MARKUP
EU-EAC MARKET ACCESS UPGRADE PROGRAMME

STUDY

COFFEE PROCESSING MANUAL FOR EAST AFRICA




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East African Community

International Trade Centre

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Foreword

The International Trade Centre (ITC) is a joint agency of the United Nations and World Trade Organization based in Geneva. Her mission is to enable small businesses export success in developing and transition-economy countries, by providing, with partners, sustainable and inclusive development solutions to the private sector, trade support institutions and policymakers. Along with the United Nations family and partner organizations, ITC's projects and programs are part of the global efforts to achieve UN Global Goals for Sustainable Development and the Aid for Trade agenda. The European Union (EU) funded Market Access Upgrade Program (MARKUP) is a four-year program implemented in the East Africa Community (EAC). The project is being implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the International Trade Centre (ITC), the United Nations Industrial Development Organization (UNIDO) and other partners at the national level. The MARKUP program assists small and medium-sized enterprises (SMEs) in Burundi, Kenya, Rwanda, Tanzania and Uganda to increase exports of their agri-products, promote regional integration and improve access to the European market. It targets specific agricultural commodities including avocado, cocoa, coffee, spices, tea and horticulture. The program supports SMEs to improve the quality of their products by aligning them with international standards. This will allow EAC agribusinesses to benefit from existing opportunities in both East African and European markets. The MARKUP capitalizes on this to help create sustainable market linkages between EU and EAC thus contributing to job creation and inclusive development in the region. Part of the program objectives implemented by ITC are: Strengthened capacity to advocate for the removal of sector trade barriers; enhanced export competitiveness for SMEs; and Improved business development capacities for SMEs. To achieve these objectives, ITC seeks to support technical training that will contribute to the improvement of processing efficiency, optimization of quality, enhancement of waste and water management and promotion of innovation. The purpose of this manual is to provide course materials for training coffee companies, cooperative washing station owners and staff in addition to regional based coffee post-harvest handling experts. This will in turn enhance the global competitiveness of African coffee through product differentiation and quality enhancement. The manual covers key areas namely; coffee fruit and seed anatomy; highlights on quality coffee production; coffee processing techniques; water use and treatment; factory capacities and maintenance; occupational safety and health; coffee storage and transportation; secondary processing; quality assessment; market requirements; food safety and traceability; record keeping and documentation; information monitoring and dissemination.

Contents

Abbreviatoins and Acronyms

Unless otherwise specified, all references to dollars ($) are to United States dollars, and all references to tons are to metric tons.

B	Boron
BBC	Bacterial Blight of Coffee
BM139	Bourbon Mayaguez 139
BM71	Bourbon Mayaguez 71
Ca	Calcium
CAN	Calcium Ammonium Nitrate
CBD	Coffee Berry Disease
CLR	Coffee Leaf Rust
Cm	Centimeter
CWD	Coffee Wilt Disease
DR Congo	Democratic Republic of Congo
EAC	East Africa Community
EU	European Union
F1	First Filial Generation
Fe	Iron
ft	foot
g	gram
GAP	Good Agricultural Practices
GCC	Global Commodity Chain
GHG	Green House Gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
Ha	Hectare
ICO	International Coffee Organization
IPM	Integrated Pest Management
ISO	International Organization for Standardization
ITC	International Trade Centre
K	Potassium
K7	Kent 7
Kg	Kilogram
L	Litre
MC	Moisture Content
Mg	Magnesium
ml	Millilitre
mm	Millimeter
MRL	Maximum Residue Limit
N	Nitrogen
OSH	Occupational Safety and Health
OTA	Ochratoxin A
P	Phosphorus
P1	Parchment Grade 1
P2	Parchment Grade 1
pH	Measure of Hydrogen Ion Concentration (Measure of the acidity or alkalinity of a solution)
PL	Parchment grade classified as lights
PPE	Personal protective equipment
ppm	Parts per Million
RH	Relative Humidity

S	Sulphur
SCA	Specialty Coffee Association
SMEs	Small and Medium-Sized Enterprises
SOP	Standard Operating Procedures
TDS	Total Dissolved Solids
TSP	Triple Super Phosphate
UNIDO	United Nations Industrial Development Organization
USD	United States Dollars
Zn	Zinc

**Codex Alimentarius - a collection of internationally recognized standards, codes of practice, guidelines, and other recommendations relating to foods, food production, and food safety.

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MODULE 1: PRINCIPLES OF QUALITY COFFEE PRODUCTION

1.1 Introduction

Coffee wet mill managers/operators play a big role in overseeing quality coffee processing. They receive cherry coffee from producers and oversee the whole chain of processing up to delivery of parchment to dry mills. At the dry mill, the parchment is milled, graded, classified and a quality analysis report is generated. The reports, which gives details of the final bean quality in terms of grades and cup attributes in addition to any observed defects is submitted to the wet mill managers and owners. The defects are associated with either on-farm (producer) or processing (wet mill) practices. The wet mill managers are supposed to analyse the report and obtain the root cause and possible remedies for each specific defect for purposes of advising the respective actors especially the farmers. This is important in obtaining remedial measures and to prevent recurrence of the defects in future. Therefore, the wet mill owners, managers and staff need to have knowledge on each of the farm related defects and be able to offer some advisory services on key coffee agronomic practices. This module aims at giving the wet mill team a brief overview of the best agronomic practices for purposes of monitoring and improving the coffee quality and yields from seed to cup.

1.2 The Coffee Plant

Plant Description

- The coffee plant is an evergreen tree often with multiple stems and smooth leaves which are dark, glossy green and oval in shape.
- During the first 2 months, the pinhead develops into a berry, which expands rapidly in the next 3 months.
- The green berry, which normally possesses two seeds, ripens to a crimson red cherry which turns black when dry.
- It takes 8-9 months from flowering to cherry ripening.

Coffee Fruit and Seed Anatomy

- The coffee fruit is called berry when unripe and cherry when ripe. It normally contains two coffee beans.
- Each bean is enclosed in a tough membrane called parchment. A thin testa (silver skin) adheres to each bean.
- Parchment coffee refers to coffee beans after pulping and drying.
- Dried cherries are refered to as naturals (Buni)
- Clean coffee refers to coffee beans that have been milled to remove the husk and silver skin.

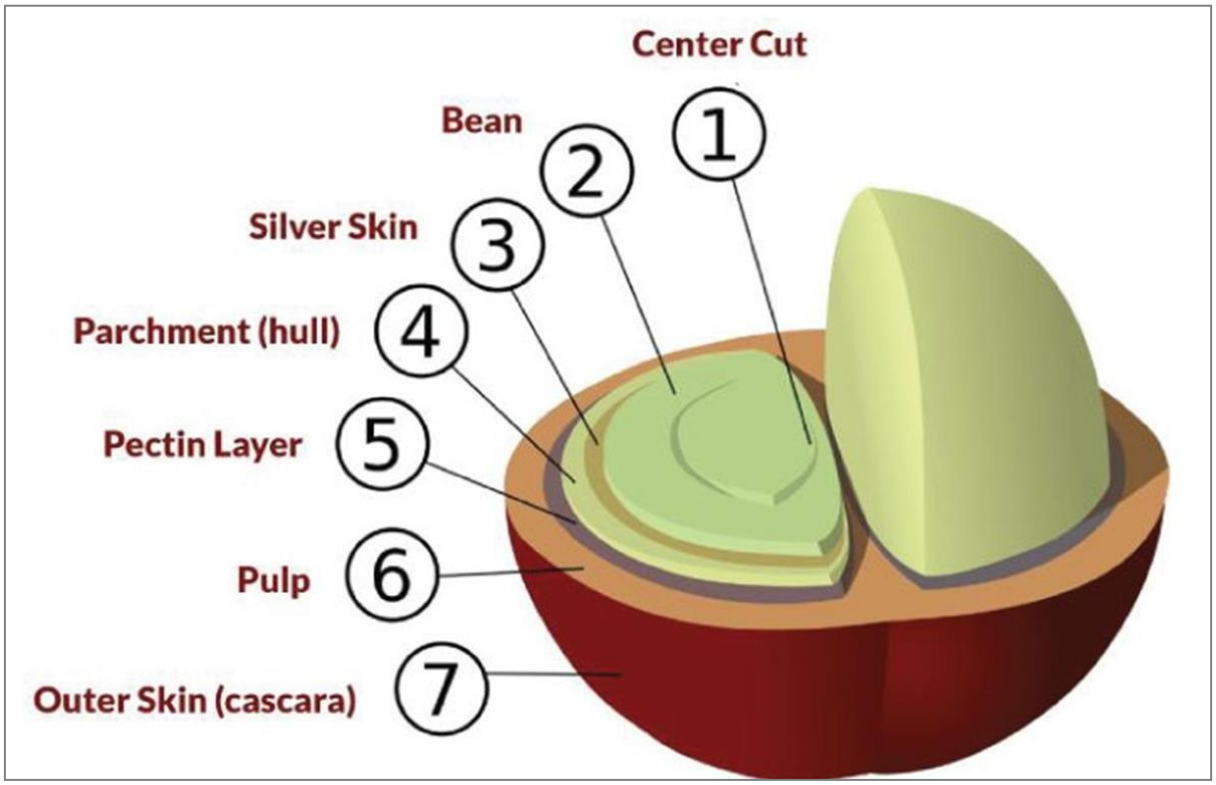


Figure 1.1: Anatomy of a coffee cherry

Major Coffee Types (Arabica vs. Robusta Coffee)

- There are two cultivated coffee species of economic importance namely; Arabica and Robusta coffee.
- Arabica coffee is normally grown in cooler, high altitude areas in tropical and sub-tropical areas while Robusta coffee is normally grown in warmer areas at lower altitudes
- Robusta coffee is more resistant to major coffee diseases but its bean quality is relatively lower attracting approximately 30% the price of Arabica. However, it yields about 30% more than Arabica and is mainly dry processed.
- Arabica coffee accounts for about 75% of the total world coffee production and the rest is mainly Robusta coffee
- Examples of Arabica coffee produced in East African region include: SL28, SL34, K7 (mainly grown in Kenya), Bourbon Mayaguez 139, Mibirizi Jackson 2/1257 Bourbon Mayaguez 71 (BM71) (commonly grown in Rwanda and Burundi), KP423 (Grown in Tanzania), Nyasaland (Nyasa) and SL14 (grown in Uganda).
- Varieties vary in the size of cherries thus the wet mill managers should have a clear understanding of these variations to enable them adjust the pulpers appropriately to avoid nipping of beans and introducing pods in the parchment.

Figure 1.2: Arabica coffee tree (a) and Robusta coffee tree (b)

1.3 Ecological Requirement

Rainfall

- Arabica coffee production requires an annual rainfall of above 1000 mm with a 2 months' dry spell to harden the wood and bring it into cycle of flowering while Robusta requires above 900 mm.
- Lack of a dry spell results to poor flowering.
- Insufficient moisture in the third and fourth month after fruit set results in reduced bean size thus loss in yields and quality

Temperature

- The optimum mean annual temperature range for Arabica coffee is 18-21ºC.
- Above 23ºC, development and ripening of fruits are accelerated, often leading to loss of quality.
- A relatively high temperature during blossoming, especially if associated with a prolonged dry season, may cause abortion of flowers.
- For Robusta coffee, the optimum mean annual temperature ranges from 22 to 30ºC.

Altitude

- Robusta coffee can be grown between sea level and 800 meters above sea level.
- Arabica coffee grows best at 1200-2100 meters above sea level.
- Coffee grown in high altitude areas tend to have better quality.

Soils

For optimal production, the soils should be deep (min 1.8m), well drained, fertile, with a pH range of 4.4 – 5.4 (slightly acidic).

1.4 Agronomic Practices

Establishment

- Proper establishment is critical in ensuring healthy coffee trees that yields beans of good quality
- Ensure proper soil and water soil and water conservation measures are undertaken as this enhances production and quality of coffee beans

Coffee Nutrition

- The coffee tree requires certain elements in large quantities (Macro-Nutrients) such as Nitrogen, Phosphorous, Potassium, Magnesium and Calcium.
- Other elements are required in very small quantities (Micro-Nutrients) such as Zinc, Boron, Iron, Manganese, Sulphur among others.
- Poorly fertilized coffee tree usually show visual deficiency symptoms and under extreme cases the tree tends to shed its leaves as it redirects the available resources to the developing berries.
- Consequently, the tree is left with poor leaf to fruit ratio and the emaciated berries remain on the tree without ripening (Figure 1.3).
- This results in dieback and eventual death of the entire tree.

Figure 1.3: Poorly fed coffee tree (a) and well-fed coffee tree (b)

Table 1.1: Element Importance in Coffee

ELEMENT	IMPORTANCE IN COFFEE	EFFECT OF DEFICIENCY ON YIELDS AND QUALITY
Nitrogen (N)	- Enhances vegetative growth - Promotes crop bearing capacity - Enhances bean size (results in larger bold beans which give high quality coffee and premium grades	- Small beans (pods) - Ragged beans - Reduced yields - Loss in quality
Phosphorus (P)	- Development of roots and bearing wood - Ensures early berry maturity - Enhances bean weight	- Lack of body in the cup - Small beans - Low density beans thus - Loss in quality
Potassium (K)	- Promotes berry development and uniform ripening - Enhances Water utilization efficiency - Ensures mucilage formation which facilitates pulping - Enhances translocation of assimilates	- Reduced size of berries - Nipping of beans during pulping - Loss in yields and quality
Magnesium (Mg)	- Enhances bean colour (Blue/Green grey colour) - Facilitates photosynthesis	- Poor bean colour - Poor quality beans
Calcium (Ca)	- Growth of terminal buds/flower formation	- Reduced yields
Zinc (Zn)	- Influences leaf size - Intensifies flower initiation and formation	- Reduced yields
Boron (B)	- Promotes shoot growth - Facilitates optimal flowering Enhances fruit set	- Flower abortion - Reduced yields
Iron (Fe)	- Chlorophyll synthesis for food formation - Promotes bean colour	- Amber beans in clean coffee - Pales in roast thus - Loss in quality
Sulphur (S)	- Enhances aroma of the liquor	- Reduced quality

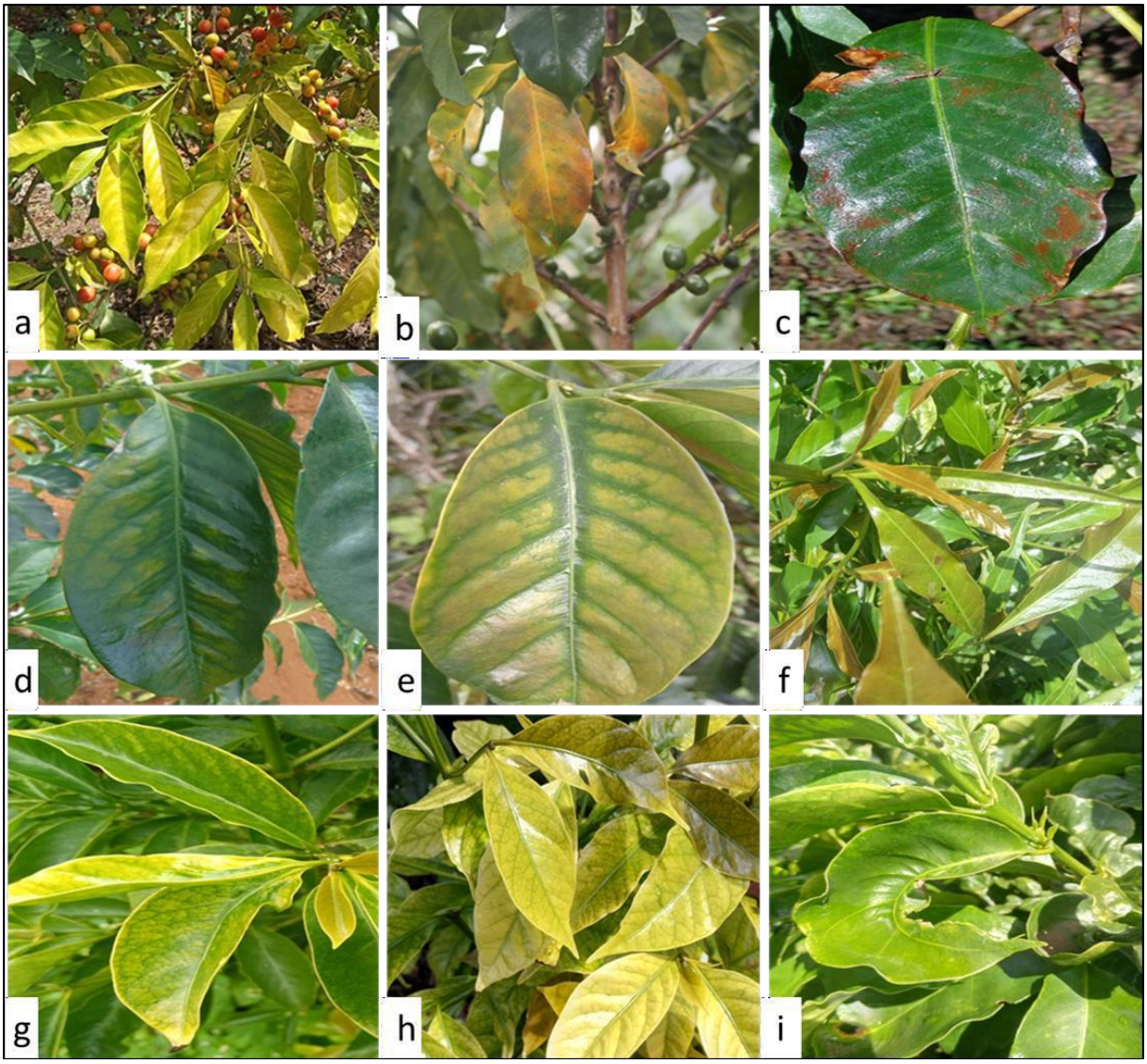


Figure 1.4: Pictorial Illustration of Some Nutrients' Deficiency: Nitrogen deficiency (a); Phosphorous deficiency (b); Potassium deficiency (c); mild Magnesium deficiency (d); acute Magnesium deficiency (e); Zinc deficiency (f), mild Iron deficiency (g); acute Iron deficiency (h) and Boron deficiency (i)

Canopy management

Canopy management is the process of optimizing bearing wood in order to concentrate energy for regular annual cropping through pruning, tree training, handling, de-suckering and change of cycle.

Figure 1.5: Un-pruned coffee tree (a) and well pruned coffee tree (b)

Importance of canopy management

- Rejuvenate the plant for improved yields and quality
- To maintain suitable crop leaf ratio in order to have good bean size
- For ease of management of insect pests and diseases
- To reduce chemical use
- Open up the tree to light and air for better flowering and fruiting

Weed management

- Weed competition can cause up to 50% reduction in yields and lead to development of light small beans of poor quality
- Weeds can be controlled using the following methods:
    - Mechanical methods e.g. hoeing
    - Cultural Methods e.g. mulching and use of cover crops
    - Chemical Control - use of herbicides
    - Integrated weed control – combination of several methods in weed management

Coffee Shading

- Shade in coffee has the following advantages:
    - Enhances coffee quality by slowing down the maturity process in high temperature areas.
    - Reduces the incidences of CLR and helps in controlling some pests such as thrips.
    - Prevents overbearing and shoot dieback under lower standards of crop management or sub-optimal ecological conditions.

- Recommended shade trees include leucaena (*Leucaena leucocephala*), *Grevillea robusta*, *Albizia spp* and *Cordia abyssinica*.

1.5 Diseases and Pest

Coffee Diseases

Coffee diseases reduces yields and quality. The main coffee diseases are;

Coffee Berry Disease (CBD)

- CBD is a problem in Arabica Coffee only
- It infects mainly the green immature berries, a stage at which it can cause up to 80% crop loss if conditions are favorable and no control is undertaken
- It can attack ripening cherries a stage at which it is referred to as the brown blight
- Management can be achieved through use of resistant varieties or chemical application

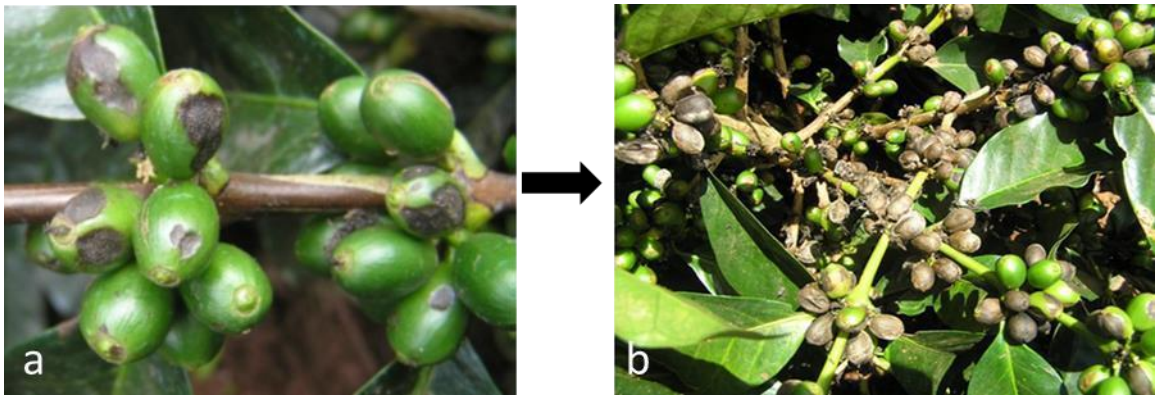


Figure 1.6: Symptoms of Coffee Berry Disease as characterized by dark lesions on expanding berries (a) and black, shriveled berries at an advanced stage (b)

Coffee Leaf Rust (CLR)

- CLR affects both Arabica and Robusta coffee but the magnitude in the former is higher than the latter.
- The disease is characterized by dusty or powdery coating of yellow spores covering the underside of the coffee leaves.
- The disease causes crop losses of 20–25% but this can increase to over 80% under favorable conditions if no control is applied.
- Management can be achieved through use of resistant varieties or chemical application
- The disease can also be mitigated by growing coffee under partial shade.

