability and transparency.
- vii. A minimum level of literacy is also necessary to understand and meet the requirements.
- viii. The level of conformity is confirmed through an audit carried out by an independent accredited body.
- ix. A successful audit results in a certificate which in most cases must be renewed every one to three years.

5.1.3.4 International Coffee Certification and Verification Programs

i. Fairtrade

Fairtrade is an approach that aims to improve the market access and strengthen the organization of small producers. This approach also seeks to improve the livelihood of these producers by paying them fair prices and providing stability in trade relationships. Fairtrade certification is only given to farmers' associations and cooperatives rather than individual farmers.

ii. Rainforest Alliance/UTZ

Rainforest Alliance-certified coffee is grown on farms located where forests, soils, rivers, and wildlife are conserved. Furthermore, workers are respected and paid decent wages, have safe working conditions, and have access to education and medical care. This coffee must be grown under tree's shade.

iii. Starbucks C.A.F.E

Coffee and Farmer Equity (C.A.F.E.) ensures that Starbucks' coffee is sustainably grown by evaluating the economic, social, and environmental aspects of its production.

iv. Common Code for the Coffee Community (4C)

The Common Code for the Coffee Community, or 4C, addresses social, economic, and environmental standards for everyone involved in coffee production—from farmers to exporters. 4C-verified coffee is primarily found in Europe but is expanding to United States' markets.

Because there are so many options available, it is important for customers to keep their price limit and priorities in mind before choosing a certified or verified coffee. They should visit the websites of various certification programs to ensure they are paying for a product that falls in line with their concerns.



5.1.4 Primary requirements for certification and verification

5.1.4.1 Environmental Sustainability

Environmental sustainability relates to the preservation of ecosystems. It also aims to have environmentally friendly coffee production that reduces the impacts of coffee production on biodiversity and the environment. Sustainable farming practices are critical in the effort to support the environment in a positive way. Coffee farmers can protect the environment through:

- **Practicing selective pruning with natural shade canopies** so farmers can grow stronger trees that produce additional crops in subsequent years.
- **Avoiding the use of banned agro-chemicals.** The list of banned chemicals is realised by Tanzania Ministry of Agriculture every year and trainers must be updated with this and share the list with farmers. This will help farmers to avoid using banned agro-chemicals (URT, 2020).
- **Planting alternative crops, such as banana trees.** When grown alongside Arabica coffee, this creates shade coverage that provides numerous benefits.
 - Tall trees promote biodiversity by creating a healthy plant and animal habitat for birds, bees, and small animals.
 - A single coffee plantation is capable of supporting hundreds of species of beneficial plants and animals that in turn support the ecosystem.
 - The presence of a strong ecosystem has proven to decrease the population of crop-damaging insect pests as well as decrease reliance on chemical pesticides and insecticides.
 - However, farmers should avoid cultivating in protected areas or a special areas of conservation.
- **Preventing water pollution.**
 - Clean water is critical for maintaining a healthy ecosystem. Farmers are supposed to avoid washing their coffee in rivers and should instead wash coffee using containers away from a water source. They should spray their coffee farms away from a water source or residential houses where children and food are exposed.
- **Managing waste properly.**
 - Farmers are encouraged to separate organic waste to make compost and separate plastic and metal waste in a pit and sell if possible. Puncture all chemical containers to prevent reuse.
 - Wastewater from coffee being processed at the mill can contain natural elements from the beans. These elements, if not filtered, can be released into local water sources. This in turn can cause algal bloom in the lakes and streams thus altering the natural balance of the environment. Adding filters to fermentation tanks can stop the release of natural vapours.

- Additionally, the use of vetiver grass and holding ponds which treat the wastewater, help stop the release of by-products from reaching water sources, thus conserving and maintaining the ecosystem.
- **Conserving energy and harvesting water:** Farmers should plant multi-purpose trees for shade and fuel use. They should also harvest water to retain moisture in the soil as well as harvest water for home use. They should use alternative sources of energy such as solar energy, bio-gas, and fuel saving stoves where possible.
- **Disposing of annual crop residues properly:** This is the other method used to conserve soil moisture if well done. Farmers should be encouraged to use the crop residue to mulch their coffee or other crops and to avoid burning annual crops in the field as this could damage the soil.
- **Adapting to climate change:** Farmers can lessen the impact of climate change by planting shade trees and cover crops in coffee; mulching; applying organic manure and inorganic fertiliser; and digging trenches, gully traps and constructing terraces to minimize the effects of erosion. The use of integrated pests and diseases management practices (biological, chemical, cultural) to control pests and diseases is also helpful as it reduces the chemicals in the environment. Where possible, farmers should irrigate coffee gardens to mitigate effects of climate change on coffee production caused by erratic rainfall and drought. Access to extension staff will help farmers on how to get the appropriate and cost-effective adaptation practices.

5.1.4.2 Social Sustainability

Social sustainability is another of the three key pillars of the sustainability cycle. Social sustainability refers to improving the quality of life of workers and farmers. It also refers to how individuals, communities and societies interact.

- **Children should attend school and not be used as child labour:** Children should attend school. Outside school hours it is OK for children to help their families on the farm with supervised light work, but they must not spray chemicals or carry heavy loads.
- **Safe use of agro-chemicals:** As instructed under the GAPs and OSHA, wear full protective gear when spraying; avoid spraying without protective gear, near other people or livestock; and seek for advice from the extension staff on the safe use of agrochemicals.
- **Safe storage of agro-chemicals** is essential for all farmers to safeguard their health. All chemicals should be stored out of reach of children and away from food and stored crops and should not be stored or kept under the bed as these practices are very dangerous.
- **Decent working conditions and good treatment of workers.** Workers should be paid the wages as indicated in their work agreement or contract, on time and in full. Their wages should be enough for them to live with dignity. Records for the payments of workers should also be well kept. The provision of safe and clean drinking water and protective equipment, where necessary, is essential for maintaining workers' safety.

- Good hygiene and health will keep all members in the community and family healthy. This is through keeping your compound clean, sleeping under a treated mosquito net, drinking safe water, using a clean latrine and washing your hands regularly.

5.1.4.3 Economic Sustainability

Economic sustainability aims to gain adequate market access and fair prices for farmers and ensure the protection of economic growth and activity whilst protecting the ecosystems and habitats that support this.

- The livelihoods and jobs of local communities depend on coffee along the value chain.
- Certified farmers receive economic benefits through premiums paid when they sell their coffee.

5.1.6 References and Further Reading

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Chapter Five Lesson Plan

Lesson Objectives:

- Recognize the purpose of coffee certifications and verifications for sustainability
- Recognize good environmental and social practices that coffee farmers should follow to be sustainable

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)

Key Points to Share:

- Sustainability means “meeting the needs of the present generation without compromising the ability of future generations to meet their needs”.
- Coffee farmers can qualify for certifications and verifications which label their produce as sustainable they meet certain sustainability criteria.
- To be certified or verified, farmers must be well-organized, maintain records and practice traceability and transparency.
- Farmers can be environmentally sustainable by preventing water pollution, handling waste properly, not using banned agro-chemicals, conserving energy and water, disposing of crop residues properly and adapting to climate change.
- Farmers can be socially sustainable by avoiding child labor, using agro-chemicals safely, treating workers fairly and maintaining good family hygiene.

| Topic | Topic Objectives | Training Activities |
|---|--|--|
| 5.1 Sustainability and Social Issues in the Coffee Industry | <ul style="list-style-type: none">• Understand reasons for sustainable coffee production and sustainability issues around coffee production• Recognize the reason for coffee certification/ verifications and some example certifications and verifications that coffee farms can qualify for | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 5.1. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Experience Sharing Ask participants to share what “sustainable coffee production” means to them and if they think they are currently using any sustainable practices.</p> <p>Experience Sharing Ask participants to share any certification or verification programs they are aware of. What are the benefits of being certified or verified? How do the certification standards help promote environmental and social sustainability? Should farmers follow these sustainability requirements, even if they are not officially certified/verified? Why or why not?</p> <p>Group Discussion Discuss how coffee farmers can be environmentally sustainable and socially sustainable. Why are these important practices to follow?</p> |

CHAPTER SIX





An association is “a group of people organized for a joint purpose” or “a connection or cooperative link between people or organisations”. A wide range of associations exist depending on the functions they fulfill, including workers' associations, farmers' associations, and traders' associations, to name just a few.

Tanzanian coffee laws and regulations allow farmers to form associations for the purpose of receiving extension services; organizing bulk input purchases; processing and marketing their coffee; and accessing loans. Depending on their particular needs and abilities, and provided they can fulfill criteria set by different regulations, Tanzanian coffee farmers can select from joining cooperatives, companies, and partnerships/joint ventures. These are described in detail below.

6.1.1 Cooperatives/Cooperative Societies

A cooperative society is an association or organisation that is formed by people of common interest who voluntarily come together and pool resources to promote their welfare. These can be in a form of a primary society, secondary society, an apex, and/or a federation.

The legal framework regulating cooperative societies in Tanzania dates back to 1932 when the first legislation was coined. The Co-operative Societies Act of 1932 was introduced in the then Tanganyika by the colonial government with a view of controlling cooperative societies in Tanganyika.

Thereafter, there have been several other legislations and amendments culminating to the new Cooperative Societies Act Number 6 of 2013 of the laws of Tanzania (the “Act”).

Cooperatives are established by individuals at village level (i.e. Primary Societies, AMCOs, and SACCOs) for the purpose of raising members' standards of living by facilitating their operations; providing relevant information and services, including supplying/distributing agricultural inputs; and collecting, processing and marketing their products. Secondary (i.e. Cooperative Unions) and tertiary (i.e. National Federation of Cooperatives) levels may be formed if its members wish for and need such structures. These levels must provide additional supporting and advisory services to its member cooperative societies as provided for in the by-laws.

6.1.2 Companies

A company is a business organization that generates profit by producing or selling goods or services. Coffee producers can register as companies with BRELA under the Companies Act of 2002. Smallholder farmers wishing to form a company for the purpose of marketing their coffee can choose between:

- Private company which is formed by people in a private relationship (i.e., family members or friends) and can comprise between 2 and 50 members who have shares.
- Public Company which comprises any number of members above seven, who can openly buy shares in the company.

The Articles of Association defines and records the purpose of the company as well as the duties and responsibilities of its members. In addition, it gives details of its name, aims, authorized share capital, conduct of meetings, appointment of directors and registered office.

Farmer Business Groups can be established as small farmer companies at village level to provide extension services to their members, facilitate internal saving systems and linkages to financial institutions and input suppliers. Farmers may also register as companies limited by guarantee for the purpose of marketing members' coffee in a professional and efficient manner (i.e., Kilicafe Company Ltd).

Provided all requirements are met, companies can be established quite quickly. Businesses are profit driven and strive to operate efficiently to generate profit. However, they are subject to a number of fees and taxes to be paid annually.

6.1.3 Partnerships/Joint Ventures

Two or more cooperative societies may form a partnership for the purpose of achieving shared goals more economically or efficiently, or for a particular short-term objective. Likewise, a cooperative society may join forces with a company to form a joint venture. Such a joint venture must be approved in writing by the Registrar of Cooperative Societies and all such partnerships must be defined by a contract as per the Law of Contract Act of 2002.

Note:

TCB makes special provisions for groups of farmers registered with the Ministry of Home Affairs under the Societies Act (CAP. 337 R.E. 2002). Such farmer groups are regarded as “Pre-Cooperatives” and are only permitted to collect coffee from their members and, with a special permit, market it through the National Auction. In southern Tanzania, such groups are called “Depot Committees”.

Irrespective of the structure they choose, members must set common goals, a purpose, and a shared vision to define the objectives and ensure sustainability of their association.

These goals are easier to define and agree if members of the farmer association share common interests, as defined in the Constitution, By-laws, Articles of Association, and contracts.

6.1.4 Importance and Benefits of Coffee Business Associations

Individual farmers may not have sufficient volumes of coffee to access good markets. The majority of smallholder coffee farmers do not have the necessary know-how or resources to access information about best practices for producing and marketing their coffee. Likewise, it is difficult for authorities to regulate individual farmers, or for government institutions, companies, and NGOs to reach individual farmers for the purpose of sharing sector information.

Farmers are better able to advocate for policy change, participate (through representatives) at regional and national sector forums and stakeholder discussions, and voice their concerns at these platforms when they do this in collaboration. Other benefits of farmer associations are as follows:

1. Accessing Extension Services



Illustration 42: Farmers Receiving Training in Their Association

When farmers are organized as a group, extension service providers (from district councils, trading companies, NGOs and similar) can reach them more efficiently. Such extension services can be provided through a range of training approaches such as farmer-to-farmer training, demonstration plots, seminars, field visits, exchange visits, or promotional visits from service providers, such as banks and lending agencies, input distributors and marketing agents.

In addition, farmers are themselves knowledgeable about farming practices, and have different backgrounds and experiences which complement skills taught by extension service providers. Farmer groups provide an opportunity for farmers to interact and learn from each other.

2. Accessing Inputs

When farmers are organized, it is more efficient for them to purchase their agriculture inputs together. Bulk prices and joint transportation reduce the price of, and time spent, buying inputs compared to individual (retail) purchasing. Money and time saved can be invested in other activities.

In addition, farmers working together can form direct business relationships with certified/ accredited input suppliers and negotiate competitive prices with them. As a group, farmers can also hold the supplier accountable for any goods provided that do not meet standards required (for example adulterated products and similar).

3. Accessing Finance

Often, smallholder coffee farmers do not have sufficient assets to qualify for a bank or micro-finance loan as individuals. Lenders often require some form of guarantee (i.e., asset in the value of the loan) in case the farmer defaults. Farmers in a strong association that has assets, good management, and faithful leadership, can jointly apply for loans. Group members must ensure would-be defaulters return their loan to secure the reputation and future credibility of the association.

Farmers can also organize themselves to set up and operate internal savings schemes for the purpose of meeting the association's needs (i.e., purchasing farm inputs, making investments, or generating working capital) or those of its members according to agreed conditions as done by Vikoba, and SACCOs.

4. Bulking and Marketing

Unlike food crops, coffee requires very particular processing and has a specialized market. Buyers of coffee want to buy large quantities of coffee of a particular and uniform quality.

To ensure desired quality is met, parchment produced by farmers must be hulled, graded, bulked, and stored accordingly. By collaborating, several farmers can hull, grade, bulk, and market their coffee together. The costs of these services are shared amongst the farmers and therefore become more affordable.



Illustration 43: Farmers Selling Coffee at their Association

Because smallholder farmers produce small volumes of coffee on their farms, they must also work together to achieve the minimum bulking volumes (50 tons of green coffee) required in order to trade on the Auction. By bulking their coffee and marketing it together, farmers can avoid selling their coffee to middlemen, who do not provide competitive prices.

By bulking and marketing their coffee as a group, farmers are more directly involved in the value addition of their produce and learn to participate in the coffee market. This direct involvement allows farmers a bigger proportion of the price achieved at auction or through direct export and therefore increases their income from the coffee they produce. However, expertise and skill are required to manage this complex process, which includes ensuring the right quality; researching the best market and price; ensuring that parchment is processed on time and with minimum loss; testing cup quality and cataloging for Auction; and setting reserve prices, etc. The farmer association must either acquire these skills or hire a trusted and reputable third-party consultant to do this on their behalf.

If farmers are well organized and managed, they have a stronger bargaining power, can afford a good marketing agent, or can access direct markets thus saving on the cost of an agent or middleman. An individual farmer must do all this work and bear the costs alone.

6.1.5 Sustainable Coffee Business Associations

A coffee business association does not provide any long-term benefit to its members unless it is strong and economically sustainable. This requires the association to be business-minded, have strong leadership, and adequately address the needs and services of its members. It must have a clear purpose from the beginning and should fulfill all legal requirements (registration and necessary documents) so it can be held accountable to its members and external authorities.

6.1.6 Administrative Structure

Members must firstly trust each other, their leaders and management. In addition, the association must ensure the following:

1. Be governed by clear and enforceable by-laws and leadership structures
2. Have a legal status and be registered with the relevant authorities, depending on the chosen structure
3. Members must have strong savings and business skills and mindset to ensure profitability
4. Be able to sustain itself for all its operational needs, through membership fees and generation of profit
5. Keep proper financial records and share these with members on a regular basis and in a way that can be understood (transparently)
6. Create linkages with other organisations that will promote success
7. Seek and provide relevant information to its members
8. Develop social-economical and human resources (i.e., youth and women involvement, and pro-member approaches which keep entrepreneurial morals high)
9. Conduct business activities transparently (i.e., input bulking, out bulking, sales disbursement, encouraging clear information, etc.)

6.1.7 Leadership and Management

Leadership sets a direction or vision for a group to follow (i.e., a leader spearheads that direction). Management controls or directs people and resources in a group according to principles or values that have been established.

Leaders must understand the structures, By-laws and Constitution that govern their association and fulfill their roles and responsibilities towards its members, as defined by the objectives of the association and the needs of its members. Leaders need skills in conflict resolution, negotiation, and persuasive communication to deal with the challenges of leading people and meeting expectations.

Many smallholder farmer associations fail because of poor leadership. Leaders overstay their terms, mismanage funds, pursue personal interests, and mislead members. Irresponsible behavior by leaders, loss of focus and direction, and failure to serve its members causes farmer association members to lose faith in their leaders and in the vision of the association. Reliable leadership is one of the most important conditions for a successful farmer association. Therefore, members must choose people they can trust to be honest and faithful. The association should not be a means to personal gain, and leaders must bear responsibility for the success (or failure) of the group and its members.



Illustration 44: Qualities of a Good Leader

Decisions made by leaders affect the profit and loss of an association, so leaders are accountable to the association's members. This means that they must explain the association's performance with respect to income, expenditure, profit, and loss. Any member of the association has the right to know about how their individual contribution to the association has been used. Part of building trust between members and leaders is to be transparent about decisions made at management level.

6.1.8 Business-minded Farming

If farmer associations are to be successful in providing the necessary services to farmers and improving their income from coffee, they must be managed as a business. The leaders and management must be able to perform critical functions that are common to all businesses, and in some areas may be unique to the farmer association's business model. These include:

- Management
- Roles, Rights, Responsibilities and Organization (By-Laws)

- Finance
- Accounting and Bookkeeping
- Business Planning
- Marketing

The management must strive to acquire skills in these elements of basic business and cooperative operations in order to succeed.

However, it is not enough to only acquire these technical skills. Farmers and their organisations must also change their mindset if they want coffee farming to be a long-term profitable undertaking. In short, they must think like entrepreneurs.

6.1.9 Household-centered Coffee Farming

Various studies show that women do the bulk of field and housework in a farming household. A recent survey carried out in Tanzania shows that men do most of the work related to growing, processing, and marketing coffee. In addition, male household leaders receive payment for coffee sold, and manage these resources with little to no consultation with the rest of the family. For this reason, coffee is often considered “a man's crop”.

Family members are rarely involved in the same farmer association. Husband and wife often belong to different groups with separate interests, and children are not included in farmer group meetings and training, even though they all work on the same farm. Training experience gained from extension services is often not shared across the family. Such situations create inefficiencies in the management of the home and farm, and foster self-interest instead of collaboration and productivity.

When the use of family resources is not jointly decided, the family members whose needs are not addressed lose interest in the activities that generate these resources. This is often the case with coffee; because women and children often struggle to directly benefit from the proceeds of the coffee they have helped to produce, they are not interested in developing the crop and would rather engage in other activities to generate their own resources whose use they can more directly manage.

Farmer associations should strive to diversify its membership to represent a broad spectrum of the coffee farmer population in the area. Women should be given equal opportunity and encouraged to take on leadership and management roles. This will ensure that the interests of female members are also heard and addressed. Young adult coffee farmers too, should be given the opportunity to participate in the management and leadership of farmer associations in their area as they may engage the interest of the younger generation's participation in coffee farming.