Figure 1.7: Symptoms of Coffee Leaf Rust on the underside of the leaves

Coffee Wilt Disease (Robusta only)

- Indicative symptoms include wilting, chlorosis and defoliation of the aerial parts of the crop and numerous vertical and spiral cracks in the bark of the trunk and finally death of the tree
- Infected berries turn red and appear to ripen early.
- Seed infection causes blue-black dis-coloration of the parchment and silver skin.
- The disease can be controlled through:
    - Use of disease-free seed
    - Frequent inspection of the crop, along with burning infected material and spraying the soil surface with 2.5% copper sulphate.
    - Replanting should not be done until 6 months after uprooting infected trees to allow the disease in the soil to decline.

Figure 1.8: Symptoms of Coffee Wilt Disease

Other Coffee Diseases

- Other coffee diseases include Bacterial Blight of Coffee (BBC), Fusarium Bark Disease and Fusarium root disease.

Coffee insect pests

Antestia Bug

- Causes “zebra” lines on the parchment
- Can be prevented through timely pruning and de-suckering
- Chemical control is recommended when infestation reaches 1 - 2 bugs per tree
- Some naturally occurring parasitic wasps attack Antestia eggs. Attacked eggs are black while normal eggs are white).

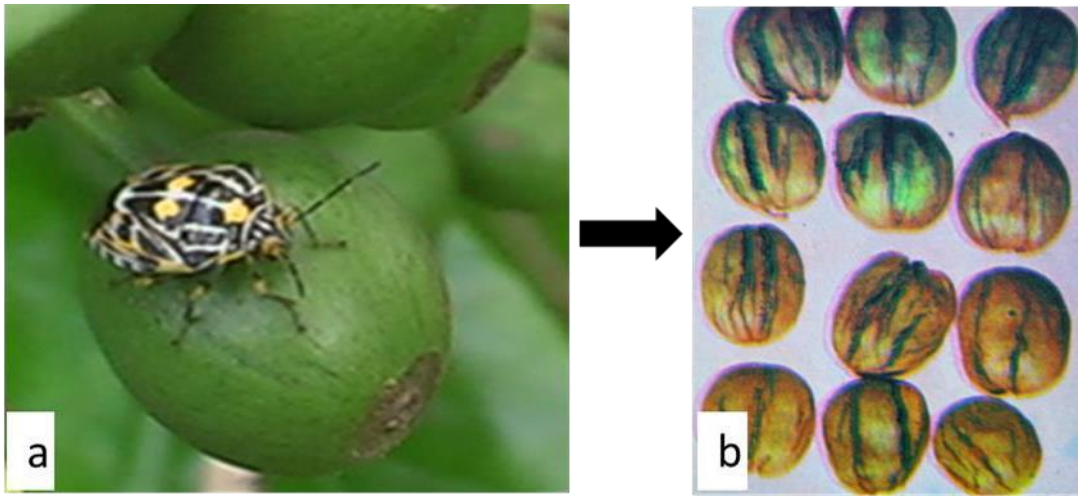


Figure 1.9: Adult antestia bug and manifestation of damage caused on the coffee beans

Berry Borer

- It is a small beetle which digs a short tunnel from the top of the fruits, marked on the outside by a small hole (1mm diameter).

Control

- Regular picking and field hygiene (strip after harvesting and dry as buni; collect fallen beans and bury/ burn).
- The pest has several natural enemies including Uganda wasp.
- Heavy shade however, can cause outbreak of the pest discouraging its natural enemies.

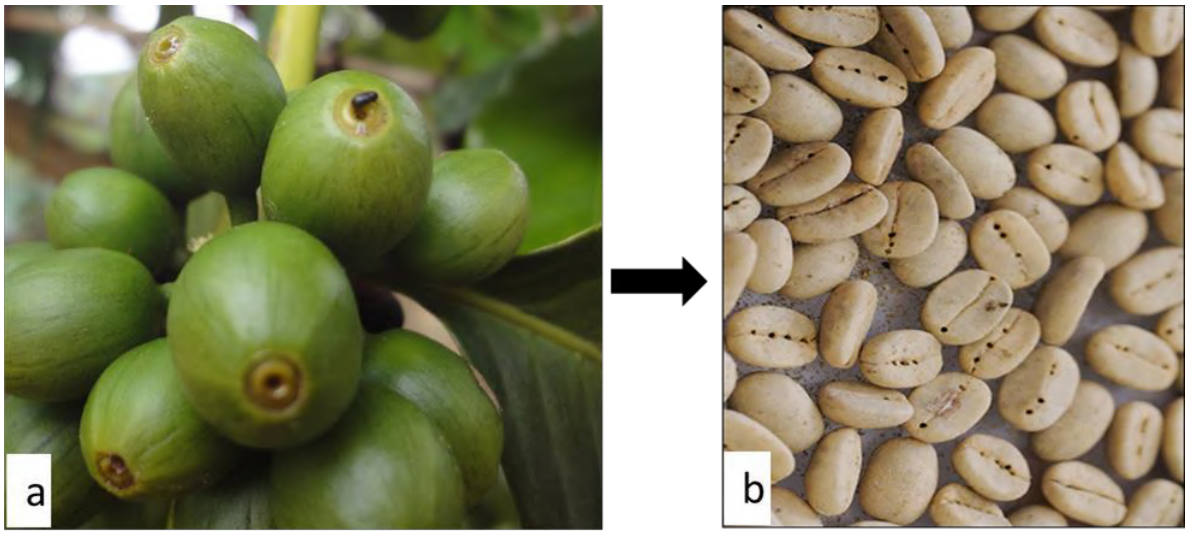


Figure 1.10: Berry borer entering a coffee berry (a) and resultant damage on the coffee beans (b)

Berry Moth

- The larvae develop in the fruits.
- The entry holes are 2mm in diameter on the bottom of the fruit.
- Berry clusters are webbed and one or more berry is brown or black, dry and hollow. Brownish frass (solid insect excreta) will be observed on attacked berries or entangled in the web.

- Damaged beans are of low quality and may be an avenue for mould infection.
- Berry moth damage is less in lightly shaded coffee.

Control

- Scouting for the pest during early berry development stage is recommended and if noticed, should be immediately sprayed with recommended insecticides and repeated 5-6 weeks later.
- All webbed clusters of berries should be stripped and destroyed by burning or deep burying
- The pest is also attacked by parasitic wasps which occur naturally in coffee farms.

Figure 1.11: Berry moth damage

Coffee Mealy Bug

- Mealy bugs suck sap from coffee plant tissues, especially the soft and succulent ones leading to loss in quality of beans
- White masses of bugs can be seen on upper side of leaves, and between berries, flower buds or on sucker tips.
- Infected coffee plants shed their leaves and can dry up under heavy infestation.
- The pest can be controlled through a combination of measures:
  - Banding the tree trunks with 20 cm wide plastic bands covered with a sticky substance mixed with insecticides to keep off the ants.
  - Remove suckers and branches that touch the ground as well as tall weeds
  - Naturally by parasitic wasps that feeds on the bug

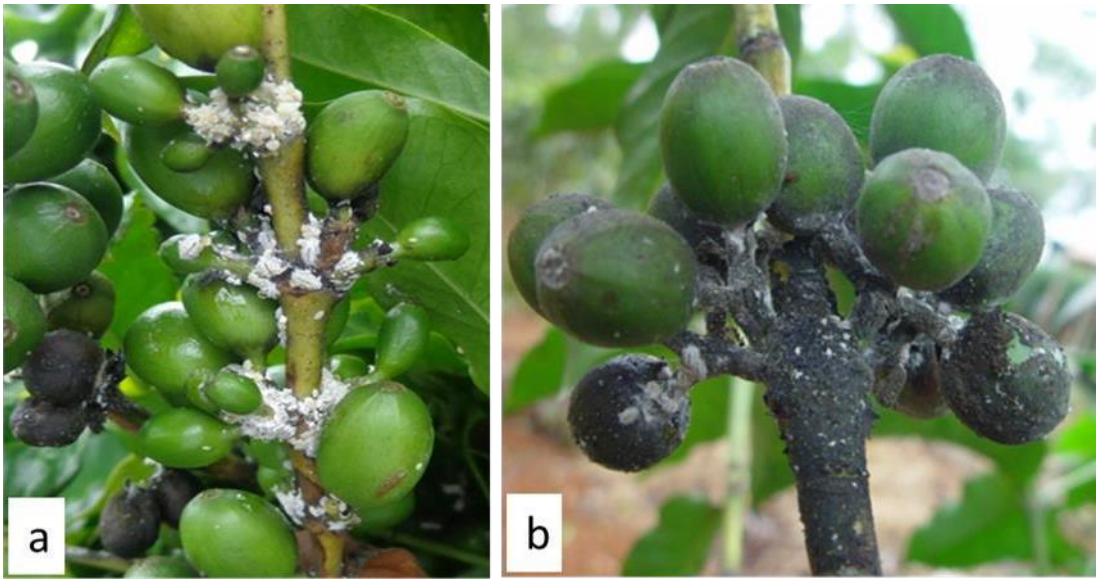


Figure 1.12: Coffee mealy bug damage at early (a) and late (b) stages

Coffee Thrips

- Attacks the underside of leaves causing silvery patches covered by minute black spots during the hot and dry periods
- In severe attacks, the berries and green shoots are also affected leading to severe loss of yields and quality

Control

- Some species of fairy fly (tiny wasps) parasitizes the eggs. Nymphs and adults are attacked by various predators especially other species of thrips.
- Mulching controls thrips by preventing pupation which takes place below the soil surface.
- Coffee shading helps to regulate harsh weather conditions thus making it unfavourable for thrips multiplication.
- Chemical control is necessary if thrips exceed 1-2 per leaf during dry periods.

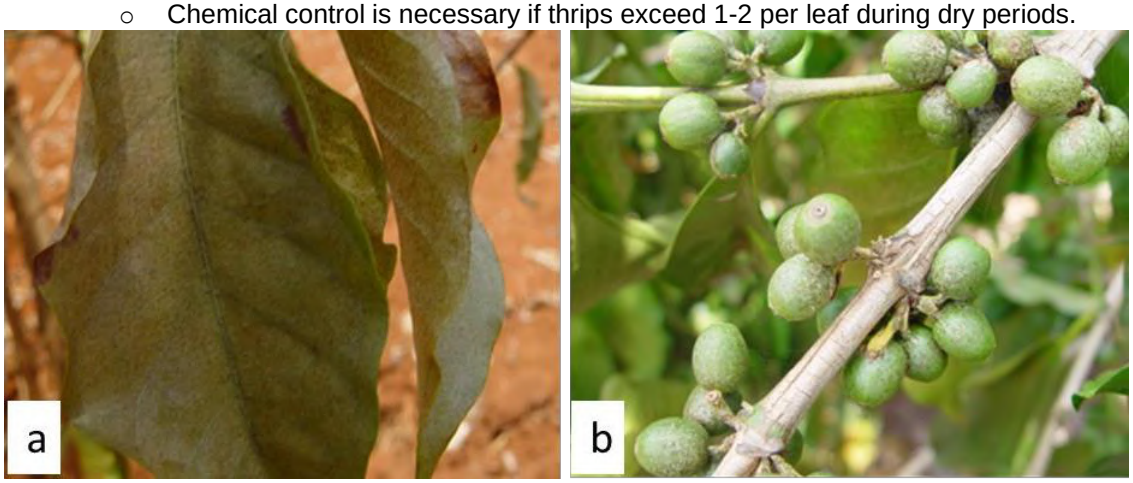


Figure 1.13: Thrips damage on leaves (a) and berries (b)

Scales

- There are many types of scales that attack coffee including green scales, brown scales, white waxy scales and star scales.
- Sucks sap from coffee plant tissues especially the soft and succulent ones.
- This leads to reduction in yields and quality.
- Scales produce (sugary) honeydew that attracts black ants.
- Soot-like black fungus may grow on honeydew.

Figure 1.14: Green scales damage on coffee twigs

1.6 Traceability and compliance in agromonic practices

To ensure best agricultural practices are adhered to;

- Proper records should be kept for every activity undertaken. These include activity, input and production records.
- Producers should use only internationally recommended chemicals and spray only when economic injury level is reached in case of insect pests.
- Producers should also endeavour to acquire various certification standards.

MODULE 2: CROP ESTIMATION AND FACTORY CAPACITIES

2.1 Introduction

Crop and factory capacities estimation assists the wet mills managers in planning for adequate processing facilities such as fermentation tanks, drying tables, and materials needed for coffee drying and storage space. The estimates also assist in budgeting for coffee picking and processing expenses.

2.2 Crop estimation

Timing of crop estimation

Crop estimation can be done at various stages of crop development depending on the purpose:

- Flowering stage – the bearing branches with flowers should be considered

Figure 2.1: Coffee tree at flowering stage

- Pinhead stage - Estimation at this stage is important in determining additional N to apply. However, estimating by actual count method at this stage may result to losses due to mechanical damage
- Rapid expansion stage – This is the 7 – 17 weeks after flowering
- Endosperm growth stage - Soft green berry stage at 12 – 19 weeks from flowering
- Endosperm hardening stage: Green berry stage at 19 – 35 weeks after flowering
- Green mature berry stage - this is the stage where berries are over 35 weeks

Figure 2.2: Coffee berries at rapid expansion stage

Methods used in crop estimation

- Past production records – This is based on production over a period of time (5 – 10 years) by taking the means/averages
- Visual observation method
    - Entails a visual assessment of the bearing canopy at every stage of crop growth.
    - Can be used in conjunction with past record/production trends to make a fairly correct forecast
    - Requires on-farm experience to achieve significant level of reliability
    - It is less costly/tedious
- Actual count method – This is a reliable but costly exercise that involves the following steps;
    - Randomly select a sample area of about 10% of total production unit or as may be convenient if the farm is big
    - The sample should be representative of the rest of the sample unit area i.e. trees in a sample unit area
    - On the selected tree samples, count and record the number of bearing branches
    - Select randomly from the sampled tree(s) 3 or more bearing branches - should be representative of the rest of the branches at the lower, middle and high canopy areas
    - Count and record the berries on each selected branch for every tree sample (in the sample unit area).
    - Sum up the total number of berries on the sampled branches, record and then take the mean (average).
    - Multiply the mean number of berries by the mean number of bearing branches on the sampled tree(s)
    - Sum up the total number of berries for all trees in the sample unit
    - Calculate the mean (average) number of berries in the sample unit
    - Multiply the mean (average) from sample unit by total number of trees in the production unit.
    - Convert the number of berries to kg of cherry/Clean coffee. *Assumptions:*
        - 500 to 600 berries (good coffee) is equivalent to 1Kg of Cherry.
        - 6 to 7kg of cherry is equivalent 1Kg of clean coffee

Steps in computation

- No. of berries on sample trees (a) = No. of bearing branches (b) x Mean No. of berries (c) a = (b x c)
- No. of berries in the sample unit (d) = No. of berries per sample tree x No of trees in the sample unit area (T) d = {(b x c) x T}
- Total No. of berries in the whole production unit area (e) = Total No. of berries in the unit sample (d) x Total No. of trees (TT) in the whole production unit area e = (d x TT) berries
- Thus e = {(b x c x T) x TT} berries. Then convert to kg of cherry/Clean coffee

Computation example

Assume that the

- Total number of trees in the farm = 200
- Number of selected trees is 10% x 200 = 20
- Sum total number of bearing branches on the 20 sampled trees- T1+T2……T20 = 800
- Sum total number of sampled branches - 3 branches x 20 =60
- Sum total number of berries (T1B1+T1B2+T2B1+T2B2…....T20B20) = 3000
- Mean/average berries per branch - 3000/60 = 50
- Sum total number of berries - 50x800 = 40,000
- Average number of berries per tree - 40,000/20 = 2000
- Total number of berries in the farm - 2000x200 = 400,000
- Then convert to kg of cherry/Clean coffee 400,000/500 = 800kg
- Production per tree = 800/200 = 4 kilograms

2.3 Factory capacities estimation

Standards / norms for coffee factory facilities

- 1,000 kgs cherry will need 0.6 m^3 of fermentation space
- 1,000 kgs cherry will give about 0.5 m^3 of wet parchment
- At skin drying and white stage, drying depth should be 2.5cm or 1 inch
- At soft black stage to hard black stage, drying depth should be 5cm or 2 inch
- 1 bag of quality parchment is approximately 50 kgs
- 1 bag of parchment takes 0.1 m^2 store space if stacked 8 bags high.
- At skin drying and white stage, 1 table of approximately 1.8 m by 20 m should have 1 person daily and 2 persons from soft black stage to hard black stage
- Approximately 1,000 kgs of good cherry produces 200kgs of dry parchment which require a space of 0.5 m^3 in the conditioning bins
- One disc pulper can pulp 1000 kgs of cherry in one hour

Estimating capacity needed for processing

The capacity needed per season should be based on a crop estimate. For instance, if in a season the crop estimate indicates that 600,000kgs of cherry are expected and that the highest daily intake at the peak of the season is approx. 30,000kg of cherry harvested twice per week, and if the harvesting is done on a Tuesday and a Thursday. Then, the following can be estimated:

- Number of fermentation tanks needed daily/week/Month

    - 30000kg will yield (30000/1000) x 0.6 = 18 m^3 of parchment
    - If every tank has a measurement of 2m x 1.5m x1.5m, a volume of 3 m^3 will be effectively employed hence 18/3 = 6 tanks
    - In a week, the same will be adequate since fermentation takes less than 24 hours
    - In a month the same will be needed
- Number of skin drying tables needed per day / week
    - 30000kg will yield (30000/1000) x 0.5 = 15 m^3 of parchment
    - The drying depth should be 2.5cm=0.025m
    - The area needed to dry is thus 15 m^3 /0.025m=600 m^2
    - If every table has a measurement of 20m x 2m, then each has a surface area of 40m^2
    - The number of tables needed at skin drying per batch is thus 600/40= 15
    - Per week, the same is adequate since skin drying should be done in a day
- Number of drying tables needed for white stage per batch/ week/month
    - At white stage, the drying depth is still 0.025m
    - Assuming the same size of tables as above, 15 tables will be needed per batch per day
    - In a week, 15 x 2 = 30 tables will be needed at the peak of season since the harvesting will be done twice
    - Per month the same is needed since the white needs 2- 4 days to be complete
- Number of drying tables needed for the rest of the drying stages
    - For the rest of the stages which may take up to 10 days or less depending on weather, the drying depth can be increased to 5cm = 0.05m
    - Therefore 15/2 = 7.5 tables will be needed per batch
    - Per week, 7.5 x 2 = 15 are needed
    - In two weeks, given that 10 days needed for the three final stages of drying, 7.5 x 2 x 2 = 30 tables are needed
    - In a month 30 are needed since the first two batches will be complete
- Size of store needed
    - 600,000kgs of cherry translate to 600000/5 = 120,000kgs of parchment
    - This translate to 120,000/50 = 2,400 bags of parchment
    - Since each bag effectively occupy 0.1m^2 in a stack of 8 bags, this translates to a floor space of 2400 X 0.1 m^2 = 240 m^2

Budgeting for coffee processing labour

The labour needed for processing can be estimated from the drying tables needed for each stage of drying multiplied by the cost of a Man-day, taking regard to the standard norms for labour needed for each stage of drying

For instance;

- If the cost of labour is 3 USD per man-day per day, the cost of labour at the skin drying tables during the peak harvesting season per day will be 15 tables x 2 people x 3 USD = 90 USD
- Per week it will be 15 tables x 2 people x 3 USD x 2 harvests = 180 USD
- Per Month, it will be 15 tables x 2 people x3 USD x 2 harvests x 4 weeks = 720 USD
- The cost of labour needed for white stage per batch at the peak period will be 15 tables x 2 people x 4 days x 3 USD = 360 USD
- The cost of labour needed for soft black, medium black and hard black stage per batch at the peak period will be 7.5 tables x 40 m^2 x 2 people x 10 days' x 3 USD / 280 m^2 = 64.3 USD

MODULE 3: COFFEE PROCESSING AND DRYING

3.1 Introduction

Appropriate coffee processing is important in sustaining bean quality as it ensures better prices to growers.

There are three principal methods of coffee processing used globally as follows:

- Fully Washed Process – the pulp and mucilage are removed by pulping, fermentation and washing. It's also called wet processing. This is the conventional form of Arabica coffee processing used in most parts of the world. It has the effect of producing high quality beans. In the East African region, the fully washed (wet processing) is the pre-dominant practice.
- Semi washed process - The fermentation step is skipped by use of de-mucilagers to remove pulp and some or all of the mucilage. This process is called pulped natural. It has the advantage of avoidance of over-fermentation that leads to low quality beans.
- Honey Processing – In this process, the skin and pulp are removed, but some or all of the mucilage (Honey) remains hence the name honey processing method. It is largely practiced in Costa Rica and to a small extent in Tanzania.
- Dry Processing (Naturals) - The pulp and the mucilage are dried with the beans without undergoing the process of pulping and fermentation. The additional time where there is contact of the bean and the sugary mucilage in the fruit imparts sweetness on the bean. In East Africa, this is limited to Robusta coffee.

Coffee processing is a complex procedure that involves a myriad of stages during which the coffee is converted from a raw farm produce to numerous high value marketable products. This process is therefore very important as it's the main determinant of quality for all consumable coffee products. Coffee processing starts when the cherry is harvested and ends when the coffee is milled ready for roasting.

3.2 Cherry harvesting

Coffee can be harvested either by stripping or selective picking. In strip picking, trees are harvested entirely at one time by stripping off the branches all the ripe cherries and unripe berries. Thus this process cannot yield specialty coffee. Typically, only Robusta coffee is strip picked either manually or mechanically by use of metal fingers.
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 remaining cherries as they ripen. Selective picking is more expensive due to the labour involved and is only used for Arabica coffee. However, it yields higher quality beans. To achieve better quality beans;

- Clean harvesting bags, baskets or tins should be used to ensure food safety and to avoid introducing off-flavours;
- Timely and selective picking of bright red cherry should be practiced to ensure smooth pulping and uniform ripening which improves the flavour;
- Avoid picking green and under-ripe berries which may interfere with pulping and fermentation process thus reducing the coffee quality;
- Avoid dropping cherry on bare ground during picking as this may introduce unpleasant earthy flavour in coffee.
- The harvested cherry should be kept under shade to protect it from direct sunlight which may cause premature fermentation resulting in foxy beans

- The cherry should be transported the same day to a pulping station since the process of fermentation starts immediately after harvesting;
- Cherry should be transported in clean containers/bags to ensure food safety and to avoid introducing off-flavour in coffee.

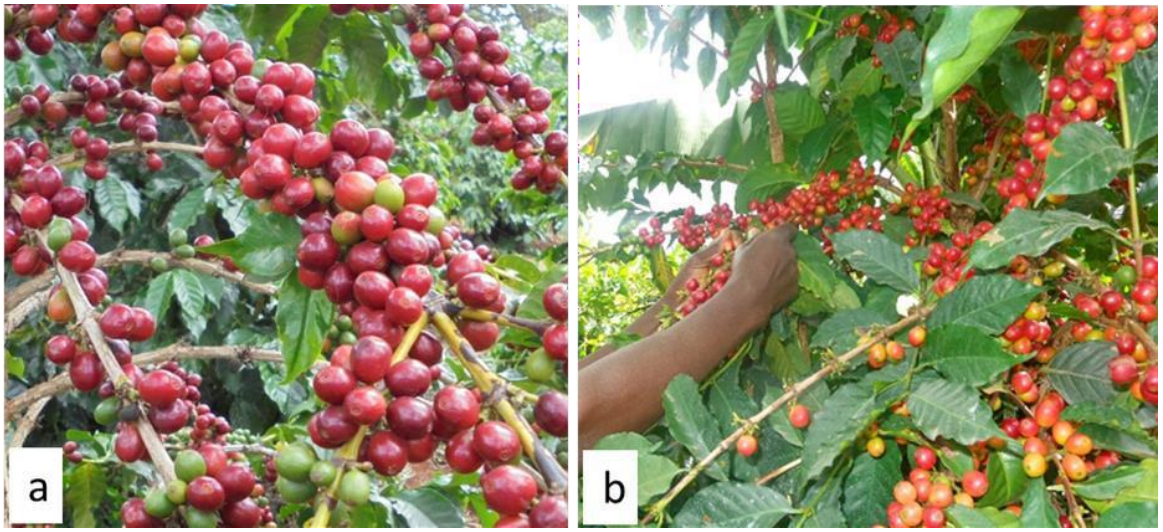


Figure 3.1: Red ripe cherry (a) and selective cherry harvesting (b)

3.3 Cherry sorting

- Cherry sorting is particularly important for wet processed (fully washed and semi washed) coffee than dry processed coffee (naturals).
- The green, under/over ripe, dry, insect damaged or diseased berries, twigs, leaves and any other foreign materials such as stones should be removed as these may eventually introduce off-flavours in coffee.
- The under-ripe cherry usually takes longer to ferment as compared to over ripe cherry thus sorting ensures successful lot separation for proper monitoring of fermentation process.
- Lack of sorting and lot separation may result in over-fermented beans (stinkers) thus introducing an off-flavour in the cup.
- The sorting yard should preferably be clean and cemented to keep off dust.
- Cherry sorting should be done on a clean material such as tarpaulin or nylex or on raised trays to avoid contamination from the soil.
- The cherry should then be weighed and recorded to ensure traceability.
- The sorted out lower grade cherry (under ripe, over ripe and greens) may be processed through the dry method as naturals.

Figure 3.2: Cherry sorting on nylex spread on the ground (a) and on raised trays (b)

3.4 Wet processing method

Wet processing is largely used for Arabica coffee. Immediately after harvesting, the ripe coffee fruits go through a flotation process to clean debris and remove floaters (low-density fruits). The coffee fruit is then pulped, put through a 20 to 22 hours of fermentation, followed by overnight underwater soaking, and then dried until the moisture content reaches 10%–12%. Wet processing is the most complex processing method and it undergoes the following procedures:

i) Pulping and pre-grading
ii) Fermentation
iii) Intermediate washing
iv) Final washing and grading of parchment
v) Underwater soaking of parchment
vi) Parchment drying
vii) Conditioning (11-10.5% MC)

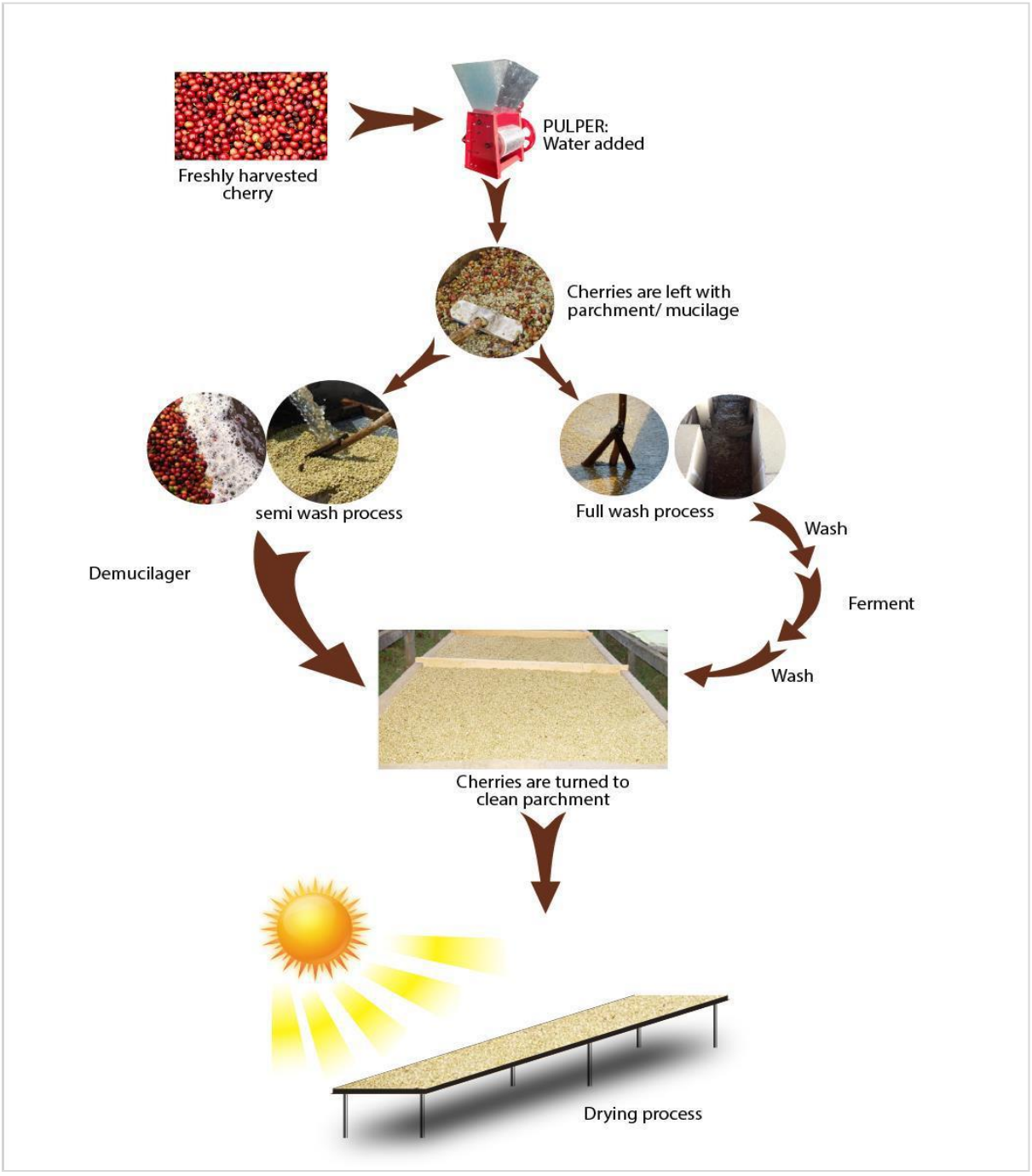


Figure 3.3 Diagrammatic presentation of wet processing procedure

Pulping and pre-grading

- Pulping involves the removal of the outer red skin (pulp) of the cherry.
- Pulping should be done the same day the cherry is harvested since delayed pulping causes premature fermentation which result in foxy beans
- To ensure food safety, clean water devoid of biological, physical or chemical contaminants should be used.
- The pulping machine used should be clean, in good mechanical order and well-adjusted depending on the size of beans. This increases efficiency thus reducing operational costs.
- Control the cherry feed rate to avoid clogging which may cause too much pulp being introduced in the parchment. Presence of pulp in the parchment interferes with fermentation and may also introduce moulds.
- If the pulper has a pre-grader, the parchment should be pre-graded into heavy and light beans. Else this can be done later in the channel.
- Clean processing water can be re-circulated to enhance subsequent fermentation. However, it is important to dispose-off the re-circulated water every day after pulping to maintain food safety and quality.
- Flush the pulping system with clean water immediately after pulping.

Figure 3.4: Small size pulping station

Fermentation

- This is done to break down the mucilage into simple non sticky substances which are easily washed off from the coffee beans
- Mucilage attracts dust, taints coffee, inhibits drying and is a media of mould growth, all of which affect bean quality. Its removal is therefore important for drying
- Place the different grades of parchment in separate fermentation tanks. The tanks should be shaded to protect the parchment from direct sunlight and rainfall
- Drain all the water and leave the parchment to ferment for about 16 hours and monitor closely till fermentation is complete. Warm weather conditions and re-circulation of pulping water quickens the process.
- Fermentation is complete when parchment feels gritty and is no longer slippery upon pressing between fingers. To test, put some fermented parchment in a bowl, add enough water, wash and check for grittiness.

- The depth of parchment in fermentation tanks should not exceed 1 meter to ease washing and ensure uniformity in fermentation
- Always ensure that the fermentation tanks are free from cracks and are well painted with appropriate paints (e.g. epoxy/epilex paints) or non-acid corrosive/clay tiles which are acid resistant and compliant with health standards
- The tanks should be roofed/ shaded to retain warmth and prevent entry of rain water/ or direct sunshine.
- No beans from previous pulping should be left in the fermentation tanks to avoid contaminating the fleshly pulped coffee with fungal moulds inoculum.
- Fermentation can be accelerated by using recirculated water, intermediate washing and use of commercial peptic enzymes.

Figure 3.5: Well painted fermentation tanks and grading channel

Recent Innovations in Coffee Fermentation

- The main purpose of the fermentation process in all methods is to remove the mucilage layer, which is rich in polysaccharides (pectin), and to decrease the water content of the coffee beans.
- The mucilage can prolong the time needed to dry the coffee beans and, in some cases, also lead to mould development, which reduces the final quality of the coffee.
- Some recent innovations in coffee processing include the following:

Coffee fermentation using commercial enzymes

- Commercial enzymes are used to fasten the fermentation process. It is commonly practiced in Brazil to avoid long periods of fermentation. These can be used especially in cold areas to enhance fermentation.
- The enzymes include Pectin lyase, polygalacturonase, and pectin methyl esterase.
- Polygalacturonase is the main enzyme involved in coffee fermentation.
- There are several commercially available enzymes for coffee fermentation including Benefax (oldest in the market), Pectozyme, Cofepec, and Ultrazym. They are mixtures of pectinase, hemicellulose and cellulose

Coffee fermentation using yeast

- Use of yeast has also been innovatively tried in coffee fermentation.
- After pulping, the parchment is washed thoroughly, soaked with water and commercial yeasts and left to ferment
- After fermentation, the beans are washed three times using clean water.

- The fermented beans are then dried in the sun until their moisture content reaches 11%.
- Use of yeast in fermentation can also be applied on unpulped coffee cherry in dry processing. In this case, the coffee cherries are harvested at the mature red stage and washed with clean water.
- The cherries are then immersed in clean water and inoculated with commercial yeast
- The yeast-inoculated cherries are then spread on a tray in layers of 5 cm and processed using the dry method (sun dried to 11–12% moisture content).

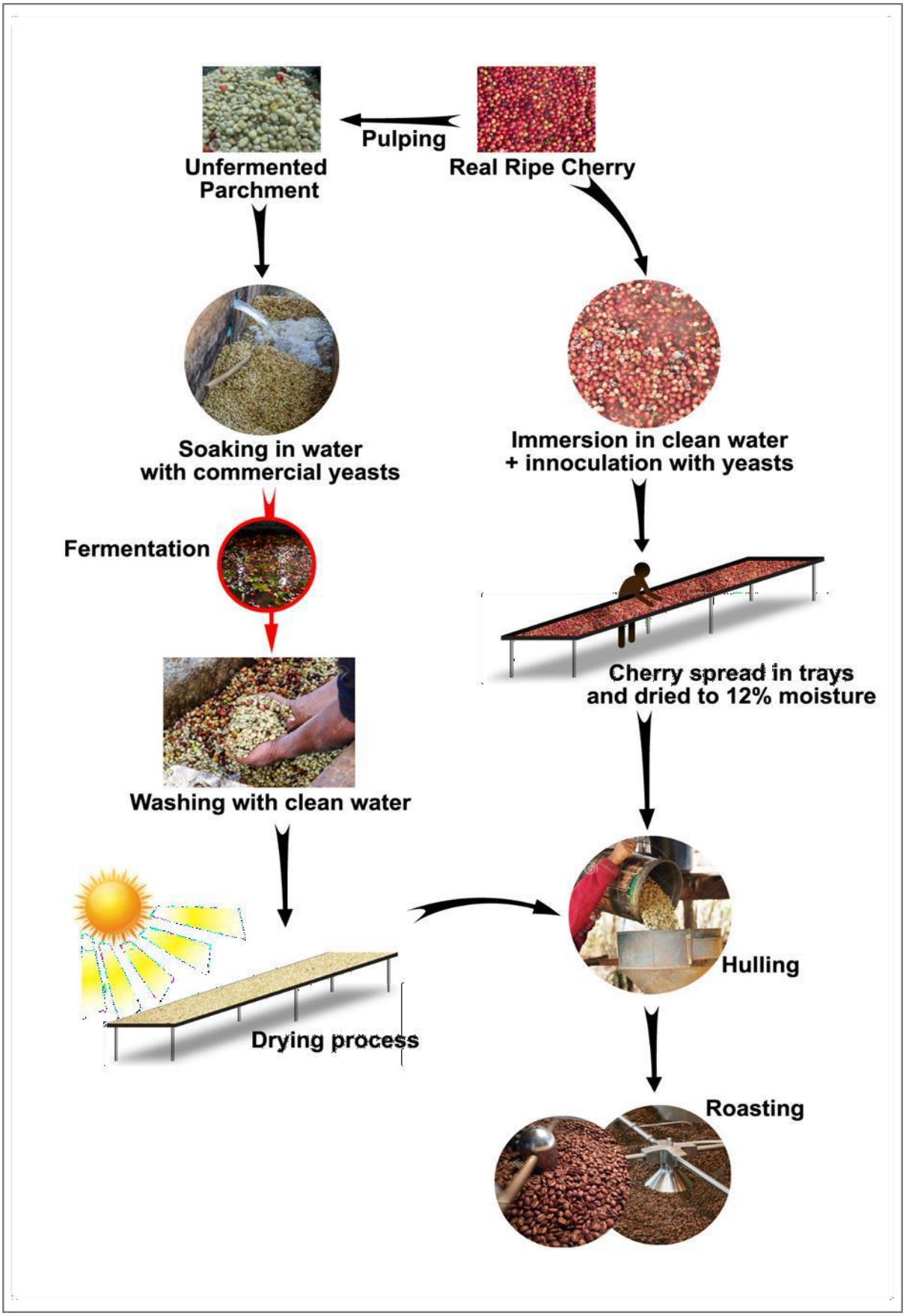


Figure 3.6: Schematic procedure of yeast fermentation

Intermediate washing

- The fermentation procedure should be ‘dry’, followed by intermediate washing (after about 16 hours or so), then 4 to 6 hours of further dry fermentation if necessary, until the gritty feel is achieved.
- The parchment is washed in the fermentation tanks to remove the degraded mucilage after which the water is drained to allow fermentation to continue if necessary
- A wooden or non-abrasive material should be used for stirring and washing.

Final washing and grading of parchment

- Final washing is done to remove any adhering dirt or remains of mucilage sugars
- Once fermentation is complete, fill the tank with clean water, stir vigorously with paddles, drain off the water and repeat several times to assist in detaching the mucilage from the parchment
- Wash the parchment thoroughly on well painted concrete channels using clean water and rubber paddles/squeezers
- Grading can be done by pushing the parchment against a stream of water to grade it into parchment 1, 2, 3 and lights (PL)

Underwater soaking of parchment

- After final washing and grading, parchment 3 (P3) and lights (PL) are taken directly to the skin drying tables while parchment 1 and 2 are soaked overnight in clean water in separate soak tanks
- This is the complete immersion of the fermented and fully washed parchment under clean water. It is done to improve the bean quality for a period of about 16 hours
- Soak parchment 1 and 2 under clean water in separate soak tanks overnight. Thereafter, wash and take the parchment to the skin drying tables
- In situations where there is congestion in the drying tables, i.e. the drying tables are inadequate, one may soak for longer periods, changing the water daily but usually not more than 7 days
- Salty or dirty water should be avoided as it may lead to loss in quality
- In the event that the parchment colour is brownish due to over-ripeness or delayed processing, the use of sodium bi-sulphate at a rate of 2.5 - 5kg for 3m^3 of parchment in soak tanks can be used to prevent further browning and restore colour. The parchment should thereafter be rinsed before drying

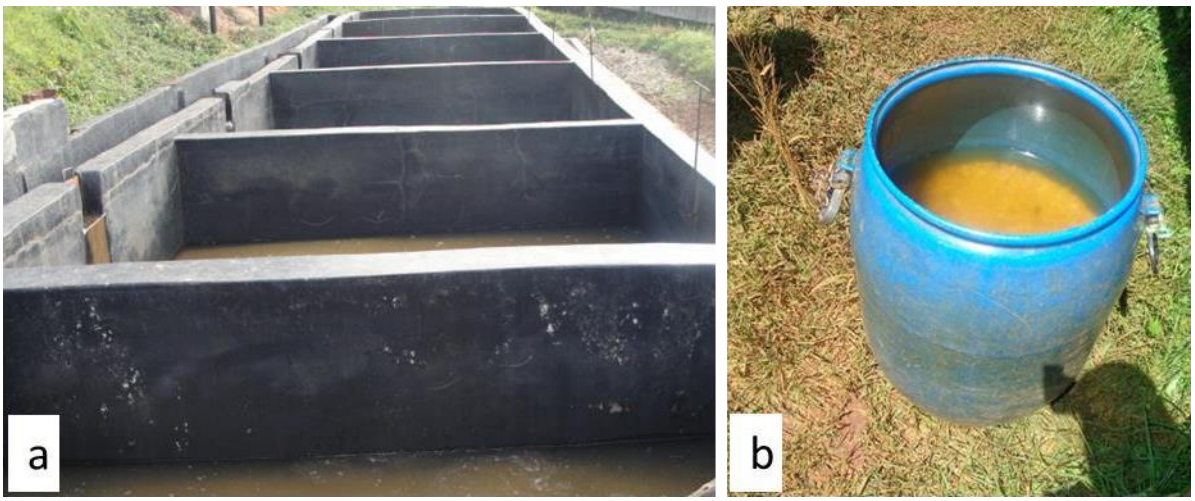


Figure 3.7**:** Underwater soaking in standard soak tanks (a) and in an improvised tank (b)

Parchment drying

- Drying is the process of reducing the moisture content of the beans from about 55% MC to about 10.5 -11% which is safe for storage, hulling, and roasting.
- The process of drying goes through five distinct stages during which characteristic physical and chemical changes occur in the bean.
- Re-wetting should be avoided at all stages.
- The five stages are as follows:

Skin drying of parchment (55 – 45% MC)

- This is the removal of surface water on the parchment.
- Skin drying tables should be constructed sloping down from the soak tanks for easier movement of parchment which is usually heavy at this stage.
- The depth at skin drying tables should not exceed 1 inch (2.5cm) for even drying.
- Skin drying should be executed within the shortest time possible (2-3 hrs in a normal day) to avoid extended fermentation, germination or mould growth.
- Regular turning is required to avoid overheating.
- Parchment should not be left on the skin drying tables overnight as this may result in over-fermentation.
- The parchment should be frequently turned to enhance water removal and prevent parchment cracking.
- During this stage, parchment can be dried mechanically, sun dried or in a greenhouse (recent innovation).
- Sort out defective beans since they are easily distinguishable during this stage.
- Transfer the parchment to the final drying beds when the skin of the parchment is free of surface moisture.
- Clear all leftover beans on the beds before placing new wet parchment.

Figure 3.8: Wet parchment drying on skin drying tables

White stage (45-30% M.C)

- The beans are white and prone to cracking. Therefore, slow and cool drying should be undertaken to avoid parchment cracking.
- Raised shade cover during the white stage is being introduced where a shade net is installed about 2m from the ground (Figure 3.8) - This ensures cool, slow drying and free air movement leading to good quality beans that are not cracked.
- Ideally, the installed shade should be erected in the hot part of the day (10.30am -3.00pm), and folded out during the cooler parts of the day.
- White stage drying can also be done inside rainout shelters (new innovation) with a polythene roof to keep of the rains and to ensure continuous coffee drying throughout the day and night.
- When rainout shelters are used, the roof should be raised more than 6m high and should have open sides to maintain cool atmosphere and to ensure free circulation of air.