6.1.10 References and Further Reading

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- ICO (2019). Coffee Development Report 2019. Growing for prosperity – economic viability as the catalyst for a sustainable coffee sector. <http://www.internationalcoffeecouncil.org/media/coffeeDevelopmentReport.pdf>.
- International Cooperative Alliance (ICA). (2018). Available at: <http://ica.coop/>

Chapter Six Lesson Plan

Lesson Objectives:

- Understand different types of associations that farmers can form and the laws governing them
- Understand requirements of strong farmers' associations and the need for inclusion of women and youth

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)
- Posters

Key Points to Share:

- Basic services must be offered to ensure farmers benefit from farmer associations.
- Broader membership that includes women and youth is key to ensuring that the needs of all farmers are addressed by their association, and to strengthen them for the long term.
- Roles and responsibilities of leaders and managers must be clear to all members and fulfillment openly discussed.
- Leaders and managers must improve their business mindset, marketing and managing skills to fulfill their responsibility of securing best prices for members' coffee.

| Topic | Topic Objectives | Training Activities |
|----------------------------------|--|--|
| 6.1 Coffee Business Associations | <ul style="list-style-type: none"> • Understand the different types of farmers' associations recognized by TCB • Understand the benefits that farmers can get from their associations • Understand the characteristics of a good farmers' association | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 6.1. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Group Discussion Discuss the formation of the group's particular type of farmers' association. Are members aware of the legal requirements, association structure, goals/purpose/vision? Does the farmers' association have a Constitution/By-laws or other governing documents? Are members aware of what these say?</p> <p>Group Discussion Discuss the benefits that farmers get from their association. How else would farmers want to benefit from being in an association?</p> <p>Group Discussion Discuss the proposed qualities of a good leader and how they apply to the group's particular farmers' association. What are their leaders doing well? What can leaders of the association do better?</p> <p>Group Discussion Discuss the idea of business mindset. Does the farmer association have a business mindset? Do individual farmer families have business mindsets? If not, what needs to change?</p> <p>Group Discussion Ask farmers to consider the way in which farming decisions are made in the family, and how this affects production. Could production and incomes increase with more equality between men and women? How can youth involvement benefit the family?</p> |

CHAPTER SEVEN





Coffee is a cash crop that farmers grow to earn an income. Coffee farming as a family business needs to be carried out for the purpose of meeting all family needs (such as food, medical and educational expenses, developing the home, acquiring assets, responding to emergencies, etc.) (Hivos, 2014). In this aspect, involvement of members of the whole family in discussions about the use of coffee earnings is vital.

All members of the farming family involved in coffee production should benefit from the sale of coffee equally. Therefore, men, women, and youth should be integrated into the decision-making and management functions of farm businesses.

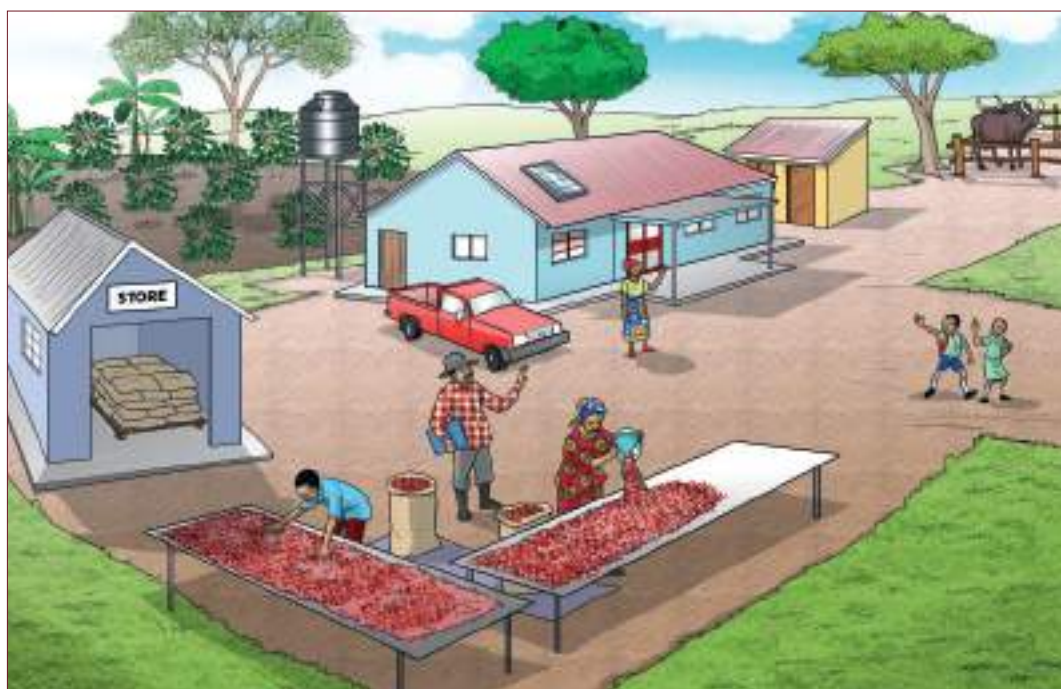


Illustration 45: Prosperous Coffee Farming Family at Home

7.1.1 Women Involvement in Coffee Value Chain

According to ICO (2018), HIVOs (2012) and USAID (2012), women contribute significantly to the global coffee sector. Between 20% and 30% of coffee farms are female-operated and up to 70% of labor in coffee production is provided by women, depending on the region.

However, women's access to and control over resources and benefits is modest at all levels. According to UNDP (2010) women predominate in world food production (50-80%,) but women own less than 10% of the land. Yet, women are crucial to food security and

providing household needs. According to FAO (2011), women use almost all their income from the sale of agricultural products and handicrafts to meet household needs. Men use at least 25% of their earnings for other purposes. As such, women should be included in decision-making about how to use the income from the family's coffee crop, since they often think first about their family's needs rather than about themselves.

7.1.2 Youth Involvement in the Coffee Value Chain

Few or no youth own coffee trees, are part of contract farming schemes or are involved in the coffee value chain. According to USAID (2018), two possible reasons are partly associated with this which include:

- heritage rules and traditions prevent families from handing over the legal responsibility of the farm to youth, which is likely to restrict their ability to work on their own farm or manage their labourers.
- the workload combined with the financial returns does not automatically spark young people's interest in coffee production.

Access to resources: As with women, youth ownership of resources in coffee production is low at all levels. When a young farmer has no formal ownership of or responsibility for land and coffee trees, it is difficult to participate in training, or access credit and tools to apply innovative production methods.

Decision-making: As male household heads are the members of the producer organization, they have a say in decisions regarding the coffee value chain (e.g., related to marketing) and they can be elected as leaders. Youths are underrepresented in membership and governance of farmers associations and have fewer resources in terms of technology and credit. At family level the income from coffee sales is perceived as the income of the male parent, who decides on the use of it. This may result in youth losing interest in investing in the coffee production or even in seeking innovations. The objective of farming as a family business is to improve the livelihoods of all family members through better income from coffee, thus improving the lives of the entire farming household.

7.1.3 What Is a Business?

A business is an undertaking operated for the purpose of earning a profit, by providing a service or product to a market (customers). Regardless of the type of business, the most basic factors to consider are costs of producing and marketing a product. Farmers must understand that coffee farming is like any other business which requires inputs, operational activities, awareness of competition, and marketing of the final product.

7.1.4 Important Aspects of a Farming Business

Before a business is undertaken, an entrepreneur must first examine the operating environment to understand both the risks and benefits of the business. In addition, a viable business goal and execution plan must be set right from the start.

- i. What to produce?
- ii. How to produce it?
- iii. Is it possible to produce it on your land?
- iv. What resources and inputs are needed and where to get them?
- v. What labor do you need?
- vi. What is the best market for the product?
- vii. What price can the product get in the market?
- viii. Is it profitable?
- ix. Do you have enough cash?
- x. What are the risks and what to do about them?

Farming as a business requires farmers to learn and adopt business management skills such as planning, budgeting, record keeping, financial management, marketing, establishing business linkages, etc. They must also adopt attitudes that support entrepreneurship, such as:

- Seeking opportunities and initiatives to improve their business and their product
- Fulfilling commitments they have made towards their goals and their market
- Striving to attain efficiency in the way they work, and delivering a quality product
- Taking calculated risks
- Setting goals to work towards and drive their endeavors
- Seeking information to generate knowledge to improve confidence and competence
- Systematic planning and monitoring
- Being persuasive (for marketing)
- Fostering independence and self-confidence (These attitudes may not come naturally to smallholder coffee farmers, but as businessmen and women, this entrepreneurial mindset is necessary to ensure success.)

7.1.5 Coffee Farming Risks

7.1.5.1 What Is a Business Risk?

A risk is a probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through pre-emptive action.

All businesses face some form of risk, and farming may appear to have more risks than other small businesses that farmers are familiar with, such as tailoring/carpentry/running a grocery shop. Some risks might be within the farmer's control, these include:

- Adoption of improved varieties and good farming practices
- Poor leadership or weak farmer organization
- Lack of business knowledge among farmers
- Land degradation due to poor farming practices
- Insufficient labor and participation of youth in coffee growing

However, other risks are outside of the farmer's direct influence, such as:

- A sudden attack by pests or disease
- Volatile markets
- Other crops competing with coffee (especially horticulture)
- Changes in climatic factors (especially temperature and rainfall)
- Price increase of agricultural inputs

Climate change is amongst the most threatening risks to farmers presently, and farmers must be educated on strategies for adapting to the new climatic situations.

One or more of these risks can affect the profit that a farmer can make from coffee farming, and they may vary from season to season. However, when the right decisions are made at the right time through proper business planning and management, and joint decision-making with relevant members of the family, most of these risks can be minimized.

7.1.5.2 Managing Coffee Farming Risks

Farmers must adopt good agricultural practices and implement climate change adaptation measures to ensure a high yield of good quality coffee. No matter how the market is, good quality coffee always fetches a better price than poor quality coffee. In a year where prices are favorable, good quality coffee can generate surplus income for the farmer, provided that sufficient volumes are produced. At the same cost of production, bigger volumes of coffee can also buffer income better than small volumes when prices are not favorable. Again, with volumes and good prices, more surplus income can be generated.

The principles of higher yield and better quality at varying prices work at the individual farmer level and also apply to farmer associations. Strong farmers and associations have marketing power when they produce high volumes of good quality coffee which buffers fluctuating prices and therefore always attains a profit, if well managed.

7.1.5.3 Income Diversification

Crop diversification as a risk management tool also ensures that farmers produce sufficient food of a wide nutritional variety on the farm, either for own consumption (therefore reducing the need to spend cash to purchase food) or for sale (to generate cash to meet household needs).

The recommended diversification options in the coffee farm that have different market opportunities include:

- i. complementary crops (i.e., banana, beans, fruit, etc.) and
- ii. livestock (poultry, goats, cows, etc.) .

A farming family might also undertake income generating activities that provide services to the surrounding community. This ensures that any failure of the coffee crop is offset by the complementary crops or income generating activities.

Diversification on the farm (such as intercropping, and animal husbandry) also benefits farm operations by providing by-products like manure, mulch, food, and fodder for use on the farm, thus reducing the need to spend money on them.

Common sense should always be applied when managing risk. This means that farmers seek expert advice about what grows best in their environment, what has a good market, and what can be grown at the best profit. At the same time, farmers must learn to utilize opportunities for innovation.

One of the greatest risks to coffee farming is the prevailing situation of ageing farmers and lack of youth involvement in coffee production. This has a lot to do with the trend of young people moving to towns to earn an income, but issues around land ownership and partitioning also affect the ability of the younger generation to inherit their parents' coffee farms or establish their own. Communities must reconsider how land and coffee farms can be passed into the care of young farmers.

One way of engaging the youth is to enable them to provide services needed by the coffee industry at different points along the value chain. This might include direct employment in agricultural services such as pruning, spraying, harvesting, and processing, as well as indirect service provision such as agricultural inputs, farmer training, and marketing services to coffee farmers.

Depending on prevailing conditions and opportunities of different regions, other ways of managing coffee farming risks might be:

- Planning the coffee farming business using Expenditure, Income, Profit/Loss Sheets
- Only undertaking economically viable and profitable activities that have been well researched by the farming family prior to investing
- Using extension services and the best agricultural techniques possible
- Exchanging information and experiences with other coffee farmers
- Planting several types of crops (coffee, beans, sunflowers, etc.)
- Setting aside profits whenever possible as savings
- Keeping and analyzing records to maximize business efficiency
- Storing some of the harvest to speculate on price changes (be informed about the price)
- Working with other farmers to reduce costs and increase profits

Farmers should also ensure that their farms provide food security for the family. This means growing food crops that can be harvested at different times to ensure at least one food variety throughout the year (for example maize, potatoes, pumpkins, and yams can provide carbohydrates during different seasons). Diverse farms have more nutritional value.

7.1.6 Farming Techniques in Business Terms

The first step for a farming family to think in business terms is to analyze the family farm as a business unit. Farmers must carefully analyze the costs, expenditure, and profit of their coffee production. They may be required to use historic information about their past production to predict their income for future seasons.

Farmers should list all costs that they incur on their farm in one season (comprising all activities related to establishing, rehabilitating, caring for the coffee farm, as well as harvesting, transporting and other post-harvest work) and their respective costs. Assumptions should be made as necessary regarding:

- Costs of inputs such as seedlings, manure, fertiliser, tools, transport, mulch
- Costs of labor such as for land preparation, field setting and digging holes, planting, pruning, weeding, fertiliser application, harvesting, etc.
- Post-harvest costs such as transport, supervision, bags, processing, and marketing. To estimate their income, farmers must estimate their expected yield per coffee season.

Assumptions can be made about the yield per tree, prevailing coffee farm-gate prices, and other expected costs depending on the farmer group's structure and selling procedures.

7.1.7 Work Plan and Record Keeping

7.1.7.1 What is a Record?

A record is a written proof of what happened, what is happening, or what is anticipated to happen. A record can also be a written proof of what was said, and who said it. Some examples are minutes of a meeting, a report on the number of group members who worked in the group project, a record of the names of members who have brought in their membership contribution (Arzeno, 2004).

7.1.7.2 Why Keep Records?

Many people do not write down how much money comes in and how much money goes out of their business. This may be because they do not know how to do it, or they do not know how it can help their business. Therefore, people do not really know how much money they are earning. Record keeping means that you write down all the money that comes into your business and all the money that goes out of your business, including the

production activities. Record keeping is important because you cannot keep everything in your head (Ntsasa et al., 2021). People are forgetful by nature.

7.1.7.3 Advantages of Record Keeping

- i. You will know how much money you have received, how much money you have spent, and how you have spent it
- ii. You will know the amount of the inputs and materials used to grow the enterprise
- iii. You will know the price of produce sold and cost of inputs
- iv. You can calculate whether you are making a profit or a loss
- v. You will be able to make better decisions on what to buy and sell
- vi. You can keep records of buying and selling on credit, so that people cannot cheat you

7.1.7.4 Consequences of Keeping Poor Records

- i. You will not know how much money you are earning, whether your business is making a profit or losing money
- ii. You will not know why you are making a profit or losing money
- iii. You will not be able to make good decisions that will allow you to make more money and prevent your business from losing money
- iv. You will not know which customers owe you money, how much they owe you or how much you owe someone else
- v. Where groups of people work together, lack of a proper record-keeping system often leads to mistrust and accusations between group members

7.1.7.5 Types of Farm Business Records

- i. Production Records
- ii. Cash flow Records (in-flow & out-flow)
- iii. Fixed Asset Records
- iv. Training records
- v. Consumption records
- vi. Profit and Loss Records

Production record

| Enterprise | Land size | Expected yield per acre/unit | Total yield (bags, tons, kg) |
|------------|-----------|------------------------------|------------------------------|
| | | | |
| | | | |
| | | | |

Cash in-flow record

| Date/year | Sales/output | Quantity | Unit price (TZS) | Total income (TZS) | Comments |
|-----------|--------------|----------|------------------|--------------------|----------|
| | | | | | |
| | | | | | |
| | | | | | |

Cash out-flow record

| Date/year | Operation/unit | Quantity | Unit cost (TZS) | Total cost (TZS) | Comments |
|-----------|----------------|----------|-----------------|------------------|----------|
| | | | | | |
| | | | | | |
| | | | | | |

Fixed Asset Record

| Date of Purchase | Item | Purchase Price | Life (years) | Comments |
|------------------|------|----------------|--------------|----------|
| | | | | |
| | | | | |
| | | | | |

Training Records

| Date | Type of training | Key contents (modules, sessions, exercises) | Number of participants disaggregated by sex |
|------|------------------|---|---|
| | | | |
| | | | |
| | | | |

7.1.7.6 The Expected Profit or Loss

Profit is a function of volume and price. The combination of the Profit and Loss sheets, the work plan and records enable the farmer to analyze past performance and think about future options.

The simple Income and Expenditure sheets are tools for comparing advantages and disadvantages between different crops and different farming and business methods. It helps to answer the question “Where do I want to go?”. Farmers can use these forms to make projections concerning the cost or benefit between different crops and farm business approaches. The farmer can copy this template into an exercise book, and fill it season after season for comparing the business performance over time.

| SHUGHULI ZINAZOFANYIKA SHAMBANI | | | | | | | |
|---------------------------------|------------------------|-------------------------|------------------------|-------|-------|------------------------|-----------------------|
| Tarhihi | Shughuli zinazofanyika | Pembajaji zinazofanyika | Ngumu kazi iliyotunika | Kiasi | Idadi | Chukwama ya Kiasi (Tn) | Jumla ya gharama (Tn) |
| 22/05/22 | Kupiga dawa | Native | — | MLS | 400 | 1,200/= | 48,000/= |
| 22/05/22 | Kupiga dawa | — | Kibarua | Saa | 5 | — | 10,000/= |
| 24/05/22 | Kuchuma | — | Familia | Ndoa | 10 | — | — |
| 27/05/22 | Kuchimbua Samadi | — | Familia | Saa | 6 | — | — |
| 30/05/22 | Mauzo | — | Kibarua | Saa | 2 | — | 5,000/= |
| 6/6/22 | Kunyunyiza dawa | Native | — | MLS | 400 | 1,200/= | 48,000/= |
| 10/8/22 | Kuchuma Kahawa | — | Familia | Ndoa | 10 | — | — |
| 26/9/22 | Kunyunyiza dawa | Tan Coper | — | Kgm | 1 | — | — |
| 5/10/22 | Kuchuma Kahawa | — | Familia | Ndoa | 10 | — | — |
| 10/10/22 | Kuchuma Kahawa | — | Familia | Ndoa | 12 | — | — |

Illustration 46: Real Example of a Farm Expenditure Recording Sheet

| Mahesha ya Jumla ya Mapato | | | | | Mwami |
|-----------------------------------|---------|-------|-------------------------|---------------|-----------------|
| Eka/ 2 Mti inayozalisha 1,100 | | | | | |
| Kinawa | Kiasi | Idadi | Bei Area Total (TZS) | Suma (TZS) | |
| Jumla ya Mapato (mauza ya bidhaa) | | | | | |
| Karambi | Kiti | 750 | 3,000 | 2,250,000/= | |
| Cherry | | 1,500 | 600 | 900,000/= | |
| | | | | | |
| | | | | | |
| Jumla ya Mapato | | | | 3,150,000/= | |
| Gharama | | | | 1,050,000/= | |
| Mikukatazi | | | | | |
| Kukata mabao | 20 siku | 2 | 100/ha | 200,000/= | Mikata mabao |
| Kupunguza dawa | 4 siku | 2 | 200/ha | 400,000/= | Mipunguza mabao |
| Kuchimbia maji | 3 siku | 4 | | 120,000/= | Mera tota |
| Wafizi | 2 siku | 4 | | 80,000/= | |
| Wafizi | 2 siku | 3 | | 60,000/= | |
| Mibao ya KPE 2 | | | 100/ha | 120,000/= | |
| Mibao ya CAN 2 | | | | 80,000/= | |
| Kuchimbia maji | 1 siku | 4 | 20,000 | 80,000/= | |
| Kuchuma Kahawa | | 53 | | 210,000/= | Kuchuma mwami |
| | | | | | |
| Pembajaji | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Illustration 47: Real Example of Farmer's Income and Expenditure Sheet

Profit and Loss record

| Enterprise | Quantity | Unit Price or Cost | Total |
|----------------------------|----------|--------------------|-------|
| Income | | | |
| Sales | | | |
| Home consumption | | | |
| Other | | | |
| Total Income (TI) | | | |
| | | | |
| Expenses | | | |
| A: Fixed Costs | | | |
| Purchase of land | | | |
| B: Variable Costs | | | |
| Establishment Costs | | | |
| Land preparations | | | |
| Pegging | | | |
| Layout | | | |
| Holing | | | |
| Seedlings | | | |
| Fertiliser for planting | | | |
| Manure | | | |
| Planting | | | |
| Management Costs | | | |
| Hand weeding | | | |
| Fertiliser applications | | | |
| Manure applications | | | |
| Pesticides applications | | | |
| Fungicides applications | | | |
| Mulching | | | |
| Pruning | | | |
| Irrigation | | | |
| Cost for fertiliser | | | |
| Cost for pesticides used | | | |
| Cost of fungicides used | | | |

| | | | |
|-----------------------------------|--|--|--|
| Pruning | | | |
| Harvesting | | | |
| Total Variable Costs (TVC) | | | |
| Total Fixed Costs (TFC) | | | |
| Total Costs (TC) | | | |
| (TVC + TFC) | | | |
| Profit = (TI-TC) | | | |

7.1.8 Farm Enterprise Budgeting

7.1.8.1 What is Farm Budgeting?

A budget is a formal plan for carrying out some business activities in the future. It shows the process of carrying out an activity and the result. Budgeting is the planning process or the development of a plan of action (budget). The budget is based on activities likely to take place in the future—therefore, budgets are based on estimates.