Figure 3.9: Parchment drying under installed shade

- Place the parchment on drying beds lined with sisaltex, hessian cloth or tilder/shade net maintaining a parchment depth of about 2.5 cm (1 inch)
- Else, pile coffee into a ridge of about 4-5 inches deep along the centre of the table and turn regularly.
- Spread the parchment in a thin layer and turn it regularly during the morning hours and in the evening to distribute the accumulated temperatures.
- Finalize the sorting out of the damaged and defective beans
- In the evening and during rainy weather, cover the parchment with both hessian cloth and nylex to prevent rewetting.
- Avoid dropping parchment on bare ground or on the grass as this may introduce earthy of grassy flavour in coffee. Any parchment collected should be put in the parchment lights category.
- The drying tables should be firm and flat. Sagging tables encourage un even drying.
- Maintain drying tables in clean condition and absolutely flat for even drying

- Any tall grass below the tables should be cut off or mowed to enhance ventilation and minimize conditions suitable for mould growth.
- Avoid the use of herbicides as a means of weed control at the wet mills

Figure 3.10: Covered parchment drying on wooden final drying tables

Figure 3.11: Parchment drying on improved mettalic drying tables

Soft black stage (30 - 20% MC)

- The beans are soft and translucent
- At this stage, sun light is essential in the formation of the final bluish-green colour.
- Two days of actual sunshine (About 50 hours of sunshine) are recommended. Mechanical drying is not recommended
- The parchment depth can be increased to about 5cm

- Like in all stages, avoid over-heaping to prevent uneven drying

Medium black stage (20 -16% MC)

- The beans are fairly dark and hard
- Mechanical driers can be used since the bean colour is already formed
- In case of congestion at the drying tables, temporary storage in ventilated bins can be done. However, this should only be applied as the last option as it affects the water activity in the bean and may reduce the shelf life of coffee.
- Greenhouse coffee drying (recent innovation) can be applied at this stage as it allows coffee drying throughout the day and night.
- Greenhouse drying shortens the coffee drying period and drying continues even in rainy weather.
- Greenhouse technology prevents rewetting and saves on labour costs. However, care should be taken to avoid over-drying due to high temperatures experienced in the green house.

Hard black stage (16 -11% MC)

- Fully hard beans and dark in colour
- Parchment can be dried rapidly without loss of quality.
- Greenhouse coffee drying can also be applied at this stage.

Figure 3.12: Coffee drying inside a greenhouse

Parchment Conditioning

- This is normally done in ventilated stores or bins to even out moisture level.
- The parchment is ready for storage when it has a moisture content of 11 to 10.5%.
- Use a well calibrated moisture meter to measure the moisture content in order to avoid over or under-drying
- Coffee in the bins should not be heaped more than 1 m in depth for proper moisture evening out.

Figure 3.13: Testing of parchment moisture using a moisture meter

Figure 3.14: Conditioning bins for evening out moisture level

3.5 The semi-washed processing method

- This method is sometimes referred to as “semi-dry processing” or “pulped naturals” since the coffee cherry are depulped but the fermentation process occurs directly under the sun on a platform.

- This process combines pulping and mechanical removal of mucilage by friction or attrition in one operation by use of eco-pulpers.
- The mucilage is removed immediately after pulping using a demucilager that is fitted in the eco-pulper.
- The method is becoming more popular than the fully washed method as it is more efficient in terms of saving resources such as water, power, labour and time.
- Some eco-pulpers are already fitted with a grader which separates the beans into P1, P2 and lights.
- The mucilage adhering to the parchment after pulping can be washed or left on the drying parchment as in the case of honey processing.
- Underwater soaking of P1 and P2 can also be done in a similar way as in the fully washed method to improve the quality of the beans.

Figure 3.15: A medium throughput eco-pulper

3.6 Processing at small and medium estate farms

- Where farmers pulp individually and have small or medium size farms, drum pulpers, hand and motorized pulpers can be used for pulping
- Fermentation can be done in hard plastic containers filled up to ¾ depth to enable intermediate washing and final washing.

- Since this yields mixed grades of parchment, grading can be done thereafter in grading channels if the farmer has the facilities.
- Underwater soaking of P1 and P2 is then done overnight before drying.
- Where prior grading is not possible, the whole lot of parchment is soaked.

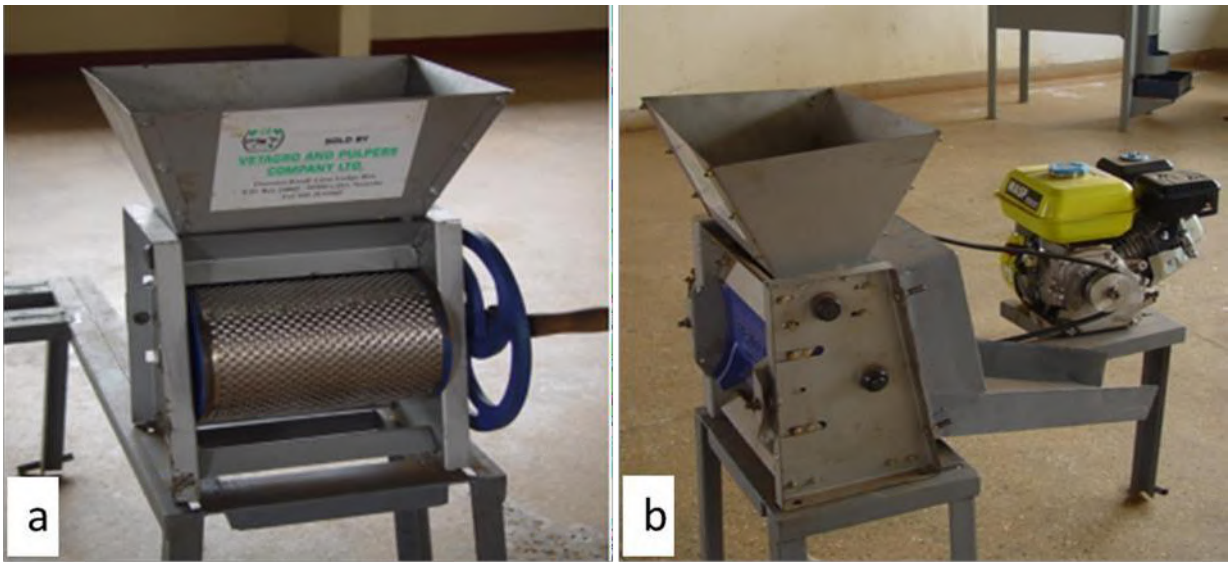


Figure 3.16: Hand pulper (a) and motorized pulper (b)

3.7 Important considerations in coffee processing

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

3.8 Dry processing method (Naturals)

Dry processing method for Arabica coffee

In East Africa, this method is primarily applied to low quality Arabica coffee which is sorted out from the good cherry, commonly referred to as Buni in Kenya. It is thus used to dry the over-ripes, under-ripes, and cherry that dry in place on the trees which is stripped off at the end of the harvesting season. The method is also applicable in situations where wet processing facilities are not available or if the wet processing method is deemed to be relatively expensive. If done to perfection on good quality cherry, the loss of quality may be relatively minimal compared to wet-processed cherry.

- Cherry drying should be done on a clean and well drained surface after harvesting e.g. on a concrete surface or raised surface
- The drying cherries should be regularly turned and covered with rain proof materials when there is rain to avoid re-wetting which may cause growth of moulds.

- Avoid mixing freshly picked or sorted out cherry with the drying ones. Each lot of cherries should be dried separately to avoid mixed drying which may result in over or under drying of some lots.
- The coffee is dried to attain the required moisture content of 12% and then stored.
- Naturals received from farmers should be inspected, sorted and the moisture content determined before weighing and storage
- The coffee can then be hulled where the dry pulp and parchment are removed in a single operation.

Figure 3.17: Drying naturals in Burundi (source Café imports)

Figure 3.18: Correct drying of naturals

Figure 3.19: Improper drying of naturals on the grass resulting in mould formation

Figure 3.20: Improper drying of naturals on the soil - can lead to earthiness

Figure 3.21: Poorly dried naturals – with moulds (a) and well dried naturals (b

Dry processing method for Robusta coffee

Although washed Robusta attracts a premium of approximately 30%, much of the Robusta coffee in East Africa and particularly in Uganda is dry processed.

- The harvested cherries are usually not sorted before commencement of the drying under the sun. Careful harvesting to exclude immature cherries and extraneous matter e.g. stones is thusessential.
- Drying should begin immediately after harvest to avoid the development of undesirable taints and moulds.
- The cherries should be spread out to dry in the sun on suitable drying surfaces e.g. raised trays or tarpaulins. The coffee must be frequently stirred to achieve uniform drying.
- Coffee rewetting should be prevented at all cost at any time during the drying process.
- Drying will be complete when the dried cherries have attained moisture content of 12%.

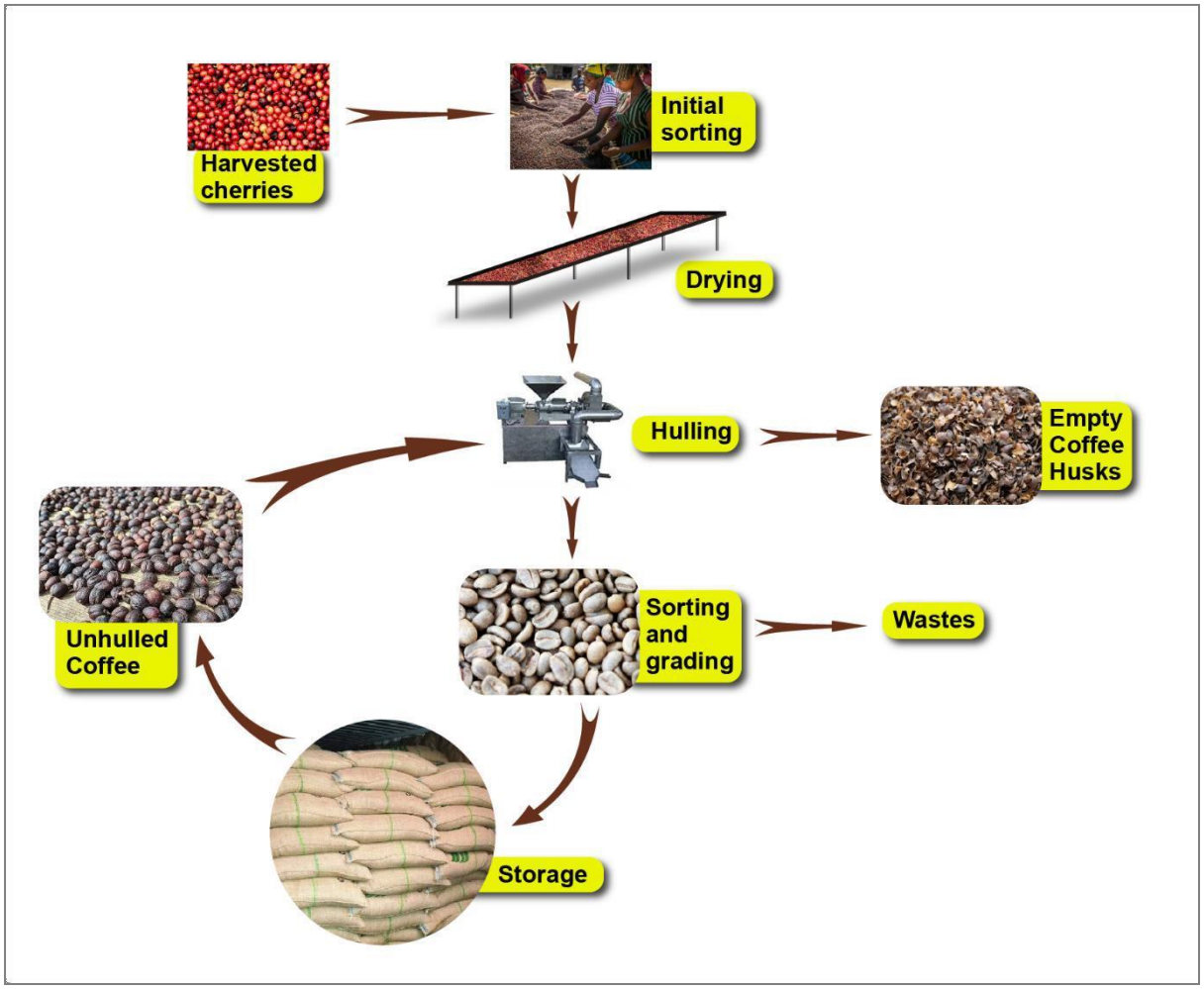


Figure 3.22: Schematic procedure of dry coffee processing

MODULE 4: COFFEE STORAGE, TRANSPORTATION AND SECONDARY PROCESSING

4.1 Storage of parchment

Proper storage aims at preserving coffee quality by maintaining the right moisture content, protecting coffee from damage by insects or moulds and preventing contamination. It also facilitates identification and handling of coffee lots. When storage conditions are too humid, coffee beans acquire a darker color and a mouldy, fermented flavor hence loss in quality.

Some important highlights on coffee storage are:

- Store bulk coffee in well ventilated bins or on wooden floors and stir regularly
- Coffee stores should be constructed so as to allow ventilation and avoid rewetting
- High, insulated roofs with air vents minimize heat transfer to the storage area and facilitate good ventilation should be put in place
- The store should be sited away from chemical store and any other possible source of contamination.
- For parchment stored in bags, wooden pallets should be placed on the floor at a minimum distance of 6 inches away from the floor and the wall to facilitate good ventilation and to avoid re-wetting through condensation.
- Smoking should be avoided in the stores as this will introduce off-flavour in coffee.
- Clean gunny bags should be used for storage. Preferably sisal or jute bags
- The coffee store must be well ventilated and corrugated iron sheet roof adequately insulated to minimize heat transfer
- Avoid pro-longed storage as this leads to quality loss.
- Moisture monitoring of stored coffee should be done regularly in order to take corrective action.
- Moisture meters should be calibrated regularly and at least once per year
- In the event that sorting was not adequately done during the skin drying and white stage, it should be undertaken before delivery to mills
- Documented cleaning programs for the ventilated bins and stores should be regularly implemented and records kept.

Figure 4.1: Properly designed coffee store with insulated roof and fitted with wooden pallets

4.2 Preparation for delivery to mills

- Appropriate permits and documents should be sought from the relevant authorities in preparation for coffee delivery for milling depending on the specific countries
- Proper documentation of parchment or cherry coffee in the store and balances after delivery should be clearly done.
- Parchment weighing should be done using a calibrated weighing machine before delivery (Take into account the weight of the empty bag which is usually 1 kg)
- The parchment should be confirmed dry before bagging. Proper drying ensures easier removal of the husk during milling.
- In order to ensure food safety and quality, clean and odour free sisal or jute bags should be used for coffee bagging.
- Bags that have been used for chemicals or for animal feed should be avoided at all cost as these may introduce chemical toxins or aflatoxin.

4.3 Transportation to the mills

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

4.4 Secondary processing (dry milling)

Dry milling is the final stage green coffee undergoes before it is sold or shipped to the roaster.

Monitoring of moisture content

Once coffee is delivered at the mill, moisture content should be checked using a calibrated moisture meter. According to ICO moisture should not be below 8 percent or in excess of 12.5% for both Arabica and Robusta coffee.

- Correct moisture content provides storage stability and facilitates hulling
- Over dried coffee is prone to physical damage resulting in increased chipped beans and increased percentage of ears and broken beans.
- Hulling of soft, under dried beans results in bruised and partly split beans
- Coffee which is under dried may be re-dried at the mill at a cost.

Cleaning

- The cleaning or pre-cleaning aims at removing light impurities, impurities larger than the coffee beans and metallic contaminants.
- The aim is to get a product free of impurities and protect the equipment.
- Suction is used to remove dust and light impurities like strings and husks.
- Magnets remove metallic materials like nails, screws, bolts etc found mixed with parchment or cherry coffee.
- De-stoning is done by density separation since stones are denser than coffee.

Hulling

- Hulling entails rubbing the beans against each other and against metal parts of a hulling machine
- When hulling fully washed coffee, the dry parchment husk is removed to obtain green coffee
- When hulling natural coffee, the whole hull (dried pulp and parchment) is removed to obtain green coffee.
- In honey processed green coffee is obtained by hulling dry parchment with dried mucilage adhering to it.
- Hullers that can only hull parchment coffee often have problems with cherries that are mixed with parchment hence they will be found in the clean coffee as pods.
- Overheating, physical damage, and discharge of coffee with husks or hulls may compromise quality.

Polishing

- Polishing is carried out by friction as beans rub against each other and against the polishing machine.
- Attempts to remove silver skin of Robusta coffee at 12% or below can damage the beans.
- If the beans are already at 12% special equipment is required to dampen the coffee, polish it and then dry it again to 12%.
- If not carried out correctly, this process invariably leads to very unevenly dried coffee and beans with wide colour disparities within the same batch.

Green coffee Grading and its significance

- Coffee hulling results in beans of different sizes, shapes and densities hence separating the beans on sizes, shapes and densities is a form of value addition.
- Notable differences in the size and shape of coffee beans are influenced by botanical, variety and environmental growth circumstances.
- Grading enhances trading and increasing revenue as some grades have attained a niche in the coffee market.
- Both density and color sorting are faster and more precise when the beans to be processed are of uniform size.
- Uniform bean sizes enhance roasting because smaller sized beans will over-roast during the time it takes for the roasting of the larger, heavier beans to be completed.

Size Grading

- The bean size is determined in accordance with ISO 4150 using screen sizes specified in table 1 and 2.
- The screen holes are specified in 1/64 inch, which means 14/64 of an inch diameter of the screen. The coffee bean above screen size 14 should be recorded as percentage.
- Coffee is graded by size using rotating or shaking screens, replaceable metal sheets that have round holes in them that retain beans over a certain size and allow smaller beans to pass.
- To attain uniformity by size, flat beans are separated by screens with round holes.

Figure 4.2: Diagrammatic presentation of secondary processing

Table 4.1: Specifications of screens with round apertures in accordance with ISO 4150

A/No	Aperture size mm		Sieve No.
	Nominal diameter	Tolerance	
i.	8.00	± 0.09	20
ii.	7.50	± 0.09	19
iii.	7.10	± 0.09	18
iv.	6.70	± 0.08	17
v.	6.30	± 0.08	16
vi.	6.00	± 0.08	15
vii.	5.60	± 0.07	14
viii.	5.00	± 0.07	12.5
ix.	4.75	± 0.07	12
x.	4.00	± 0.06	10
xi.	2.80	± 0.05	7

Table 4.2: Specifications of slotted screens in accordance with ISO 4150

Width	Aperture size mm		Sieve No.
	Tolerance on width	Length	
5.60	± 0.07	30	14
5.00	± 0.07	30	13
4.75	± 0.07	20	12
4.50	± 0.07	20	11
4.00	± 0.06	20	10
3.50	± 0.06	20	9
3.00	± 0.05	20	8

Note: When determined using slotted sieves pea berries are retained on screen 12 and above

Pea berries

- Normally the coffee cherry contains two ovules but when one of the two ovules aborts due to poor pollination only one bean (seed), is formed
- When only one bean develops within a coffee cherry the bean is rounded with no flat side.
- Pea berries are believed to have better quality because they are round roll better and it is believed this flow during roasting contributing to better heat transfer and better roast.
- When determined using slotted sieves pea berry shall be retained on screen 12 and above.

Elephant beans

- Elephants beans are two seeds rolled into one like a defect.
- Two or more embryos develop in a single cavity of the ovary and form two or more abnormally shaped separate beans enclosed in a common parchment (endocarp)
- Each is enveloped in an individual silver skin (integument).

Figure 4.3: Pea beans (a) and elephant beans (b)

Gravity Separation

- The objective of gravity separation is to separate coffee beans according to density.
- Many off-colour beans also have a lower density than sound beans. This includes over-fermented beans (stinkers), and some black beans can be removed by gravity separators.
- A gravity separator, also called a densmetric table, consists of a vibrating screen deck, inclined along its length and width, assembled below or above one or more powerful fans that create an upward air current which passes through the product to be separated.
- Coffee is fed to the upper corner of the inclined screen deck and distributed to cover it completely.
- As coffee moves down the screen it meets with the upward air current that forces “lighter”, mostly defective, beans to float while the “heavier” sound beans remain in contact with the screen.

Sorting defects

The principle is to remove defective coffee beans that have a different colour from sound green coffee beans. For Arabica coffee, not more than of 86 defects are allowed per 300g sample (ICO Resolution 420) while for Robusta coffee, not more than 150 defects are allowed per 300 g sample (ICO Resolution 420). Sorting can be done by machine (colour sorter) or manually.

Electronic sorting

- Beans fed at a constant rate pass through the colour-detection device that triggers an air jet.
- This removes beans that do not conform to the accepted colour pattern from the main flow.
- Accepted and rejected beans leave the machine through different outlets.