7.1.8.2 Components of a Budget

A budget has two parts:

- Physical input and output coefficients: These concern the physical relationships of transforming farm resources into outputs (e.g., 25kg of NPK per ha contribute to yielding 0.5 MT/ha of parchment coffee).
- Financial relationships: These concern the monetary value of inputs and outputs. They allow specification of costs of production and income from production.

7.1.8.3 What is the Process of Budgeting?

The budgeting process involves:

- Estimating and specifying input requirements
- Estimating cost of production (e.g., 25kg NPK/ha * TZS 28000.00)
- Estimating quantity and value of output, i.e., returns to production (e.g., coffee at TZS 4500/kg. * 500kg)
- Comparing costs and returns to determine net returns or net benefit.

A farming business budget includes an enterprise budget, a whole farm budget, a partial budget and cash flow projections.

| | | | | |
|---|-----------------|-------------------------|--------------------|---|
| | | | | Steps |
| Step 1: Enterprise _____ Step 2: For the period from _____ to _____ Step 3: Area under cultivation (acre/ha): _____ | | | | Step 1: Put the name of the enterprise (e.g., coffee) in the space provided at the top of the template Step 2: Agree on a duration for this enterprise (e.g., for the period November 2016 to June 2017) Step 3: Estimate the area of the crop under cultivation (in acres/ha) |
| Step 4: Income | | | | |
| Item | Quantity | Unit Price (TZS) | Value (TZS) | Step 4: Calculate the income by listing the various ways in which the products have been disposed, including selling at farm gate, at a neighboring market, to an exporter, kept for home consumption, or given away. The quantities and prices for each form of disposal may be different. If the produce has been retained for home consumption or given away, make sure that the unit price reflects a market value. |
| | | | | |
| | | | | |
| | | | | |
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| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Step 5: Total Income | | | | Step 5: Once all the values have been added, it will reflect the total income from that particular enterprise. This total amount should be written in the space for "Total Income". |

| Step 6: Variable Costs | | | | |
|---|----------|------------------|-------------|--|
| Item | Quantity | Unit Price (TZS) | Value (TZS) | Step 6: Calculate all costs directly related to the production of the product (e.g., coffee). Under the column items, list all the production costs associated with this enterprise. For each item, trace the specific quantity and the unit price to arrive at the value (in \$) for each item. |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Step 7: Total variable costs | | | | Step 7: Total the value or cost for all the items to arrive at the "Total Variable Costs". |
| Step 8: Enterprise profit (Total income minus total variable costs) | | | | Step 8: To arrive at the "Enterprise Profit", subtract from the total income the total variable costs. |

Example of a budget for coffee production

Table 15: Expenditure Sheet for Establishing 1 ha of New Farm

| Descriptions | Unit | No of unit for improved coffee varieties | No of unit for traditional coffee varieties | No of unit for Robusta coffee varieties | Price | Cost for improved coffee varieties | Cost for traditional coffee varieties | Cost for Robusta coffee varieties |
|------------------------------------|----------|--|---|---|---------|------------------------------------|---------------------------------------|-----------------------------------|
| A: Plant & equipment | | | | | | | | |
| Hoe | pc | 4 | 4 | 4 | 10000 | 40,000 | 40,000 | 40,000 |
| Panga | pc | 4 | 4 | 4 | 18000 | 72,000 | 72,000 | 72,000 |
| Pruning saw | pc | 4 | 4 | 4 | 18000 | 72,000 | 72,000 | 72,000 |
| Secateur | pc | 4 | 4 | 4 | 23000 | 92,000 | 92,000 | 92,000 |
| Wheelbarrow | pc | 1 | 1 | 1 | 75000 | 75,000 | 75,000 | 75,000 |
| Slasher | pc | 4 | 4 | 4 | 18000 | 72,000 | 72,000 | 72,000 |
| Spade | pc | 2 | 2 | 2 | 18000 | 36,000 | 36,000 | 36,000 |
| Rainboots | pc | 2 | 2 | 2 | 18000 | 36,000 | 36,000 | 36,000 |
| Knapsack sprayer (solo) | pc | 1 | 1 | 1 | 255,000 | 255,000 | 255,000 | 255,000 |
| B: Site preparation | | | | | | | | |
| Slashing | Man-days | 45 | 45 | 45 | 7,150 | 321,750 | 321,750 | 321,750 |
| Plowing | Man-days | 50 | 50 | 50 | 7,150 | 357,500 | 357,500 | 357,500 |
| Field alignment | Man-days | 12 | 12 | 12 | 7,150 | 85,800 | 85,800 | 85,800 |
| Pegs | Man-days | 2,000 | 1,331 | 1,111 | 50 | 100,000 | 66,550 | 55,550 |
| Lay-out | Man-days | 10 | 7 | 6 | 7,150 | 71,500 | 47,583 | 39,718 |
| Holing | Man-days | 44 | 30 | 25 | 7,150 | 317,778 | 211,481 | 176,526 |
| C: Coffee seedling planting | | | | | | | | |
| Number of seedlings | Number | 2,000 | 1,331 | 1,111 | - | - | - | - |
| DAP fertiliser for planting | g/tree | 75 | 75 | 75 | 135,000 | 405,000 | 269,528 | 224,978 |

| | | | | | | | | |
|---|----------|-------|-------|-------|---------|------------------|------------------|------------------|
| Inorganic fertiliser application | Man-days | 10 | 7 | 6 | 7,150 | 71,500 | 47,583 | 39,718 |
| Farmyard manure | Tins | 2,000 | 1,331 | 1,111 | 500 | 1,000,000 | 665,500 | 555,500 |
| Application of farmyard manure | Man-days | 10 | 7 | 6 | 7,150 | 71,500 | 47,583 | 39,718 |
| Plantings | Man-days | 20 | 13 | 11 | 7,150 | 143,000 | 95,167 | 79,437 |
| D: Top dressing with fertilisers | | | | | | | | |
| Inorganic fertilisers | NPK | 75 | 75 | 75 | 125,000 | 375,000 | 249,563 | 208,313 |
| Inorganic fertilisers application | Man-days | 10 | 7 | 6 | 7,150 | 71,500 | 47,583 | 39,718 |
| E. Mulching materials | | | | | | | | |
| Mulching applications | Bundles | | | 2,222 | 500 | - | - | 1,111,000 |
| F: Weeding | | | | | | | | |
| Weeding 1st round | Man-days | 20 | 13 | | 7,150 | 143,000 | 95,167 | - |
| Weeding 2nd round | Man-days | 20 | 13 | | 7,150 | 143,000 | 95,167 | - |
| Weeding 3rd round | Man-days | 20 | 13 | | 7,150 | 143,000 | 95,167 | - |
| TOTALS | | | | | | 4,570,828 | 3,548,670 | 4,085,225 |

Gross margin analysis

| Cost description | Farmers category | Year 0 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5+ |
|------------------------|------------------|------------|----------|-----------|-----------|-----------|-----------|
| Percent of peak yield: | | 0% | 0% | 30% | 50% | 75% | 100% |
| Yield kg per ha | | | | | | | |
| Yield kg per ha | Adopter | 0 | 0 | 375 | 625 | 938 | 1250 |
| | Non-Adopter | | | 154 | 256 | 384 | 512 |
| Selling price | | 6,278 | 6,278 | 6,278 | 6,278 | 6,278 | 6,278 |
| Revenue per ha | Adopter | 0 | 0 | 2,354,250 | 3,923,750 | 5,885,625 | 7,847,500 |
| | Non-Adopter | 0 | 0 | 964,301 | 1,607,168 | 2,410,752 | 3,214,336 |
| Gross margin per ha | Adopter | -1,789,337 | -179,903 | 1,835,860 | 3,142,695 | 4,872,029 | 6,754,708 |
| | Non-Adopter | -1,191,403 | -261,315 | 321,885 | 862,144 | 1,466,608 | 2,157,257 |

7.1.9 Determining the Minimum Price and Yield for the Enterprise

7.1.9.1 The Break-even Price

A break-even price is the minimum acceptable price that will, if nothing else, cover the cost of production. At this price, the income received will be equal to the cost of production, and the profits will be zero. The break-even price can be calculated from the information in the enterprise budget, using the following formula:

Break-even price = total variable costs per acre / yield per acre (Maintain one SI unit, acre or Ha)

7.1.9.2 The Break-even Yield

The break-even yield is the minimum level of production that you can produce to cover the costs of production. It is calculated by dividing the total variable costs/ha with the per unit price of the produce. The break-even yield can be calculated from the information in the enterprise budget, using the following formula:

Break-even yield = total variable costs per acre / unit price of produce

7.1.10 References and Further Reading

Angelica S., Marjoleine M., Anna L., Mieke V., Jacqueline T. and Trude V. (2014). Coffee Toolkit: *Sustainable Coffee As A Family Business*: Approaches and tools to include women and youth

EAFCFA. (2003). *Coffee Farming as a Business – Trainer's Guide*, Kampala.

Green to Grow project: Handbook for Business Model Training in the Coffee Value Chain

HIVOS (2012) on youth and small-scale farming, 2012

ICO Report (2018). Gender equality in the coffee sector. An insight report from the International Coffee Organization

Michiel Kuit, Don M.Jansen; and Nguyen Van Thie (2004). Coffee hand book: Manual for Arabica cultivation

Chapter Seven Lesson Plan

Lesson Objectives:

- Understand the basic principles and activities needed to start thinking of coffee farming as a business
- Learn about simple tools for analyzing and keeping records as first steps towards thinking of coffee farming as a business

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)
- Posters
- Logbooks to draw templates in for practicing farm record keeping

Key Points to Share:

- Coffee farming should be carried out as a business to realize profit.
- Basic gross-margin and cost/benefit calculations should be used to assess farm performance.
- Profits increase through better management, improved practices and informed decision-making which result in surplus production.
- Efficiencies in business farming come from working with other farmers in a business relationship.
- Saving is a more profitable input than credit (to meet the cost of production).
- Marketing and managing sales require skills that must be acquired by farmers to generate profit on coffee produced.
- Shared responsibilities and profits in the family create efficiency, trust, and collaboration.

| Topic | Topic Objectives | Training Activities |
|---|---|---|
| 7.1 Coffee Farming as a Family Business | <ul style="list-style-type: none"> Establish the need for a farming business to meet the needs of family members Understand the different risks that farmers face in the business of farming Describe and explain some strategies to manage risk at the farm level Introduce a simple planning, execution, and monitoring strategy for farmers Reinforce the need for keeping farm activity records for monitoring farming economics | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 7.1. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Experience Sharing Ask participants to share their experiences with working to grow and sell coffee within their families. Are farmers able to meet all or a good proportion of their family's needs through coffee production? What is the involvement of different family members in coffee production? What challenges and opportunities do they face when working with their family? How can they overcome these challenges?</p> <p>Experience Sharing If any farmers operate a business, ask them to explain how they started it and how they run it.</p> <p>Group Discussion As a group, discuss the challenges they face/ could face with farming as a business. Together, work to come up with possible solutions/ strategies to the cited challenges to increasing farming profit</p> <p>Group Discussion Discuss the biggest risks farmers currently have when farming coffee as a business. What do they currently do to mitigate these risks? What can they do better to mitigate the risks?</p> <p>Business Plan Development Help farmers develop simple budgets, Income Sheets and Expenditure Sheets for their farm businesses.</p> <p>Record Practice Use the Gross Margin Calculation template to demonstrate how to record their harvests (and other farm activities). Encourage farmers to draw this template in their notebooks and use it on their farms.</p> |

CHAPTER EIGHT





8.1.1 What is Climate Change?

Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional and global climates. That means, climate change is “any significant change in climate (i.e. temperature or precipitation) that lasts for an extended period of time (typically around three decades or more)”. Such changes can be due to natural variability or human activities.

Climate change is affecting farming around the globe and the impact is noticeable. Of all the economic and livelihood activities that humans do, agriculture is most affected by climate change.

On farms, climate change is reducing crop yields, the nutritional quality of major cereals, and lowering livestock productivity.

8.1.2 Factors Contributing to Climate Change

Climate change is caused by the unusual increase in the temperature of Earth's atmosphere (also known as “global warming”). Periodic climate warming and cooling are natural processes, and some amount of climate change can be attributed to natural phenomena. Over the course of Earth's existence, volcanic eruptions, fluctuations in solar radiation, tectonic shifts, and even small changes in our orbit have all had observable effects on planetary warming and cooling patterns.

However, in recent years, the warming of our planet has been sped up considerably. The reason for this is that modern human activities and technology invented over the past 150 years are releasing an increased amount of “greenhouse gases” such as carbon dioxide into the atmosphere. These greenhouse gases trap heat from the sun in the atmosphere, causing the Earth's temperature to warm.

Modern human activities which release an increased amount of greenhouse gases include:

- **Burning fossil fuels** – Fossil fuels such as oil, gas, and coal contain carbon dioxide that has been 'locked away' in the ground for thousands of years. When we take these out of the land and burn them (in factories, by driving vehicles, by using electricity, etc.), we release the stored carbon dioxide into the air.
- **Deforestation** – Forests remove and store carbon dioxide from the atmosphere. Cutting them down means that carbon dioxide builds up quicker in the atmosphere since there are fewer trees to absorb it. Not only that, but trees also release the carbon they have stored when we burn them for firewood, etc.
- **Agriculture** – Planting crops and rearing animals releases many different types of greenhouse gases into the air. For example, animals produce methane, which is 30 times more powerful than carbon dioxide as a greenhouse gas. The nitrous oxide used for fertilisers is ten times worse and is nearly 300 times more potent than carbon dioxide!
- **Cement** – Producing cement is another contributor to climate change, causing 2% of our entire carbon dioxide emissions.

Natural changes to the climate

Some amount of climate change can be attributed to natural phenomena. Over the course of Earth's existence, volcanic eruptions, fluctuations in solar radiation, tectonic shifts, and even small changes in our orbit have all had observable effects on planetary warming and cooling patterns.

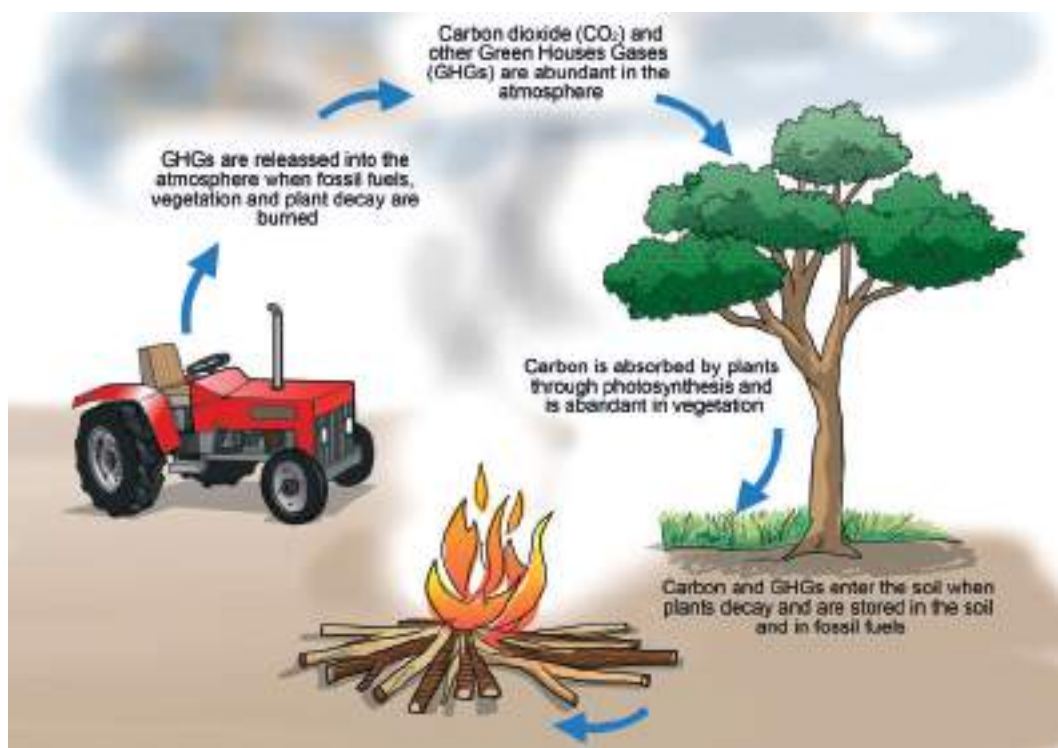


Illustration 48: The Carbon Cycle

8.1.3 Factors Causing Climate Change in Tanzania

In Tanzania also there are various human activities which contribute to the emission of greenhouse gases, hence contributing to climate change. Activities like industrial activities, agriculture activities, deforestations, mining activities and burning of fuels are among of the human causes of climate change.

8.1.4 Impacts of Climate Change

Climate hazards are potentially damaging, extreme weather phenomena felt by people (farmers in particular) because of climate change. The most common of these are:

- **Increased temperature** makes some regions hotter than they were in the past, leading to a state of dryness as humidity stored in the soil and in vegetation evaporates at a faster rate. Water sources dry up either temporarily or permanently if the situation persists and protective vegetation is removed.
- **Increased rainfall** in humid regions due to increased evaporation. More rain falls in a

shorter period, causing floods, severe soil erosion and leaching of nutrients from the soil.

- **Shifts in seasons** with longer dry periods and shorter rainy seasons which often arrive late due to changes in the atmospheric water cycle.
- **Melting of ice glaciers and ice sheets** caused by higher temperatures which induce rapid melting of ice (i.e., on Mount Kilimanjaro). Shorter periods of rain mean that this ice cannot regenerate to its normal thickness. Water sources that spring from seasonally melting ice are at risk of drying up.
- **Shifting of agricultural belts** as temperature and rainfall patterns change. As climatic conditions for growing certain crops in a particular area change, farmers must either move to cooler climates, grow different crops, or plant new varieties that can withstand hotter climates.
- **Disruption of natural ecosystems** as formerly dense rainforest areas shrink and give way to bushland and grasslands. New plant ecologies change the occurrence of insect pests and the animals that depend on them for their food. Some species of organisms might die out while others might adapt to new conditions.

The effects of climate change on natural and human systems are called climate impacts. They are a source of risk to the coffee farmer's livelihood as they can potentially affect yield and the quality of coffee produced. The global average temperature has increased about 1.8°F from 1901 to 2016 (Hayhoe et al., 2018). Changes of one or two degrees in the average temperature of the planet can cause potentially dangerous shifts in climate and weather.