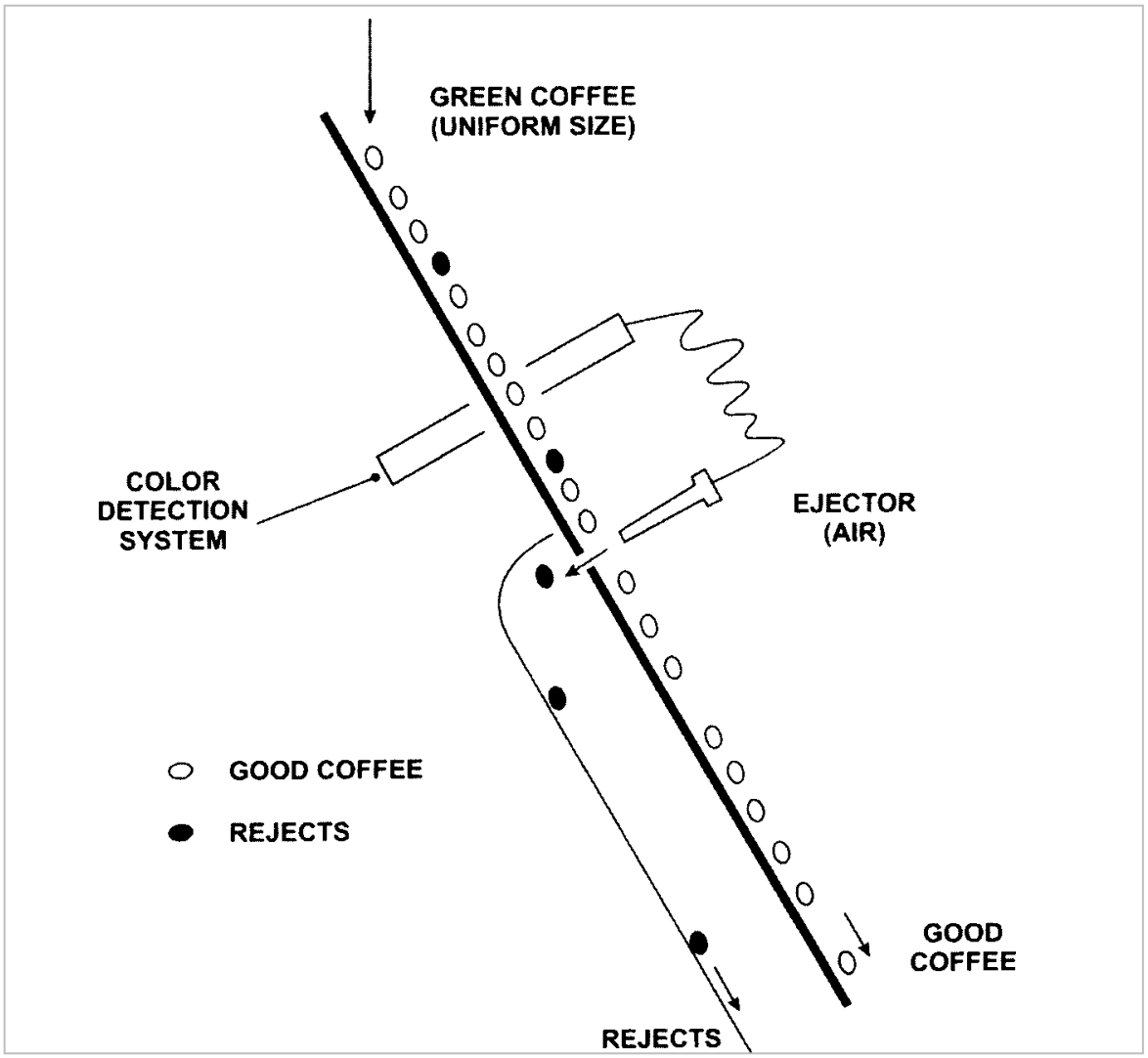


Figure 4.4: Principle of electronic colour sorting

Manual sorting

- Manual sorting is mainly done by women they are faster and more efficient.
- The sorting area must be well lit to increase efficiency of sorting.
- This activity is done either by people sitting on the floor or on sorting tables with manned conveyor belt.

Figure 4.5: Manual sorting of green coffee on tables manned with conveyor belt

4.5 Blending and bulking

- Bulking means mixing coffees of the same quality produced by different growers to obtain a homogeneous coffee lot with the volume required by the client.
- Blending means mixing coffees of different qualities (sizes, cup qualities, origins, etc.) to obtain a homogeneous coffee lot with the specifications and volume required by the client. This may be done at the milling or trading level.
- In the countries of origin, most of the mixing is carried out with elevators or conveyors that feed special silos whose design and inside features help to homogenize the final product.
- The coffee is frequently fed back into the silos to go through the circuit as often as necessary until homogeneity is considered acceptable.

4.6 Bagging and weighing

- The objective of bagging and weighing coffee is to prepare it for delivery to the end user according to the weight requirements contracted
- It is done manually or automated.
- The bags used shall
  - Be clean free of foreign odours,
  - Prevent quality deterioration of the coffee.
  - Not be potential sources of contamination.
  - Be free from foreign matter.
  - Be free from pests.
- Bags with the exact weight are closed by sewing them up either manually or with a portable sewing machine.
- In the automated system weighing and bagging stations with conveyor belts and stationary sewing machines pass the top of the bags automatically through the sewing head.

4.7 Warehousing

- Coffee should be stored under controlled temperature and relative humidity (Hulling and polishing makes the green coffee more prone to quality losses).
- Warehouse means any building, structure or other protected enclosure duly licensed by the relevant authority to be used for the storage of coffee for the purposes of trading.
- Clean coffee is stored in the warehouse depending on the grade.
- The warehouse should ensure the commercial value of the coffee is maintained for as long as possible and safety of the coffee is assured.
- Coffee in bags is stacked on wooden pallets 0.5ft above ground level and 0.5ft away from the walls. Maximum care is taken to make sure that the coffee does not absorb moisture.

Figure 4.6: Green coffee warehouse

- Coffee must also be secured against risks while in the stores and during transportation (on-transit)
- Various sources of risk include theft, fire, spoilage due to contamination, re-wetting etc.
- Methods of securing coffee include installation of security systems, engagement of armed security during transit, insurance (both in-store and on-transit)
- Records should be maintained for chain of custody and traceability, lot management and accountability

MODULE 5: COFFEE QUALITY ASSESSMENT

5.1 Introduction

Quality assessment reveals the excellence (or lack of it) in the coffee and informs the factory managers where the cup quality is being lost.

Over time, different countries have developed their own methodologies for coffee quality assessment. The variations in methodologies are meant to suit specific needs. The specialty coffee association (SCA) developed a standard protocol for coffee quality assessment with the hope to minimize variations.

5.2 Importance of quality assessment

- Quality assessment report is a quality control tool for wet factory managers and growers to ensure continuous improvement
- Quality assessment is important for blending, bulking and marketing of coffee.
- For the traders quality assessment ensures clients demands are matched with the product consistently
- For the baristas quality analysis ensures that coffees are right for specific recipes

5.3 Senses used in coffee quality assessment

Assessment of coffee quality is through human senses

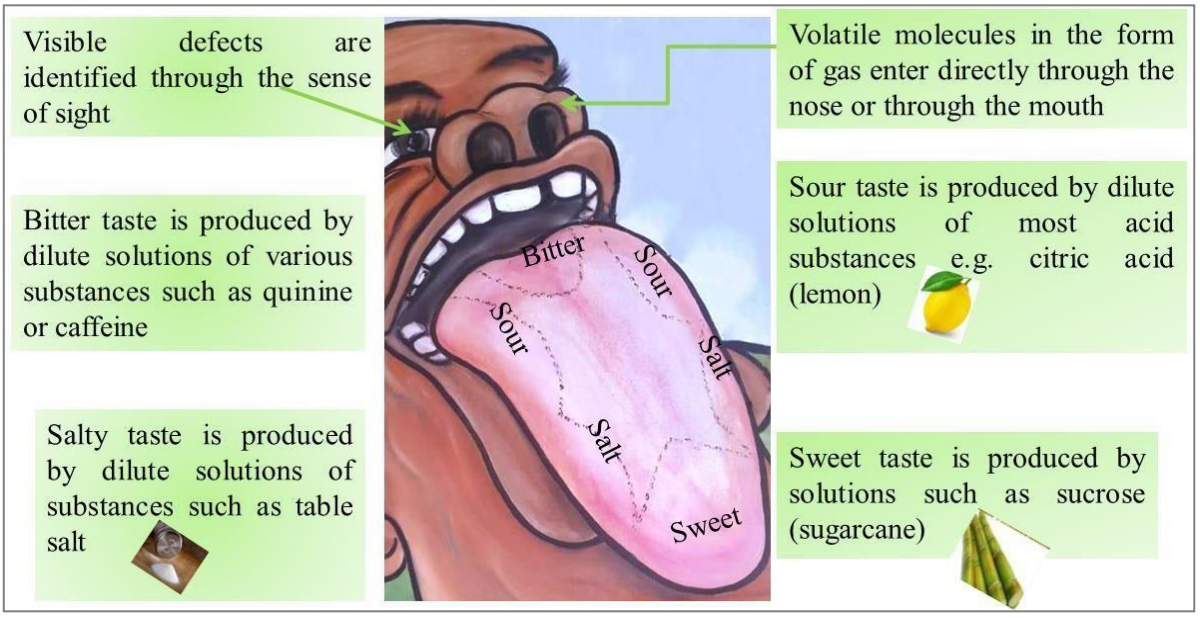


Figure 5.1: Human senses for quality assessment

5.4 Assessment of green coffe quality

Green coffee attributes considered in quality determination include:

Size

- The size of bean is determined by the good agricultural practices
- Uniform bean size, provides better heat transfer and consequently better roast

Smell

- The green coffee sample should have a characteristic smell of green coffee.
- Mouldy smell often referred to as mustiness is an indication that moulds had grown on the coffee at some stage
- Earthiness is an indication that coffee coffee having come into contact with bare earth or dust
- Fermenting pulp smell in green coffee is an indication of faulty fermentation
- Smell of petroleum or gasoline also referred to as baggy is an indication that green coffee was stored in jute bags treated with mineral oil

Colour

- For Arabica blue to grey colour is the most desirable faded, straw yellow colour is undesired
- For Robusta the colour is grey when washed and golden brown when prepared by the dry cherry or natural method.
- Insufficiently dried coffee may have a blue colour immediately after drying this colour soon fades so it is recommended to dry coffee thoroughly
- Picking overripe, insufficient prewashing and drying coffee directly on the ground causes brownness in the raw coffee
- Under fermentation also gives green coffee a brown tinge

5.5 Defects in green coffee

Defects are imperfections found in a green coffee sample. Larger amounts of imperfections will increase the probability of finding off-flavours and lesser homogeneity in the cup. However, absence of visible defects does not necessarily correlate with higher cup quality.

Defects originating from the farm and their mitigation

These are defects caused by stress due to climatic conditions, water or nutrient deficiencies, inadequate cultivation or harvesting practices.

Pods

- Pods are small cherries which escapes pulping and milling and are observed in clean coffee.
- They are caused by:
    - Lack of adequate nutrients in the soil to support the coffee
    - Soil moisture drought where by the tree cannot absorb the nutrients.
- Pods can be controlled through:

- Soil sampling and analysis for proper soil fertility management recommendations
- Proper weed management
- Proper pruning
- Sorting out the very small cherries before pulping
- Flotation (grading by density) of cherry before pulping
- Subsequent grading of parchment into lights and heavies in the washing and grading

Figure 5.2: Pods (small cherries in clean coffee) (a) and withered /ragged/wrinkled beans (b)

Ragged/ withered

- Ragged beans can be identified by the wrinkles and misshape on the surface.
- May result from lack of nutrients in the soil to support the coffee or effect of drought where by the tree cannot absorb the nutrients.
- It could also be an indication of improper weed management and poor pruning.
- The soil should be sampled and analysed for proper soil fertility management. Practice proper weed management and pruning.
- Flotation (grading by density) of cherry before pulping and subsequent separation of parchment into lights and heavies in the washing and grading channel can reduce the defect.

Immature

- Immature beans portray themselves as greenish ‘boat-shaped’ with a shrivelled surface.
- They indicate improper harvesting techniques as in strip harvesting resulting in berries at different stages of ripening.
- It may also indicate that selective harvesting was not practices and sorting of cherries before pulping was not effective.
- Careful post-harvest separation of cherries at different ripeness stages can reduce this defect. When the dry process is used to produce natural coffees, over-ripe cherries as well as those partially or fully dried on the tree may be separated by flotation and dried separately. Unripe cherriesin any process relates to weight loss as these cherries would eventually develop to full maturity andfull weight. Soils should be sampled and analyses and a soil fertility program recommended applied.

Amber beans

- Amber beans are described as smooth yellowish beans occurring in trees suffering from iron deficiency.
- The soil may be lacking iron or existing conditions inhibit absorption or the iron may be in a bound form.
- Maintain soil PH between 4.4 -5.4,
- Control termites because their activities bind iron
- Spray ferrous sulphate to correct iron deficiency

Figure 5.3: Immature beans (a) and amber beans (b)

Coated

- Coated coffee beans have the silver skin closely attached concealing the bean's surface and true colour.
- During roasting the silver-skin tends to burn off during roasting and the resultant chaff can pose problems.
- Coating could be an indication of poor feeding, overbearing, drought improper weeding or poor pruning.
- The soil should be sampled and analysed for proper soil fertility management.
- Practice proper weed management and pruning

Antestia-damaged beans

- The parchment is characterized by presence of zebra stripes on the surface and beans have black depressions.
- Potato flavour is associated with Antestia infestation damaged. Antestia bugs should be controlled.
- Timely pruning and sorting at skin drying and white stage is recommended

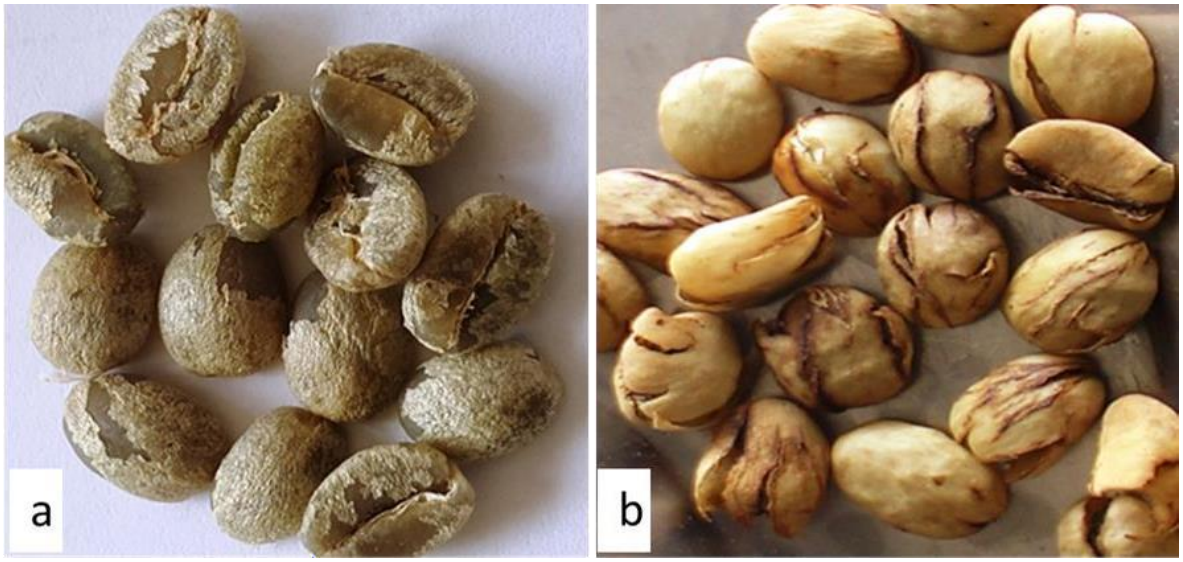


Figure 5.4: Coated beans (a) and Antestia damaged beans (b)

Damage by coffee berry borer (CBB)

- Coffee Berry Borer (CBB) damage is identified by one or two small circular clean holes or more than three small holes or tunnels inside the bean respectively.
- The bulk of the damage is on the endosperm
- Berry borers should be controlled using recommended insecticides
- Timely pruning and field hygiene can reduce berry borers.
- Flotation (grading by density) of cherry before pulping is of great importance,
- Subsequent separation of parchment into lights and heavies in the washing and grading channel.

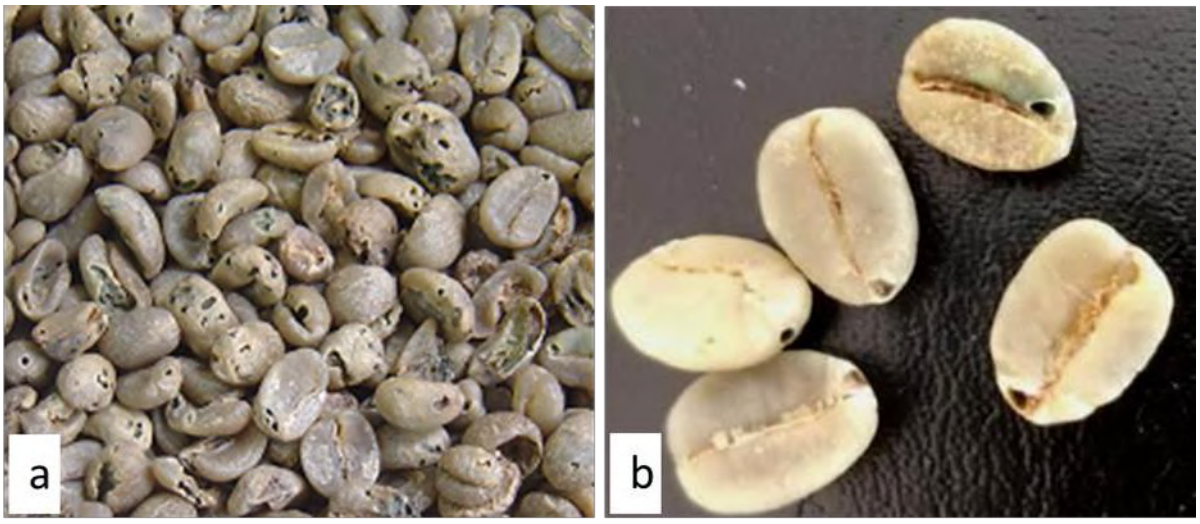


Figure 5.5: Severe (a) and moderate (b) berry borer damage on coffee beans

Defects originating from primary processing

These are defects caused by improper primary processing operations or badly managed storage conditions.

Foxy bean

- Foxy beans are identified from the oxidized reddish to light-brown silver skin.
- The reddish visual colour is particularly noticeable in the center-cut.
- In washed Arabica foxy beans are usually due to the harvesting of overripe cherry, or delayed pulping whereby fermentation begins while the bean is still covered in pulp.
- Foxiness is acceptable in naturals but for wet-processed (washed) coffees they have a negative connotation as they translate to into fruitiness, sourness and even an over-fermented taste.
- Timely harvesting and processing is recommended.

Pulper damaged

- Pulper-nipped beans are the result of incorrectly set pulpers.
- Due to the injury on the beans they may also become over fermented resulting in fermented, foul or unclean cups.
- This defect can be prevented by sorting unripe berries,
- Setting of knives correctly and a test run before pulping.
- Sort out pulper damaged beans in a dry mill after hulling

Figure 5.6: Foxy beans (a) and pulper damaged beans (b)

Stinkers

- Extreme form of an over-fermented bean characterized by tobacco color, with frequent expulsion of the embryo, indicated by a small cavity at the base of the bean and the production of foul-smell.
- Result of extreme over-fermentation
- Poor sanitation owing to improper cleaning of pulpers, fermenting tanks and washing channels.
- Fermentation should be controlled and heaping coffee at skin drying avoided.

Mottled beans

- Are blotched, spotty or stained usually due to uneven drying.
- Uneven colour is usually a consequence of poor drying techniques such as; spreading parchment too thickly when drying, coffee not turned often enough, or that dried too rapidly.
- Such beans subsequently show up as quakers in the roast. Controlled drying is recommended especially at skin drying and white stage.

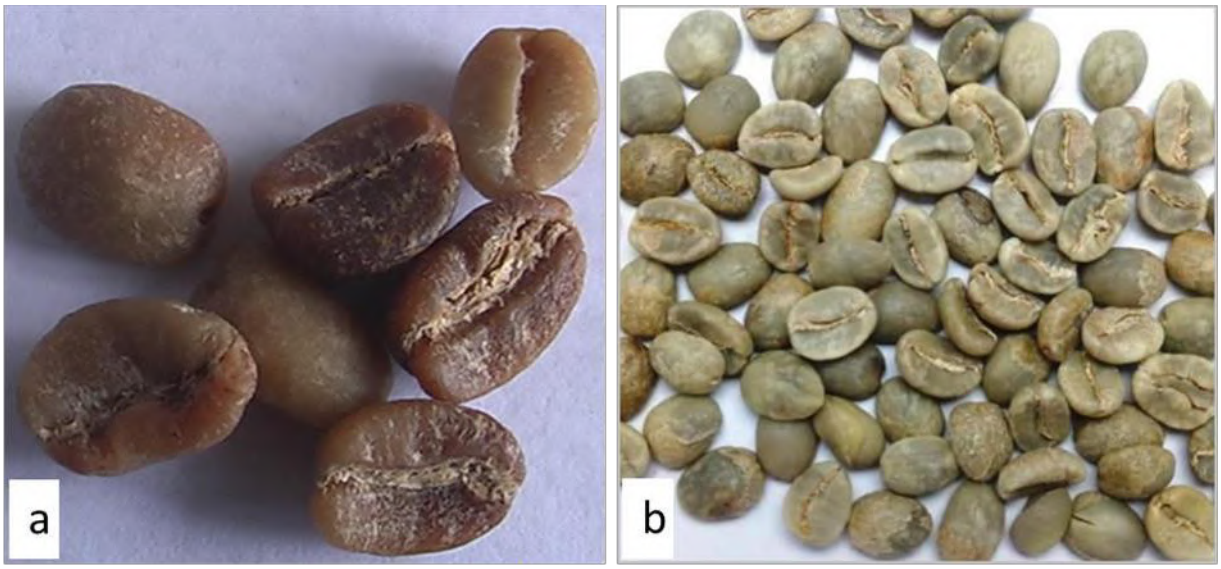


Figure 5.7: Over- fermented (stinkers) beans (a) and under-dried (mottled) beans (b)

Green, water-damaged and Black beans (Musty beans)

Green, water-damaged beans are identified by green stain on the bean. It is brought about by dry parchment or hulled coffee becoming wet. However black beans have a partial or solid black surface which may result from rewetting of dried coffee.