- Warmer temperatures increase the frequency, intensity, and duration of heat waves, which can pose health risks, particularly for young children and the elderly (USGCRP, 2017).
- Climate change can also impact human health by worsening air and water quality, increasing the spread of certain diseases, and altering the frequency or intensity of extreme weather events (Ebi et al., 2018).
- Rising sea levels threaten coastal communities and ecosystems (Sarofim et al., 2016).
- Changes in the patterns and amount of rainfall, as well as changes in the timing and amount of stream flows, can affect water supplies and water quality and the production of hydroelectricity (Fann, et al., 2016).
- Changing ecosystems influence geographic ranges of many plant and animal species and the timing of their life cycle events, such as migration and reproduction (Reidmiller et al., 2018).
- Increases in the frequency and intensity of extreme weather events, such as heat waves, droughts, and floods, can increase losses to property, cause costly disruptions to society, and reduce the affordability of insurance (Ebi et al., 2018).
- Farmer incomes can decrease due to a decrease in coffee yields and an increase in the costs of production associated with irrigation and control of coffee insect pests and diseases (Jassogne & Läderach, 2013).



Illustration 49: Effects of Climate Change

8.1.5 Impact of Climate Change in Tanzania

The adverse impacts of climate change are already taking their toll on the livelihoods of people and on different sectors of the economy in the country (Kahimba et al., 2015). Frequent and severe droughts in many parts of the country are being felt with their associated consequences on food production and water scarcity, among others. The recent severe droughts which hit most parts of the country leading to severe food shortages, food insecurity, water scarcity, hunger and acute shortage of power signifies the vulnerability of the country to the impacts of climate change.

- The mean temperatures in Tanzania's Arabica growing regions increased by 1.42 °C between 1960 and 2010 and are projected to rise by a further 2 °C by 2050 (Wagner et al., 2021).
 - Projecting this forward, every 1 °C rise in Tmin will result in annual yield losses of $137 \pm 16.87 \text{ kg ha}^{-1}$ ($P = 1.80\text{e-}10$). The effect on rainfall is more difficult to predict (Craparo et al., 2015). Warmer air means quicker water evaporation from surfaces, causing dry spells or droughts.
- Besides the potential impact on yields, climate change further threatens coffee quality as warmer temperatures speed up maturation, which could lead to smaller sized, lighter, and less dense beans.
- Decrease in rainfall (Mbwambo et al., 2022) is another impact noted in Arabica coffee growing areas.
- The extreme drop of water levels of Lake Victoria, Lake Tanganyika and Lake Jipe in recent years and the dramatic recession of 7 km of Lake Rukwa in about 50 years, are associated, at least in part, with climate change, and are threatening economic and social activities.
- Eighty percent of the glacier on Mount Kilimanjaro has been lost since 1912 and it is projected that the entire glacier will be gone by 2025.

Some potential negative climate impacts on Arabica and Robusta varieties are summarized in Table 15.

Table 16: Some Direct and Indirect Impacts of Climate Change on Arabica and Robusta Coffee

| Climate Hazard | Direct Impact on Arabica Trees | Direct Impact on Robusta Trees | Indirect Impacts on Coffee Growing Systems |
|----------------------------------|---|--|---|
| Extreme Temperatures | <p>>23°C: Faster fruit ripening, leading to progressive quality loss</p> <p>>25°C: Reduced photosynthetic rate</p> <p>>30°C: Reduced tree growth. High temperatures can cause leaf and stem abnormalities and flower abortion.</p> | Damage to leaf tissue and trunks at extremely low temperatures | Pests and diseases may increase |
| Heavy Rain/Hail/Strong Winds | Tree damage, increased fruit fall, especially close to the harvest | Tree damage, increased fruit fall, especially close to the harvest | Weaker trees, wilting, increased mortality of young trees |
| Intermittent and Unseasonal Rain | Greater flowering frequency | | Possible increase of some diseases; post-harvest drying difficulties |
| Prolonged Rain | May reduce flowering, affect fruit set, lower photosynthesis because of continual cloudiness | | Increased humidity may favor some fungal diseases; may increase mortality of some insect pests such as coffee berry borer (CBB); poor drying of parchment, thus affecting quality |
| Prolonged Drought | Weaker trees, wilting, increased mortality of young trees | Robusta requires heavier rainfall, so irrigation may be needed | Stressed trees are more susceptible to some pests |

8.1.7 Mitigation Measures

Mitigation measures for climate change suggested and taken in Tanzania include:

1. Afforestation
2. Reforestation
3. Intercropping/agroforestry
4. Building water reservoirs like dams, ponds etc.
5. Use of environmentally friendly energy sources like geothermal, natural gas, solar, and wind energy rather than charcoal, coal, and fuel woods.
6. Use of organic manure which prevents nutrient and water loss.
7. Soil, as the biggest carbon sink on the planet, sequesters greenhouse gases by proper soil conservation methods like contour planting and no-till farming which do not disturb the soil.
8. In reducing methane, farmers may prevent submergence of rice fields and cultivate upland rice or other upland crops.
9. Destocking
10. Establishing greenhouse emission reduction projects like carbon trading, carbon sequestrations, REDD, REDD+, CDM.
11. Planting tree crops

8.1.7.1 Adaptation to Climate Change

Adaptation to climate change involves the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In Tanzania, adaptation measures undertaken and suggested include:

- Farmers planting different crops for different seasons
- Building levees against sea level rise
- Temporary and permanent migration
- Destocking
- Building water reservoirs
- Re-use, recycle and reduction of the use for resources like water
- Rainwater harvesting and retention
- Changing the planting seasons
- Intercropping
- Using less greenhouse gases sources of energy
- Livelihood/occupational diversifications
- Growing early matured crops
- Rearing drought resistant livestock
- Formulation of social climate resilient groups venturing in rural savings, table banking schemes, getting funding from innovations funds and micro-financing institutions
- Conservation agriculture (mainly reduced tillage soil cover)

- Crop rotations
- Establishment of community-based climate change adaptation organisations
- Establishing climate early warning systems
- Farming intensification and extensification
- Mulching to conserve moisture during droughts
- Kitchen gardens
- Pumping irrigations
- Chemical weed control
- Switching to off-farm activities

8.1.8 Adaptation and Mitigation Measures in Coffee Production

A coffee growing system that is exposed and sensitive to the effects of climate change is vulnerable, especially if it has only limited capacity to adapt. In contrast, a system is more resilient if it is less exposed, less sensitive, or has a strong capacity to adapt to the effects of climate change. Farmers must learn and adopt strategies that build their resilience to overcome climate change vulnerability. Mitigation strategies involve activities that reduce, prevent, or remove greenhouse gas emissions and therefore slow down or stop rapid climate change. This involves reducing industrial pollution and decreasing deforestation.

Coffee farmers must implement adaptive measures or utilise opportunities of climate change. Some proven methods for reducing the impacts of climate change on coffee production in Tanzania are:

8.1.8.1 Adapting to Rising Temperatures

(Impact: less soil moisture, more occurrence of diseases such as coffee leaf rust, more occurrence of pests such as coffee berry borer):

- Farmers must plant coffee varieties that are more drought-resistant and can better tolerate diseases such as coffee leaf rust. TaCRI has produced disease-resistant varieties that are available to farmers.
- Farmers must improve pest and disease management practices on their farms (scouting to detect early symptoms, physical removal of pests, preventive spraying).
- Farmers must grow trees on and around their farms. Trees help to shade coffee from the hot sun and maintain warmer temperatures when the air is cold. Trees with deep roots also help to draw water and nutrients from deeper layers of the soil, thus making them more accessible to the coffee plant.

8.1.8.2 Adapting to Increased Rainfall

(Impact: soil erosion, leaching of soil nutrients, humidity):

- Soil conservation measures such as mulching, growing cover crops, and digging channels slow down runoff caused by heavy rains, and rainwater can be collected for drier periods.

- Soil nutrition plans must compensate for depletion of nutrients (especially nitrates) due to leaching caused by too much rain.
- Proper coffee canopy management (pruning) can decrease favorable conditions for fungal diseases and pests.

8.1.8.3 Adapting to Drought

(Impact: extreme heat, dry air, and soil):

- Farmers must intensify their application of soil mulches and cover plants, and adopt irrigation, water harvesting and infiltration techniques.
- Drought resistant varieties of coffee have been developed and are available.
- Seedlings can be trained to grow longer tap roots to reach deeper and more humid layers of the soil.

8.1.8.4 Adapting to More Frequent and Stronger Winds

(Impact: damage to crops, warm air):

- Wind barriers around farms break the force of winds that physically damage crops, carry away bare soil, and cause warm winds to draw moisture from the soil and plants.

8.1.8.5 Adapting to Higher Risk of Variable Income

(Impact: less yield, poorer quality crops, higher cost of production):

- A diverse crop production reduces risks of lower yields and income from coffee. Farmers should consider income generating activities or business ventures related to coffee such as preparing and brewing coffee for local consumption and growing and processing food that is rich and varied in nutritional value (poultry for meat and eggs, vegetables, milk, yogurt, butter, honey) on the farm. Excess produce can be sold to meet the farm household's cash requirements.

8.1.7.6 Adapting to Uncertainty of Weather and Climate

- The capacity of farmer associations to jointly carry out mitigation/adaptation measures must be built or strengthened. This largely means strengthening leadership, improving cooperation between farmers, and building partnerships with stakeholders that can provide skills and knowledge needed to build climate change resilience.
- Farmers must develop interest and capacity to access and use weather forecasts and early warning systems to reduce their vulnerability against the impacts of climate change.



Illustration 50: It Is Important to Obtain News and Information about Climate

8.1.9 Opportunities Arising from Climate Change

Climate change will not affect all farmers and coffee growing areas in the same way. Areas that become unsuitable for growing Arabica coffee may become more appropriate for growing Robusta coffee. Farmers in those regions should consider diversifying the type of coffee they grow. Robusta is generally easier and cheaper to maintain than Arabica coffee.

Similarly, areas that did not have the right climatic conditions for growing coffee in the past may become suitable for growing either Arabica or Robusta coffee, depending on the climatic changes that take place. These farmers can diversify their present farms to include the coffee type and variety most suitable to the emerging weather conditions in their area. Farmers must seek advice from a TaCRI representative or agricultural extension officer.

Coffee growing areas that are expected to experience increased temperatures and more rainfall may benefit from increases in coffee yields.

The challenges to coffee farming presented by climate change and variability will force farmers to be more innovative and business-minded in their farming undertakings. This creates efficiency and drives profits.

8.1.10 References and Further Reading

International Coffee Council. (2009). *Climate Change and Coffee*, ICC 106-6 Rev. 1, London.