- During the drying process, the coffee should be protected from rain and dew, since the parchment and the dried berries are very hygroscopic.
- Leaking roofs should be fixed.
- Heaping wet coffee and rewetting coffee once drying commences should be avoided.
- Apart from later loss of cup quality, rewetting may support mould growth and eventual development of mycotoxins specifically ochratoxin A.

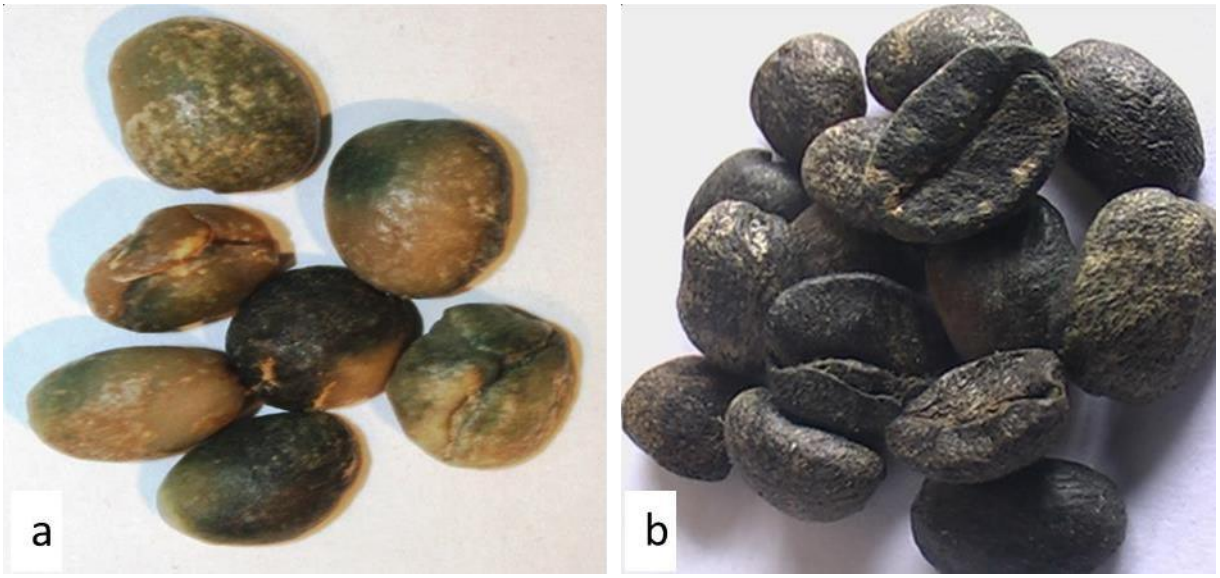


Figure 5.8: Green water damaged and full black beans

Defects originating from secondary processing

Defects caused by imperfect storage conditions and by storage pests or due to poor cleaning operations following de-husking and de-hulling.

Faded

- Fading is an indication of loss of green coffee colour.
- Fading can occur due to prolonged storage (ageing)
- May be an indication of over-dried coffee, especially in Arabica.
- Under-dried may result to faded coffee once the moisture is lost
- May be an indication of poor storage in moist, humid conditions, without adequate air circulation.

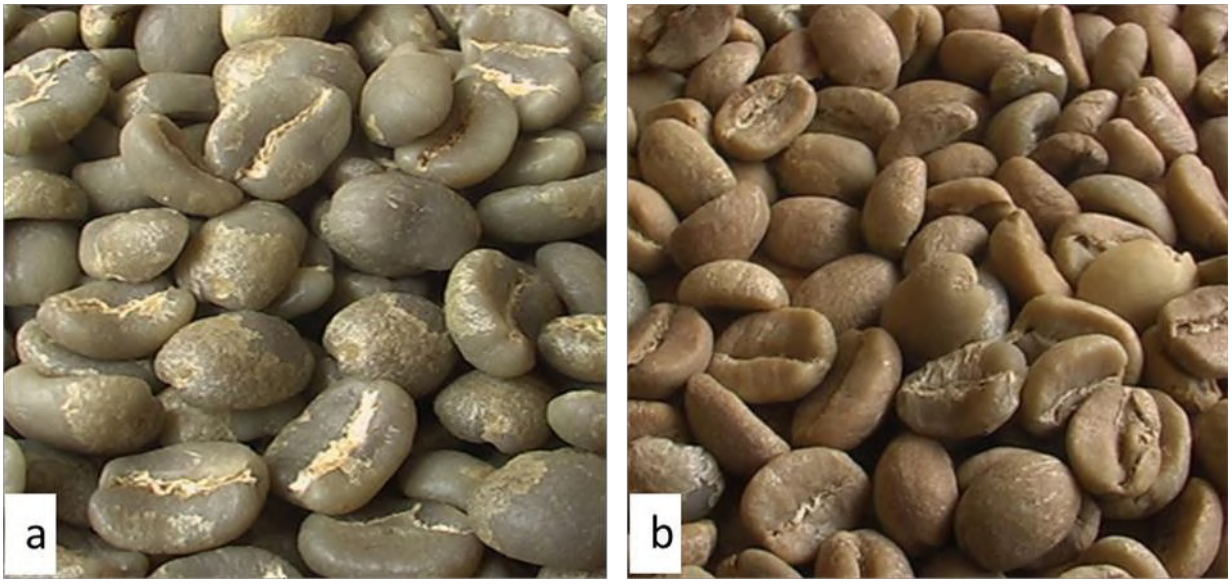


Figure 5.9: Normal beans (a) and faded beans (b

Baggy

This defect is a flavour absorbed from the bag itself during storage. It is frequently the result of a lengthy storage period where there is a high moisture content (above 13%). It can also be caused by re-using bags or treating them with hydrocarbon oils.

Mouldy

This is a typical fungi flavour which is caused by the development of fungi on the beans. It is one of the worst off-flavours.

5.6 Scoring of defects

- The assessment of the defective beans is done by hand picking all the defects from a specified amount of coffee (weight or volume), then grouping similar defects, counting them and finishing up with one number representing the total amount of defects (Table 5.1).
- Another approach to determine the amount of defective beans is to weigh them after grouping and then get a percentage (weight basis) of a particular defect

Table 5.1: SCA defects classification

CATEGORY 1	**Full Defects equivalent**
Full Black	1
Full Sour	1
Dried Cherry	1
Fungus Damage	1
Foreign Matter	1
Severe Insect Damage	5
CATEGORY 2	**Full Defects equivalent**
Partial Black	3
Partial Sour	3
Parchment	5
Floater	5
Immature	5
Withered	5
Shell	5
Broken/Chipped/Cut	5
Hull/Husk	5
Slight Insect Damage	10

5.7 Assessment of roast bean quality

Coffee Roasting

- Roasting causes chemical changes to take place as the beans are rapidly brought to very high temperatures.
- Moisture is forced out of the bean causing it to dry and expand.
- At the end of roasting the smell, the colour green bean will transform into a brown and the bean will expand due to the released gases.
- The roast should be completed in no less than 8 minutes and no more than 12 minutes and immediately air-cooled to arrest the roasting.

Roast Profile for Robusta coffee

- Robusta beans in general are considerably denser than most Arabica beans and present greater resistance to heat.
- For this reason, the surface of Robusta whole beans need to reflect a considerably darker roast than Arabica whole beans in order to achieve similar flavor development and roast color after grinding.
- Robusta whole bean roast color should be medium to medium-dark, not light to medium-light as is common for Arabica cupping roasts.
- On the M-Basic (Gourmet) Agtron scale, a ***Robusta whole bean*** reading of approximately 48 is needed to produce a ***ground*** M-Basic (Gourmet) Agtron reading of approximately 78 ground, +/- 1 point (Agtron/SCA tile #45 for whole bean and Agtron/SCA tile #75 for ground).

Roast Profile for Arabica coffee

- An even roast is desirable when almost all the beans have roasted to about the same colour and brightness, with a white or whitish centre-cut that is not too irregular.
- The Roast profile for arabica should be medium roast,
- Measured through the M-Basic (Gourmet) Agtron scale of approximately 58 on whole bean and 63 on ground, +/- 1 point (55-60 on the standard scale or Agtron/SCA Roast tile #55).

Quality of the roasted coffee

- The roast coffee is checked for its type if it is dull or brilliant, the colour of the centre cut and presence of pales.
- In washed coffee, brownish centre-cuts or no centre-cuts are suggestive of overripe, over-fermentation, use of dirty water or the presence of too many skins in the fermentation tanks.
- Some defects like ambers result in pales in the roast. (Specialty coffee should not have any pales in a 100 g sample of roasted coffee)
- Under dried coffee pops during roasting giving a soft roast.
- Immature beans, uneven fermentation, uneven drying may result in uneven roast.

5.8 Assessing the quality of the coffee brew

Cupping also known as liquoring is a method used to systematically evaluate the aroma and the taste characteristics of coffee organoleptically. To enable this, the beverage to be cupped must be prepared using the recommended procedures which entails the following:

- Cupping samples should be weighed out as whole roasted beans and ground in preparation to cupping.
- The ground coffee should be sniffed deeply to evaluate the dry aroma (fragrance)
- The cupping process should start with infusion of ground coffee with water, no more than 15 minutes after grinding.
- The hot water should be poured directly onto the measured ground coffee in the cup to the rim of the cup, making sure to wet all of the ground coffee.
- The water should be approximately 200º F (93ºC) at the time it is poured onto the ground coffee.
- The water used for cupping should be clean and odour free, but not distilled or softened.

- The optimum ratio of ground coffee to water is 8.25 grams to 150 ml of water.
- Ideal total dissolved solids are 125-175 ppm, but should not be less than 100 ppm or more than 250 ppm.
- Allow the grinds to steep undisturbed for 4 minutes before evaluation.
- The crust is then broken while stirring gently and sniffing aromas emanating from below the crust. This is referred to as the wet aroma.
- The brew is skimmed when rinsing the spoon from cup to cup and left to cool.
- The brew is rapidly sipped - a technique known as **slurping** and held in the mouth only long enough to evaluate the sensory attributes then spit out and the quality attributes recorded.

Figure 5.10: Systematic Steps in Cup Preparation and Evaluatio

5.9 Primary sensory characteristics assessed in coffee

- Aroma - define a smell, more specifically a pleasant scent
- Flavour- Is the distinctive taste and smell of coffee
- Aftertaste - the flavour that lingers after coffee has been expectorated or swallowed
- Acidity - a basic taste produced by dilute solutions of most acid substances for example citric acid in Lemon. In coffee some of the acids contributing to this sensation are formed during the

development of the coffee bean while some are generated during roasting.

- Body - sense of weight or heaviness that coffee brew exerts in the mouth sometimes referred to as mouth-feel.
- Balance- Assessment of how well the flavour, aftertaste, acidity, and body fit together in a synergistic combination
- Clean cup- Absence of defects in the flavor of coffee
- Uniformity - consistency of flavor of the different cups of the sample tasted.
- Sweetness is the basic taste produced by solutions such as sucrose (sugarcane)
- Overall is the rating is meant to reflect the holistically integrated rating of the sample as perceived by the individual cupper.

Table 5.2: Off-flavors detected in the cup and their causes and remedy

OFF-FLAVOR	DESCRIPTION	CAUSE	REMEDY
Over fermented	A taste in coffee that produces a highly displeasing sour or stinking taste depending on the degree of over fermentation. Taste and smell of rotting pulp (foul)	- Delayed pulping - Prolonged fermentation - Delayed skin drying due to heaping of coffee at skin drying stage	- Pulping of coffee immediately after harvesting - Use the “gritty feel” principle to mark end of fermentation, Place coffee at a depth of approx. 2.5 cm and stir constantly - Proper sanitation in the wet mill
Onion flavour	Taste of onion in coffee	- Delayed skin drying due to heaping of coffee at skin drying stage - Heaping coffee at skin drying resulting to delay in skin drying	- Place coffee at a depth of approximately 2.5 cm and stir constantly
Musty	An odour taints giving coffee a mouldy smell	- Heaping under-dried coffee - Rewetting coffee	- Maintain proper parchment depth during drying - Avoid rewetting
Woody	A taste in the coffee beans that produces a distinct, unpleasant wood-like character.	Prolonged storage under uncontrolled temperature and humidity	- Deliver coffee to the mills immediately after drying - Hulled coffee should be stored in designated store where temperature and relative humidity is controlled
Earthy	An odour in the coffee that produces a dust like taste and aroma	Coffee coming into contact with soil	- Sort coffee on canvas or nylex - Avoid dropping coffee on the ground while harvesting - Pulp coffee picked from the ground separately - Cover coffee during transportation
Grassy	Herbal or hay like aroma	Prevalent in coffee harvested when not fully ripe	- Harvest red ripe cherries - Intensify sorting of cherry before pulping
Potato flavour	Taste and smell of raw potatoes in coffee	Associated with antestia damage	- Control antestia in the farms - Sort coffee at skin drying or white stage
Baggy	Smell of petroleum in coffee	- An off flavour absorbed from the bag itself during storage.	- Use clean bags free of foreign odours or foreign materials - Avoid using bags that had been used for other purposes

		- Results from lengthy storage period under high moisture content (> 13%). - Also caused by re-using bags or treating them with hydrocarbon oils.	- Only sisal or jute bags should be used for coffee storage

5.10 Buyers' expectations in aroma and taste

- Natural processing entails drying the beans entirely encompassed within the pulp.
- Natural coffees are sweeter than washed coffees to an extent because of the fermentation of sugars in the pulp
- Washed process removes the entire soft fruit residue, both skin and pulp, before the coffee is dried.
- Washing results in cleaner, brighter coffee with fruity, floral, and caramel notes in the final cup
- Honey or pulped natural processing is a middle-ground, in which the skin of the fruit is removed before the beans are dried, but almost all of the pulp remains on the beans.
- Sugars in the pulp left on natural or honey processed beans undergo metabolic changes that alter the chemical composition of the green beans.
- Honey processed coffee is sweet with more buttery aromas, nut notes and heavy body in the final cup

5.11 Types of quality in the world coffee markets

Mainstream coffee

- This coffee offers an average but acceptable taste experience that varies from market to market,
- Is available in large to very large quantities and is nearly always marketed as blends with little or absolutely no indication of origin.
- Components of these blends are largely interchangeable, meaning if one origin is not available then coffee from another can be substituted.
- Prices for these coffees are directly linked to the futures markets and what transpires there. As a result, prices are widely known and can fluctuate considerably.
- However, there are no clear data available to confirm or deny this, partly also because 'quality and taste' are subjective judgments that vary from person to person.
- It is generally accepted that between 80 to perhaps 90% of all coffee worldwide is of mainstream quality.

Specialty coffee

- The Specialty Coffee Association (SCA) defines specialty coffee in its green stages coffee that is free of primary defects, is properly sized and dried, presents no faults or taints in the cup and has distinctive attributes.
- Specialty, as defined by the Specialty Coffee Association (SCA) Q grading, comprises coffees with a cupping scores of over 80.
- Total production of specialty coffee is estimated at 14% of the total coffee volume including the premium, mostly sold under a brand.
- In the specialty coffee industry, maintaining traceability and integrity is an important part of the value of the coffee in order for customers to make informed purchases that match their values and preferences.

- The following Scoring Key has proven to be a meaningful way to describe the range of coffee quality for the Final Score.

Table 5.3: SCA Coffee Quality Scoring Criteria

Total Score	Specialty Description	Classification
90-100	Outstanding	Specialty Rare
85-89.99	Excellent	Specialty Origin
80-84.99	Very Good	Specialty
< 80.0	Below Specialty Quality	Below Specialty

Certified coffees

- Certification guarantees (through a certificate) that specific rules and regulations of voluntary standards are met in a certain environment (e.g. individual producer, producer group, cooperative or even region).
- Producers have to meet certain requirements – social, economic, environmental
- Certification calls for independent third-party confirmation of this status, conducted by an accredited auditor.
- Mostly, certifications have to be renewed on an annual basis.

MODULE 6: COFFEE MARKET REQUIREMENTS AND SAFETY

6.1 Introduction

The global coffee market operates within the global commodity chain (GCC). A *commodity chain* is 'a network of labour and production processes whose end result is a finished commodity. The coffee chain involves a number of actors that shape the social and power relations within the global coffee trade as shown in Figure 6.1.

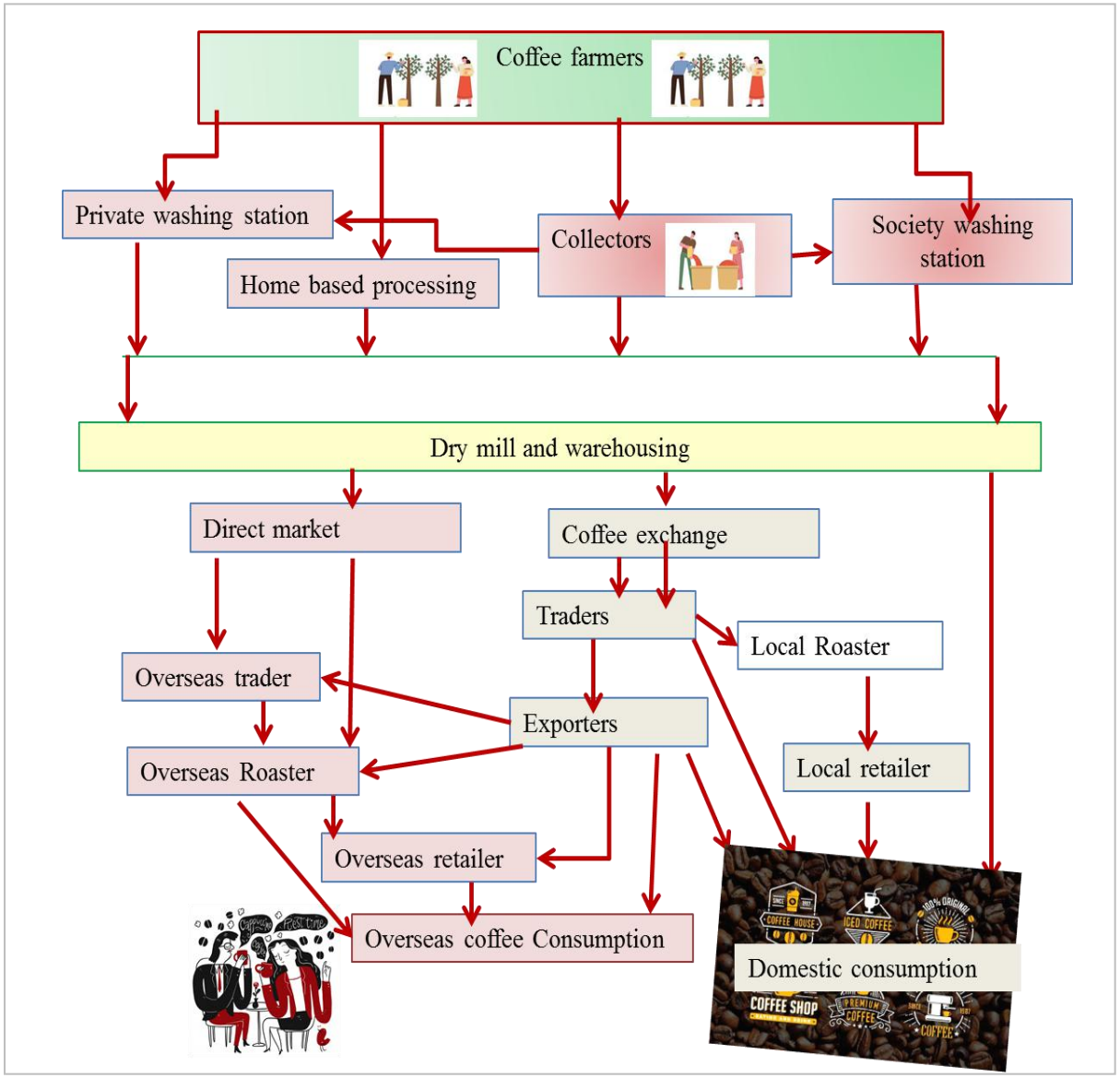


Figure 6.1: Global coffee value chain

6.2 Introduction

- Traceability identifies the path from which a product has originated and to whom it has been supplied
- It consists of an inter-linking chain of records between steps in a process operation and/or between different stages within the supply chain
- Records should be maintained for identification of lots

6.3 Coffee Marketing Channels

Farm gate market

- Producers may sell their coffee in cherry form or parchment or naturals to collectors who may sell either to licensed coffee buyers, cooperatives, farmer groups or associations.
- Coffee is sold in this market in the form of wet processed parchment or dried cherry.
- Buyers then take the coffee for drying and curing to produce clean coffee (green beans).

Coffee auction

- Coffee is sold to exporters at the coffee auctions.
- Most of the prominent exporters are affiliated with the multinational companies which sell coffee to roasters in consuming countries.
- Prices in this market are generally set in reference to New York Futures market for Arabica coffee and London Futures market for Robusta coffee.
- All coffee submitted for auctioning must obtain a certificate of grade and quality from the exchange.