S. Mzezele & P. Kibuuka. (2011). *Geography in Focus, Form 4 – Student's Book*, Oxford University Press.

United Nation (2020). Causes and Effects of Climate Change Cited from <https://www.un.org/en/climatechange/science/causes-effects-climate-change>

(Coffee and Climate Initiative (2015). *Climate Change Adaptation in Coffee Production*, Available at: <http://www.coffeeandclimate.org/training.html>



8.2.1 Introduction

The Sustainable Agriculture Land Management (SALM) comprises measures and practices farmers are required to adopt so as to address biophysical and socio-economic conditions aimed at the protection, conservation and sustainable use of resources (soil, water and biodiversity) and the restoration of degraded natural resources and their ecosystem functions.

We Effect and Vi Agroforestry (2014) define Sustainable Agriculture Land Management (SALM) as a methodology for farmers to adapt to the impacts of climate change and achieve increased environmental resilience in different climate or agro-ecological zones.

According to FAO (2016) development and application of SALM technologies in a wide range of agro-eco systems (crop, livestock and tree-based) across coffee growing regions helps to restore healthy soils, vegetation and biodiversity.

The combination impact of SALM practices creates a conducive environment for coffee growing which leads to improved coffee production.

8.2.2 Common SALM Practices

8.2.2.1 Nutrient Management

The aim of this includes awareness creation among farmers on the common soil nutrients and the importance of soil nutrients for crop growth and productivity, as well as the discovery of ways through which they can increase and/or maintain the nutrients in the soil for food production. The ways to increase and/or maintain the nutrients in the soil include using mulching; application of composting and manure; planting cover/nitrogen-fixing crops; using recommended mineral fertilisers; and avoiding the use of restricted chemical fertilisers and chemical management.

8.2.2.2 Soil and Water Conservation

Coffee is cultivated in high lands where soil erosion can take place easily if not well controlled. Effective soil and water management practices can improve soil fertility and increase yields in a sustainable way. Therefore, farmers must understand the means for conserving soil and water to ensure high productivity. The ways used for soil and water conservation include terracing; contour bunds; broad beds and furrows; semi-circular bunds; trash lines; diversion ditches and cut-off drains; retention ditches; pitting; trenches; tied ridges; grass strips; irrigation; roof catchment; ground surfaces and rocks; irregular surfaces; tanks; birkas; pans; ponds; dams; wells and boreholes; ecological sanitation; and kitchen water.

8.2.2.3 Agronomic Practices

The implementation of appropriate and recommended agronomic practices is the best way to attain better yields and productivity, adapt to climate change and increase the resilience of the crop land. The best agronomic practices advocated under SALM practices are crop rotation, intercropping, green manure, contour strip cropping, relay cropping, and use of improved crop varieties.

8.2.2.4 Agroforestry

Agroforestry is the deliberate growing of woody perennials (trees, shrubs) as agricultural crops alongside other crops and/or livestock in the same land. It improves productivity and mitigates the impacts of climate change (adaptation and mitigation). Existing trees can be protected and managed, or/and new ones planted. Trees can be planted amongst crops; livestock; crops and livestock; insect pests; and fish. Woodlots, boundary planting, dispersed interplanting and fruit orchards are among the recommended strategies farmer can adopt to increase productivity, sustainability, and adoptability. These strategies can contribute to social, economic, and environmental benefits.

8.2.2.5 Tillage and Residue Management

The effective use of residue and leftovers in coffee farms can contribute to increase soil fertility and productivity, quality and profitability. Among the strategies for tillage and residue management are no-tillage/zero-tillage; reduced tillage; pitting systems; stubble and residue mulch tillage; dibble stick planting; strip and spot tillage; ripping; ridge and furrow tillage; and residue management.

8.2.2.6 Restoration and Rehabilitation

Land is degraded when it is infertile, saline, acidic, eroded, weedy, and low in organic soil matter. Degraded land can decrease productivity and increase the cost of crop production. Awareness creation among farmers on how they can restore the land by returning lost nutrients, improving soil structure, and finding alternative nature-based land uses such as beekeeping or planting fodder plants is essential. Among the proposed strategies are natural regeneration, assisted natural regeneration, enrichment planting, fire management and agroforestry.

8.2.2.7 Integrated Livestock Management

Coffee farming systems in Tanzania cover a diversity of crop and livestock keeping. An integrated livestock system usually consists of different mixed components, for example, livestock with crops, or livestock with bees and crops, or livestock with crops and fish. These components work together in a natural cycle to maximize resource use. The products or byproducts of one component (i.e., manure from livestock) are used as a

resource for another component (i.e., crops). Several components: land or soil, water, crops/vegetation, feeds, livestock, manure, and waste are considered to achieve efficient livestock production.

8.2.2.8 Sustainable Energy

Sustainable energy refers to the production and efficient use of renewable energy resources to ensure land productivity; reduce emission of greenhouse gases; and conserve the environment. Sustainable energy often also has other benefits such as improved health (because of less smoke from fuel wood) and lower costs (such as free solar power). Farmers in East Africa mainly use firewood, charcoal, wood wastes, and crop residues as sources of energy. But other sources are also available such as solar, wind and biogas. Farmer should know different sources of energy such as the use of biomass, biogas, farm residues, energy-efficient stoves and sustainable charcoal production.

8.2.2.9 Integrated Pest Management

Integrated Pest Management (IPM) is a system of crop production and protection. It uses a variety of methods to prevent pathogens, insect pests, and weeds from causing economic crop losses whilst ensuring cost-effectiveness and preservation of the environment. In other words, it is a long-term technique to reduce/stop pests and diseases from multiplying. Farmers should know about biological pest control, use of crop-resistant varieties, and alternative agricultural practices (spraying, use of fertilisers, pruning, mechanical pest control, cultural methods, and pest management plan) so as to increase productivity, quality and profitability.

8.2.3 References and Further Reading

FAO (2016): Informing Future Interventions for Scaling-up Sustainable Land Management; Lessons Learned For Decision Makers From A Review Of Experiences Of The Terrafrica Strategic Investment Programme On SLM In Sub-Saharan Africa (SIP) Under The NEPAD – Terrafrica Partnership Framework

We Effect and Vi Agroforestry (2014). A Training Material: Sustainable Agriculture Land Management

Chapter Eight Lesson Plan

Lesson Objectives:

- Understand basic causes and impacts of climate change, particularly those relevant to coffee farming systems
- Learn simple climate change adaptation practices and how these are related to good agricultural practices
- Recognize what Sustainable Agricultural Land Management (SALM) Practices to do to ensure good coffee yield and quality

Lesson Materials:

- Coffee Sustainability Trainer's Manual
- Flipchart/white board and marker pens (different colours if possible)
- Posters

Key Points to Share:

- Climate change is happening because carbon dioxide and other “greenhouse gases” are getting trapped in Earth’s atmosphere and are warming up the planet faster than ever before. This causes temperature and weather changes that are having serious impacts on humans and agriculture.
- Climate change is not “an act of God”, but rather human activities are responsible. Human activities are emitting more carbon dioxide and other “green house gases” than ever before.
- Farmers can adopt adaptation strategies to reduce their risk and the impacts of climate change on their farming activities.
- There are no “best” adaptation solutions for dealing with climate change impacts. Solutions depend on the particular environment, and farmers must assess their particular situation and try different options before deciding which are most suitable.
- The Sustainable Agriculture Land Management (SALM) comprises measures and practices help protect, conserve and encourage sustainable use of resources (soil, water and biodiversity) and the restoration of degraded natural resources and their ecosystem functions.

| Topic | Topic Objectives | Training Activities |
|--------------------|---|--|
| 8.1 Climate Change | <ul style="list-style-type: none"> • Define climate change and understand its causes • Understand the direct and indirect impacts and risks of climate change to farming systems • Understand the basic meaning of and difference between “adaptation” and “mitigation” strategies | <p>Lecture, Discussion and Visual Aids Introduce the information in Topic 8.1. Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Terminology Discussion Discuss the terminology (weather, climate, climate hazard, global warming) in the group. Have participants heard about these terms before? Do they understand the carbon cycle and why climate change is happening now faster than it ever has before?</p> <p>Group Discussion Identify and discuss destructive and beneficial land use practices they have observed in their area. Discuss how these practices (good and bad) can be addressed and changed (for bad practices) or increased (for good practices) in their community.</p> <p>Experience Sharing Discuss the personal experiences that different farmers have had related to climate change impacts in their area.</p> <p>Group Discussion As a group, distinguish between the direct impacts (affecting coffee plants) and indirect impacts (affecting the coffee production system as a whole) of climate change in the area. What are the risks of climate change to coffee farming in the area?</p> <p>Terminology Discussion Discuss the difference between the terms “adaptation” and “mitigation”. How can farmers adapt to climate change? How can they mitigate the effects of climate change?</p> <p>Group Discussion Identify adaptation and mitigation strategies observed or practiced by farmers in your area. Discuss the feasibility, cost, and benefit of the suggested adaptation measures, including measures they have taken themselves.</p> <p>Group Discussion Discuss how farmers currently receive information about weather and climate forecasts. How can this be improved? Discuss how adaptation and mitigation practices can be shared more widely in the community.</p> <p>Group Discussion Examine each climate change impact that is affecting your area and discuss how farmers may be able to exploit future farming and livelihood activities to take advantage of climate change.</p> |

| Topic | Topic Objectives | Training Activities |
|---|--|--|
| B. Sustainable Agriculture Land Management (SALM) | <ul style="list-style-type: none"> Understand the common SALM practices | <p>Lecture, Discussion and Visual Aids Allow participants to ask clarifying questions. Start discussions around concepts or information that is new to them. Use each visual aid to assist your lecture and discussions.</p> <p>Experience Sharing Discuss which SALM practices farmers carry out (and when) on a regular basis.</p> <p>Drawing and Discussion Ask participants to draw a map of their farm and then identify common SALM practices suitable for their land. Then discuss any SALM practices that are not commonly practiced and why they are not carried out as often. Discuss how these less frequently practiced SALMs might affect the productivity of coffee farms. Finally, advise farmers about whether they are carrying out SALMs in the correct frequency.</p> <p>Farm Visit Visit a coffee farm where SALMs are practiced and discuss the benefit of each practice.</p> |