Direct export market

- Producers of premium top grade coffees that are able to establish direct contact with buyers overseas are allowed to by-pass the auction and sell their coffee directly.
- Buyers often enter into a relationship with a grower in order to ensure that certain processes are adhered to.
- Local government regulatory bodies approve the sale contract after being satisfied that the price offered is higher compared to the coffee sold to the auctions.
- Micro-lots refer to beans that can be traced back to their original source- be it a specific farm, field or harvest- and tend to be the pick of a particular crop.
- Supply is often limited, as yields can vary from year to year, and even the smallest of climatic variations can affect their delicate flavours

6.4 Coffee safety

Introduction

Coffee safety is assurance that it will not cause harm to the consumer when it is prepared and /or taken according to its intended use. Contaminants are substances that may be present in certain foodstuffs due to environmental contamination, cultivation practices or processing. The major safety issues in the coffee industry include, mould growth leading to production of mycotoxins and Pesticide residues.

Moulds and their effect on coffee quality and safety

- Moulds are a section of the life forms termed as micro-organisms whose life units are microscopic belonging to the FUNGI kingdom.
- Moulds differ in colour and texture and cause discoloration of coffee beans hence reducing colour of raw coffee
- Moulds cause off-flavours (musty, earthy) in coffee

- Some moulds under favourable conditions produce mycotoxins and specifically ochratoxin A in coffee (proper moisture management throughout the entire processing and supply chain is important)
- Ochratoxin A (OTA) is a toxic substance (mycotoxin) produced by strains of some moulds (*Aspergillus* and *Penicillium* spp.)
- Ochratoxin A (OTA) is a toxic substance; nephrotoxic, carcinogenic, teratogenic (genotoxic), immunotoxic and possibly neurotoxic.

Conditions favouring mould formation

Mould contamination may occur through the following ways:

- Coffee coming into contact with bare earth or dust especially during harvesting and drying
- Wet coffee heaped on drying beds especially during bad weather
- Storing of under-dried coffee
- Re-wetting of already dried coffee

Preventive measures

- The use of mechanical drying methods whenever possible especially during unfavourable weather conditions.
- When sun-drying, coffee should be spread in thin layers and stirred frequently.
- Lots with different moisture content should not be mixed
- Coffee in conditioning bins should be turned regularly
- Coffee should always be monitored for fungus damage and during storage; it should be checked every 2 weeks, at least.
- The level of moisture content should be maintained below 13% and **RH** should be less than 70%.
- Moisture measuring equipment should be regularly cross checked and calibrated once a year before harvest against the ISO 6673 method.

Maximum OTA limits

- OTA present in green coffee is not completely eliminated during the coffee roasting process.
- Codex Alimentarius have not set maximum limits of OTA in green coffee
- Some coffee importing countries have set maximum levels of OTA contamination in green coffee and hence the important to understand limits target market

Pesticides Maximum residue limit (MRL)

- When pesticides are applied, only 30–40% of the product reaches the biological target while the rest of the product can remain in the agro- ecosystem and affect non-target organisms, soil, water, atmosphere, and foods.
- Maximum residue limit is the maximum amount of pesticide residue that is expected to remain on food products when a pesticide is used according to label directions that will not be a concern to human health.
- Integrated crop management is an essential measure for reducing the impact of pesticides in the coffee agro-ecosystem.

Global maximum residue limits

- Codex Alimentarius Commission has established over 4300 MRLs covering nearly 200 pesticides.
- Codex has established MRLs for 32 pesticides applicable to coffee beans (SB 0716) and roasted coffee (SM 0716)
- Green coffee beans shall not contain levels of pesticide residues, in excess of limits established by Codex Alimentarius Commission.
- Roasted coffee beans and roasted ground coffee shall not contain levels of pesticide residues in excess of limits established by Codex Alimentarius Commission
- Instant coffee shall not contain levels of pesticide residues, in excess of limits established by Codex Alimentarius Commission
- Some coffee importing countries have set maximum residue limits in more products and even at a lower level than CODEX hence the importance to understand limits for the target markets

Preventive and control measures

- Establishment of lists of pesticides that are permitted for use in specific countries
- Using only the recommended rates and frequencies
- Practice integrated pest management (IPM) as part of good agricultural practices (GAP).
- Control secondary contamination especially from packaging materials and storage practices

6.5 Interpreting buyers' expectations

- Coffee consumption patterns are strongly influenced by taste and smell – top quality coffees always find consumers who can afford them.
- In the recent years, environmental (green issues), such as organic, fair trade or sustainable coffees have also become criteria of choice for the consumers.
- Once it is clear what the market demands this can be related to the entire production process noting any need for corrective or supportive action.
- All ICO exporting members are required to ensure that all coffee issued with certificates of origin complies with the minimum quality standards.
- The ICO adopts quality standards for exported coffee that must be met to be labelled as "S" coffee on the ICO Certificate of Origin:

    - For Arabica, not to have more than 86 defects per 300 g sample (New York green coffee classification/Brazilian method, or equivalent); and, for Robusta, not to have more than 150 defects per 300 g (Vietnam, Indonesia, or equivalent);
    - For both Arabica and Robusta, not to have a moisture content below 8% or in excess of 12.5%, measured using the ISO 6673 method.

6.6 Strategies to respond to quality requirements

- Buyer demand certain qualities and quantities of safe coffee therefore growers should ensure they provide reliable supplies
- Bean size is evaluated by grading on sieves. Coffee should have a uniform sizes within the agreed screen size and tolerance
- Moisture content should be monitored to comply with levels which would not compromise quality and safety of the coffee
- Coffee should conform to

- agreed defect count
- regular roasting characteristics
- cup quality rating should be as per agreed scale

MODULE 7: WATER AND WASTE MANAGEMENT IN A COFFEE WET MILL

7.1 Introduction

For several years, there has been concern in East African Countries about pollution of streams by affluent discharge from coffee wet mills. Wet processing method is predominantly used in processing the high quality Arabica coffee produced in Kenya, Tanzania, Rwanda and Burundi. Uganda's coffee which is more than 90% Robusta is processed mainly by the dry method. Wet method requires high amounts of water (20 m^3 per ton of cherry) and as such rivers and streams have mostly been used as location factors for wet mills. Consequently, effluent disposal sites are usually located very close to water courses, mostly on sloppy grounds as conveyance of the affluent is mostly dependent on gravity. This poses a threat to the ecosystem since the effluent can easily reach the rivers when there is overloading of seepage pits during peak seasons or run off during heavy rains.

The significant characteristic of the effluent is its bio-degradability and the reduction of the level of oxygen in the water. Further, the same water is utilized downstream by other wet mills and this may significantly result to coffee quality loss. To address these threats to the environment and coffee quality concerns, there is a great need to train the wet mill owners, managers, workers and machine operators on proper water and waste management practices.

7.2 Wet processing water requirements

In coffee processing, water is required for;

- Pre-fermentation step which includes: cherry washing; driving cherry from hopper to pulper; pulping; pre-washing/grading; transport to fermentation tanks
- Post-fermentation step which includes washing, grading, occasionally soaking and transport to pre-drying/drying tables.

7.3 Sources of quality processing water

- Quality water is key to quality coffee processing. Polluted water may affect the center cut and contaminants are picked out during cupping hence degrading the cup quality
- Sources include dams, rivers, rain water harvesting, wells, streams, springs and boreholes.
- Rain water catchment system is ideal especially as a source for water required for parchment soaking. Care should be taken to disconnect the system just before the rains to enable cleaning of the roof and avoid dust pollution.

Figure 7.1: Clean and uncontaminated river water (a) and Rain water catchment system (b). *Source: Gaia Foundation (a) and Aqua Clara (b)*

7.4 Quality checks for processing water

- Processing water should be clean with optimal mineral contents and free from impurities like silt and vegetation. Further, the water should be free from contaminants like:
    - Algae, dead and decomposing fauna and flora
    - Chemical residues
    - Effluent from upstream wet mills
    - Livestock and other animals' contaminants such as excreta and urine.
    - From human activities (washings, dumping of waste, pesticides); Siltation
- Water quality analysis kits are installed at the point of intake from the processing water source to regularly monitor the quality of water used in processing and soaking
- Avoid silted water (Figure 7.2a) and water sources contaminated by human/animal activities (Figure 7.2b)

Figure 7.2: Silted water (a) and water source contaminated by human and animal activities (b). Source; infonile, Geodata journalism (a) and Daily monitor 2016 (b)

7.5 water consumption in selected coffee processing systems

A lot of water is required in wet processing and efficient water utilization processing methods need to be designed. Different reports have estimated water requirements for different coffee processing systems as shown in Table 7.1.

Table 7.1: Water requirements for different coffee processing systems

Location	Authors	Process description	M3/ton Cherry
Central America	PEICCE(1994)	Whole wet process	2-7.6
Columbia	Zambrano & Zuluanga (1993)	Pulping Full washing	7.2 4.8
Kenya	Mburu et al. (1994)	Whole process	17-20
Kenya	Finney (1989)	Pulping Pulp discharge Pre washing/grading Transportation to tanks Washing-grading Soaking Pulper cleaning **TOTAL**	4.5 0.8 8.3 0.6 3.1 0.3 0.2 **19.0**

Source: FAO (undated)

7.6 Efficient utilization of coffee processing water

Arising from the effects of climate change, wet coffee processing method is currently faced by challenges of inadequate water supply. Rivers, dams, wells and boreholes, which were hitherto providing adequate water to wet mills are drying up. There is need to adopt the use of efficient water utilization and monitoring methods which may include:

- Use of eco-pulpers to economize on water consumption and reduce amount of processing waste water
- Use of washing water for pulping
- Installation of water quality analysis kits and meters to monitor quality and regulate usage
    - Water meters are installed at the point of entry to the processing water reservoir
    - Opening and closing meter readings plus cumulative amounts are recorded on daily basis.
    - It helps in monitoring consumption and relating the amount to quantities processed.
    - Monitoring helps cut down costs plus the amount of processing water released to the treatment lagoons.
    - Can be used to work out water treatment capacities.

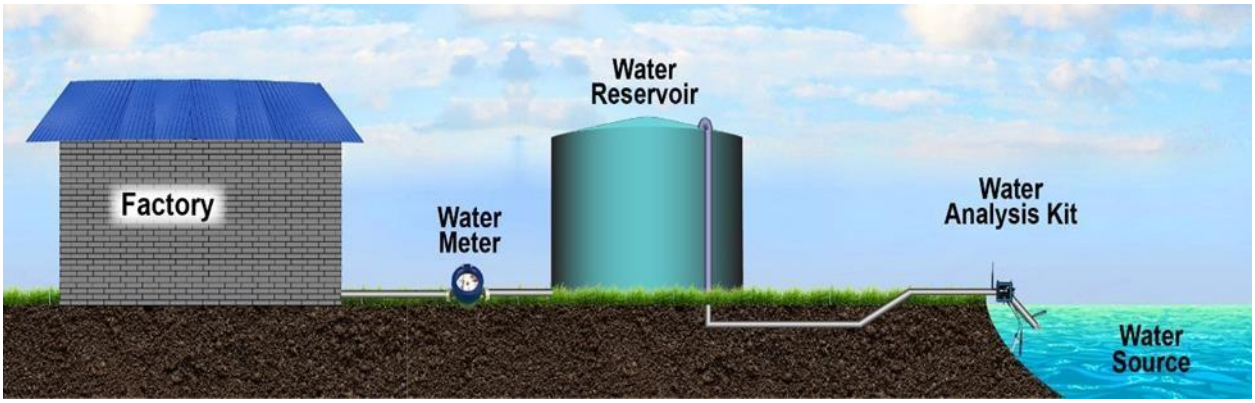


Figure 7.3: Water meter and quality analysis kit to monitor consumption and quality

- Water re-circulation
  - Water from pulping, pre-washing of parchment and transportation to tanks can be re-used.
  - Criteria used to determine if recycled water is suitable for processing are generally based on clearness of water
  - Water from pre-fermentation stage can be recycled for few hours but some fresh water must be added in the process.
  - Water from post-fermentation can be used cautiously and only once since it may bring in off-flavours.

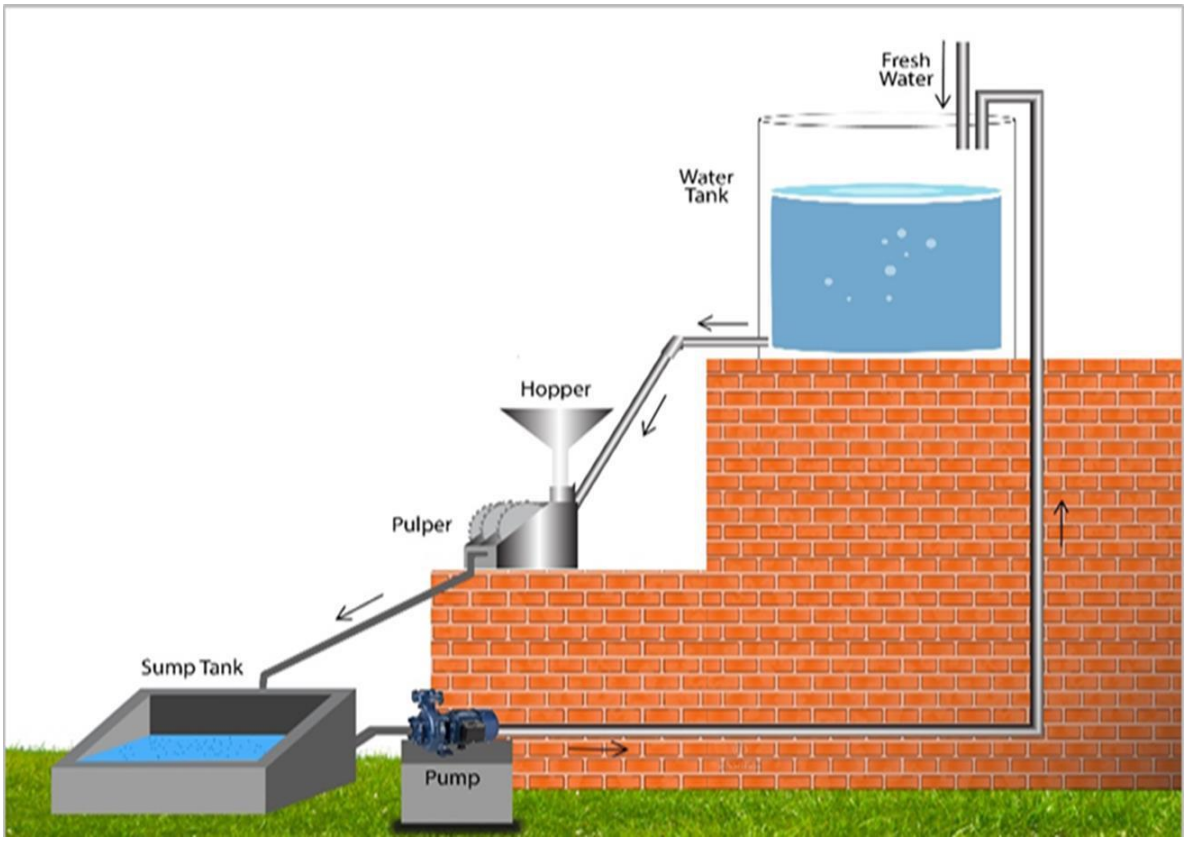


Figure 7.4: Water Recycling Mechanism

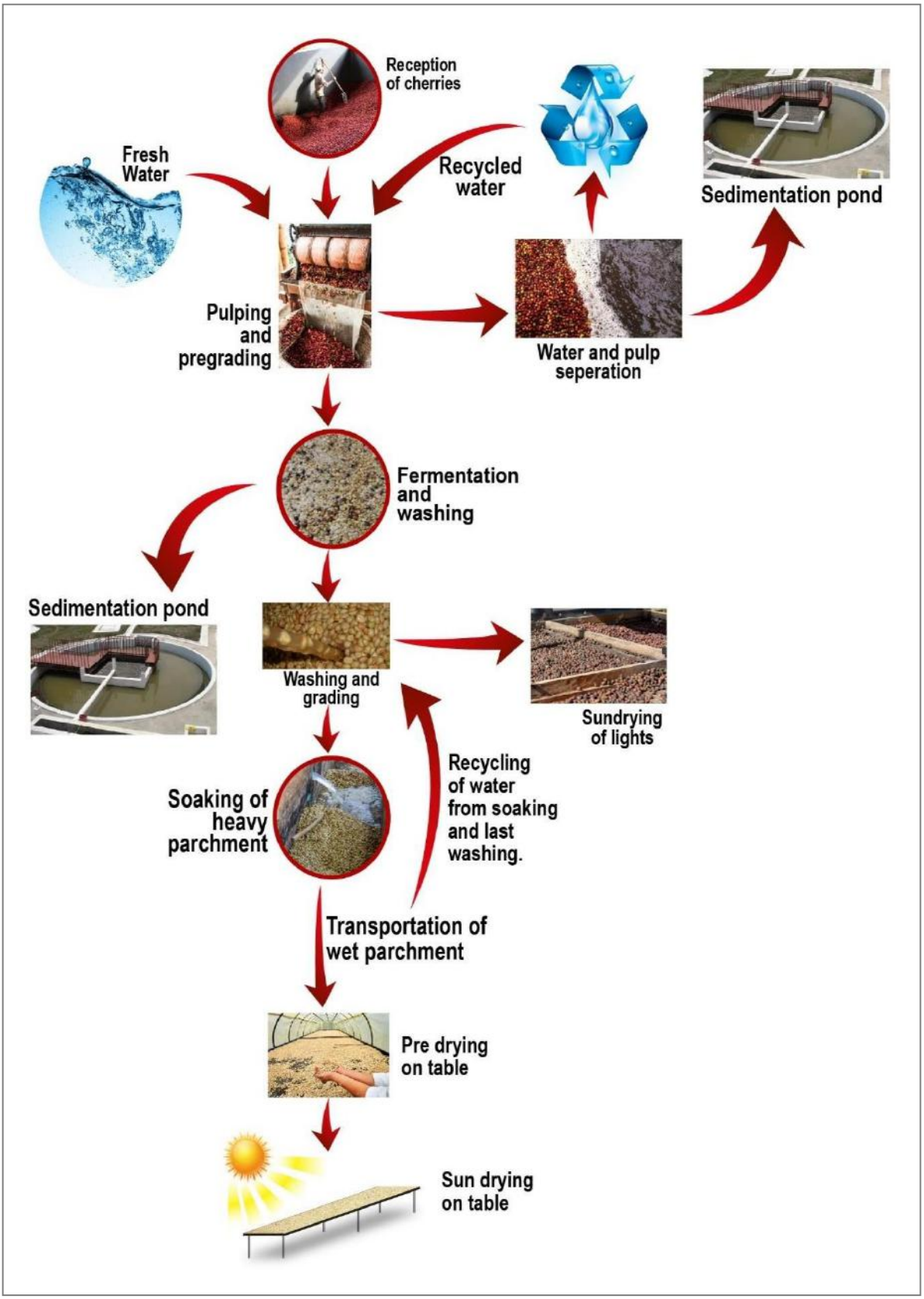


Figure 7.5: Water recycling for efficient utilization

7.7 Coffee processing wastes and their characteristics

- According to Enden and Calvert (2002), 6.25 tonnes of cherry produces 1 tonne of dry green beans, 2.5 tonnes of pulp and 25,000 litres of water
- Coffee pulp represents 29% dry-weight of the whole cherry. It is essentially rich in carbohydrates (21 – 32%), proteins (5 – 15%), fats (2 – 7%), and minerals (9%)
- According to Treagust (1994), waste water contains;
  - Up to 20.00 mg/litre of Biological Oxygen demand(BOD) which provides a figure on how much oxygen is needed by bacteria to break down the pollution load in a given time (normally 5 days)
  - 50.00 mg/ litre Chemical oxygen demand (COD) which refers to the resistant organic materials which can only be broken down by chemical means
  - Acidity of below pH4
  - High organic matter
  - Sugars, proteins and pectins from pulp and mucilage

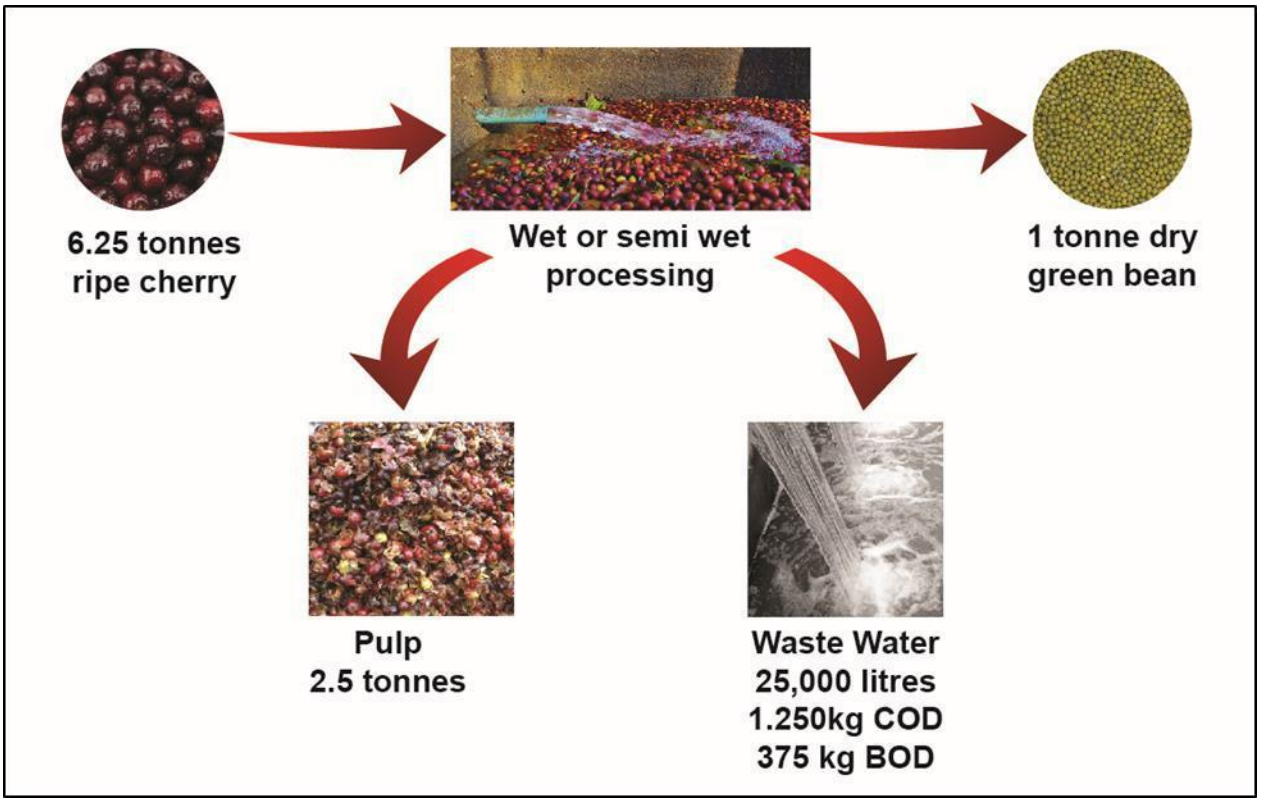


Figure 7.6: Coffee processing products and by-products

7.8 Effects of coffee processing waste to the environment

Untreated coffee processing waste if released to the environment may have serious environmental effects:

- Combination of high acidity and high BOD widely exceeds self-purification capacity of rivers and does not allow higher aquatic life
- Oxygen for biological breakdown exceeds oxygen in water leading to anaerobic conditions - bad smell through “rotting” and good growth conditions for health threatening bacteria when found in drinking water
- Provide a breeding ground for pests and pathogens as well as cause significant odour issues from decomposing coffee pulp

- Cause greenhouse gas (GHG) emissions depending on the method used in decomposing pulp
- Bring about enrichment of rivers with minerals and nutrients which induce excessive growth of algae. This process may result in oxygen depletion of the water bodies thereby affecting aquatic life
- Prevents sunlight penetration into deeper portions of water bodies due to the highly colored nature of waste water and this affects aquatic life
- Contribute significantly to soil pollution, acidification, inhibition of seed germination and cause soil manganese deficiency, indirectly damaging agricultural crops

7.9 Utilization of coffee processing wastes

Waste derived from coffee wet mills has been put into various uses in the coffee growing countries both regionally and globally. These include;

- Composting - Coffee pulp is a rich source of nutrients: 0.5% nitrogen; 0.15% phosphorus, and 0.5% potassium. Pulp composting has been common in India, Brazil and Rwanda. In Uganda, biochar is added to composting pulp to produce a fertilizer with high nutrient holding capacity

Figure 7.7: Fresh coffee pulp (a) and composted pulp (b)

- Vermicomposting is also applied in some countries such as Rwanda. This is where earthworms feed on coffee pulp releasing vermicompost, which is earthworm's excrement called castings and is used to improve biological, chemical, and physical properties of soil.
- Coffee pulp is also used in mushroom production in India and Rwanda. After having fermented for two days, pulp is pasteurized with hot water, drained, dried, and mixed with mushroom spores.
- Dry cherry pulp is used to make a nutritious flour in Vietnam, Nicaragua and Guatemala. A gram of the flour contains more iron than spinach, more fibre than whole grain wheat or coconut flour, more potassium than a banana, less fat and has significant antioxidant properties and high protein levels.
- Use of pulp in production of animal feed supplements is also practiced in India and Rwanda. The pulp needs to be treated as quickly as possible to prevent the development of fungi. Usually, coffee pulp is treated with calcium hydroxide and dried under pressure.
- Coffee pulp can also be used in production of caffeine, pectin and pectin acid enzymes like it is the case in India
- Use of coffee pulp for Ethanol wine and vinegar production is a common practice in Brazil
- Biogas production is also practiced in Mexico, Kenya and Rwanda

7.10 Treatment of coffee processing wate

To counter the effects of coffee processing waste to the environment, wet mills need to come up with waste management strategies. Some of the methods include:

- Peptic enzymes can be applied in coffee waste to help in the decomposition of the solids and are very useful in waste water treatment. The enzyme breaks down pectins contained in coffee pulp by degrading the cell walls which become weaker and easy to detach
- Traditional biological treatment by use of seepage pits which should be located away from water bodies. The sludge should be removed from the bottom and sides of the seepage pits annually. The pulp should be separated from waste water and the water should not be left to flow to water bodies. The challenge to this method is production of uncontrollable biomass sludge with fluctuating settling properties, sludge bulking, incapability to remove toxic substances and poor filterability.
- Use of an acidification pod where waste water is left to rest for 6 hours at a shallow depth, followed by a neutralization tank filled with ground limestone. The water flows to a biogas reactor and then to a wet land planted with macrophytes (aquatic plants growing in or near water) for secondary purification. After this, the water flows to a water hyacinth pond for tertiary purification and later to the open water way. This is largely practiced in Vietnam.
- Aerobic/anaerobic bioreactor; involves the utilization of an Equalization, Anaerobic and Aerobic tanks and is largely practiced in India. At the equalization tank the effluents from pulping, washing and soaking are let into an equalization tank for homogenizing the pollution load with the addition of limestone ($CaCO_3$). According to Treagust (1999), 250g of limestone is required to buffer 1 litre of acid water and change it from pH 3.8 to 6. The water from equalization tank moves into aerobic tank which is filled up to 10% of its total capacity with cow dung slurry. As a result, high strength organic wastewater containing high quantity of solids is degraded. The supernatant liquid from anaerobic tank is fed into an aerobic tank. The wastewater may be aerated by fixed or floating aerator of suitable oxygenation capacity for 48-50 hours. In case of small grower sector, instead of aeration, water from anaerobic lagoon is diluted at 1:10 fresh water and utilized only for agricultural purposes.

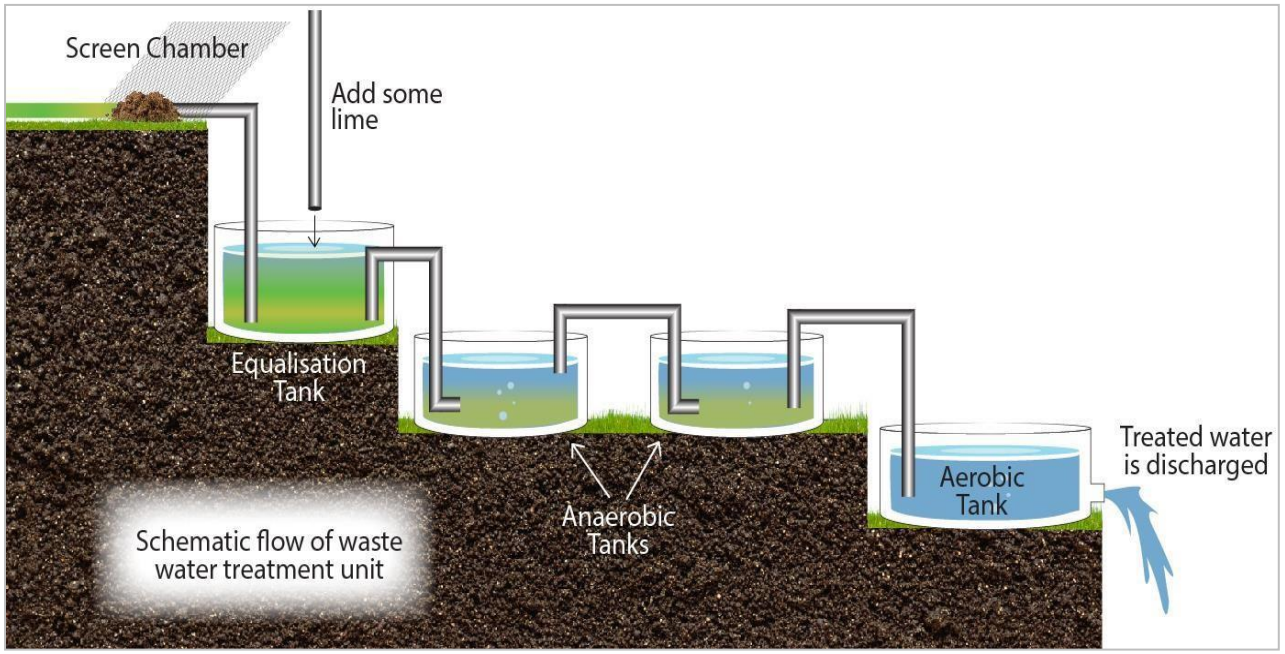


Figure 7.8: Anaerobic/ Aerobic Bioreactor

- Naturally occurring fungi break down coffee waste and the water is released to naturally growing vegetation as practiced in Uganda
- Use of vetiver grass wetlands in Ethiopia. The deep rooted Vetiver grass suck a lot of water contained in the coffee processing waste and can therefore be planted within a wet mill.

Figure 7.9: Vetiver grass planted within a wet mill (Source: Technoserve, 2013)

  - According to Truong et al. (2008), vetiver grass is able to extract Nitrogen and Phosphorus from waste water. Vetiver is also able to achieve some degree of filtration and achieve disinfection role by reduction in E. Coli organisms present in waste water

- Use of Moringa seed extracts in Kenya. *Moringa oleifera* seed powder applied at a concentration of 50g/L for a period of a month changes the colour of coffee effluent from dark brown to light greenish brown coloration while the odour becomes more pleasant
- Use of aerobic lake system-aerobic lagoons as in Brazil
- Use of acidification, neutralization, settlement and clean up method which involves;
  - Raw effluents from processing (recycled water, demucilager effluents, fermentation tank effluents are channelled to a long and shallow acidification tank. Mucilage and pulp components undergo fermentation, acidification and sedimentation.
  - During acidification, a thick crust of raw mucilage will build up floating on the water. The middle layer is clear acid water while sediments settle to the bottom.
  - The clear acid water from Acidification tank moves to a neutralization tank and undergoes neutralization by use of finely ground limestone ($CaCO_3$) to pH 6
  - From the neutralization tank, the water moves to a settlement tank or a bio-digester where methane gas is produced.
  - Water from the bio-digester moves to a settlement tank after which it undergoes final clean up and reduction of BOD and COD by use of; wetland planted with reeds and rushes; anaerobic settlement pond; artificial aeration
  - The final clean up method depends on the amount of discharge water of the factory

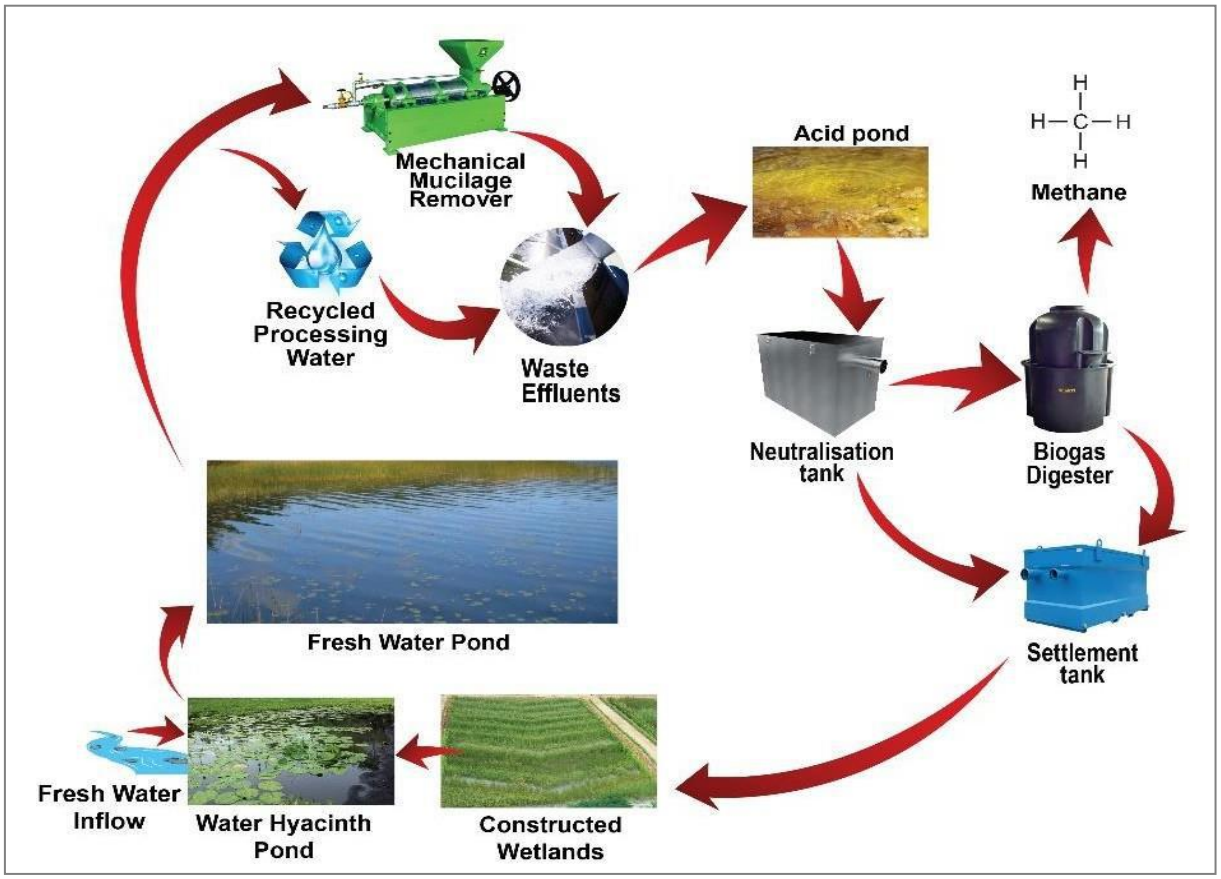


Figure 7.10: Waste water collection, treatment and recycling

MODULE 8: COFFEE FACTORY MAINTENANCE

8.1 Introduction

Significant losses occur due quality drop as a result of major breakdowns during coffee processing. The breakdowns mainly happen when product input is high resulting in congestion hence quality drop of significant amounts. Thus as soon as the coffee processing season is over the factory manager must inspect his factory carefully and put right the faults which have come to light in the preceding season. Certain mechanical parts will need to be replaced and that plaster and paint work might need improvement. It is also advisable to have a well organised technical service department to be carrying out maintenance after every processing season. Therefore, Coffee factory maintenance is about putting right all faults and undertaking both major and minor servicing. The manager also needs to implementthe necessary occupational health safety policies, legal requirements, procedures and equipment as well as factory sanitation and hygiene.

8.2 Aims of coffee factory maintenance

Maintenance in a coffee factory machinery, structures and equipment is aimed at:

- Increasing the lifetime of the to-be maintained item or structure and thus decrease the depreciation. This ensures the item or structure will stay for a long time with replacement or overhaul.
- Increasing the safety of personnel and product. This ensures that the operators are well protected from injuries and the final product is not contaminated.
- Ensuring dependability. This guarantees that the coffee processing will continue throughout the seasons without frequent breakdowns

8.3 Losses due to lack of maintenance

Lack of maintenance in coffee factories may lead to considerable losses which include:

- Breakdowns during processing resulting to delayed activities
- Product spoilage or contamination
- Safety of personnel is compromised
- Factory congestion resulting to delayed activities
- Drop in coffee quality

Although no accurate statistics are available concerning losses due to lack of maintenance all the above factors will result to reduced returns.

8.4 Guidelines for coffee factory maintenance

Coffee factory maintenance mainly involves:

- Replacement of broken materials, components
- Adjustments of equipment and machinery
- Plastering of all concrete surfaces and works
- Repainting
- Use of manufacturers manuals
- Having stocks of frequently used spares parts like bearings, bolts, nuts, V belts and discs
- Keeping the cleaning and maintenance records

8.5 Step by step activities of coffee factory maintenance

Sorting house

If a sorting shed exist carry out the following work once a year after the processing season: -

- Treat all timber with a wood preservative
- Check and if necessary repair roof and construction
- Consider expansion of sorting shed depending on future capacities
- Consider the improvement of lay-out

Figure 8.1: Well-maintained sorting shed

Weighing scales

Since the weight of cherry is the basis for the payment to the growers especially in cooperatives, the weighing scales must be in perfect conditions and accurate. The following must be done:

- Inspection and stamping of the weighing scales by the department of weights and measures annually
- Following the manufacturers manual for any instructions
- For all other repairs and adjustments call a specialist from the suppliers, service Department

Most of the organizations are digitalizing their data capture including digital weighing scales which are more accurate, accountable and convenient.

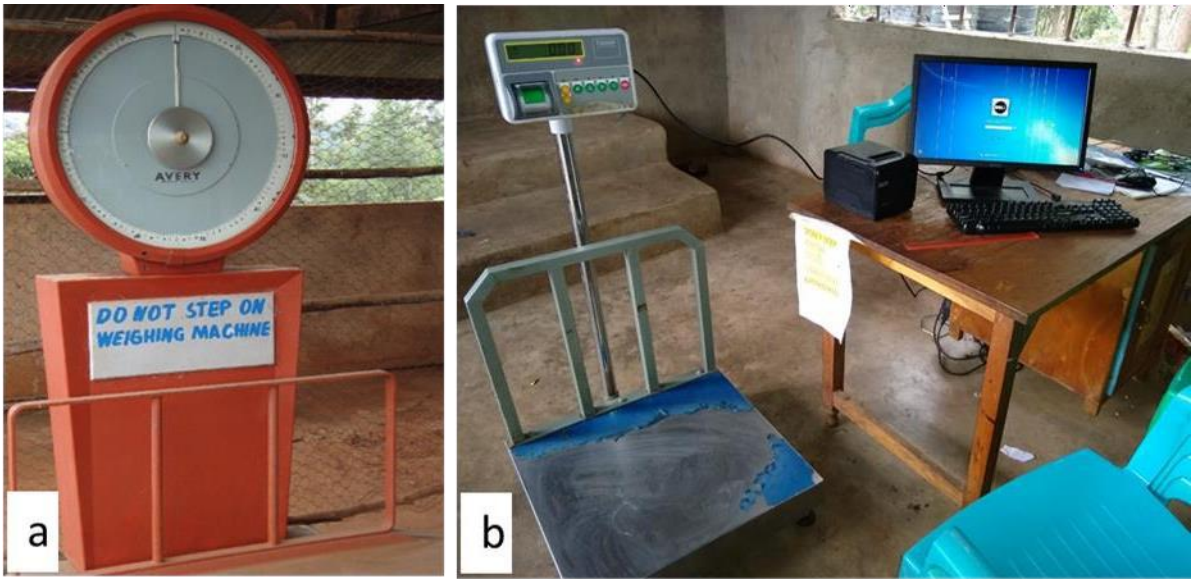


Figure 8.2: Analogue (a) and digital (b) weighing machine

Cherry hopper

Check whether the slope of the hopper is satisfactory. This allows for free flow of cherry to the pulper. At the end of each picking season check and where necessary repair and plaster all concrete and stone work. Always clean the cherry hopper before next pulping

Engines

The maintenance and repair of engines should by no means be restricted to the off-season but should be carried out regularly throughout the processing season and off-season in accordance with the running hours and the manufacturers' maintenance instructions. A record of running hours and service has to be kept throughout the use of the engine. Where there are electrical motors and appliances, technical or service team should be contacted to carry out maintenance or correct any faults.

Rotary feeder, pulper, pre-grader

The rotary feeder, pulper and pre-grader are the main components of the wet mill. This is where cherry is turned into parchment and initial grading achieved. The major maintenance activities include:

- Lubrication and greasing all movable parts
- Sandblasting of discs
- Unclogging all clogged areas
- Painting all iron surfaces
- Preventing damage of discs through misuse especially by foreign bodies entering the disc pulper.

Correct running speeds for various components should be maintained. In general, the revolutions/minute as recommended by the manufacturers should be followed, especially where a shaking sieve is incorporated, as over speed in this case will result in excessive vibration. Wrong pulper speeds result in inefficient pulping and poor separation of skins.
Other activities include cleaning, carrying out various adjustments and correcting various faults (Table 9.1).

Table 8.1: Disc pulper, faults and remedies

Fault or Symptom	Possible Cause	Remedy
Many berries passing through pulper without being pulped	(a) Plough set too far away from disc. (b) Cherry of incorrect ripeness.	Adjust plough to a closer setting. Take more care in picking and sorting.
Nipping or breaking of beans and/or fragments of beans being passed through with the pulp on to the back sheet	(a) Plough set too close to the disc (b) Knife set too far away from the disc (c) “End - float" of disc shaft (d) Cherry is of incorrect ripeness	Adjust plough to a wider setting Adjust knife to a closer setting Replace worn out bearings Take more care in picking and sorting
Whole beans being passed through with the pulp on to the back sheet	(a) Knife set too far away frorn disc	Adjust knife to a closer setting.
Excessive amount of pulp being delivered with pulped coffee.	(a) Rate of feed into the pulper too high (b) Disc surfaces have become polished	Reduce feed rate until satisfactory delivery is obtained For quick temporary improvement, etch disc surface with hydrochloric acid For longer lasting repair, surface should be sandblasted.
Flow of coffee ceases or almost ceases.	(a) Foreign materials such as leaves or twigs has entered the pulper causing blockage (b) Feed rate too high (c) seriously overripe coffee being pulped (d) Undue delay between picking and pulping (e) Insufficient water being supplied to the pulper.	Stop the machine and clean the blockage Cut off the feed altogether until machine clears itself. If the lowest possible feed is still too high, the discs are probably worn out Take more care in picking and sorting Pulping must be carried out on the same day as pulping Increase water flow.
Intermittent ringing sound coming from disc pulper.	(a) Knife or knives set too close (b) Loose disc shaft (c) One of various cover plates fouling disc (d) slots in hopper not correctly aligned. (e) Hard object trapped between disc and plough	Adjust knife or knives accordingly Check bearings Adjust Adjust by means of screw provided in the pulper side frames Remove

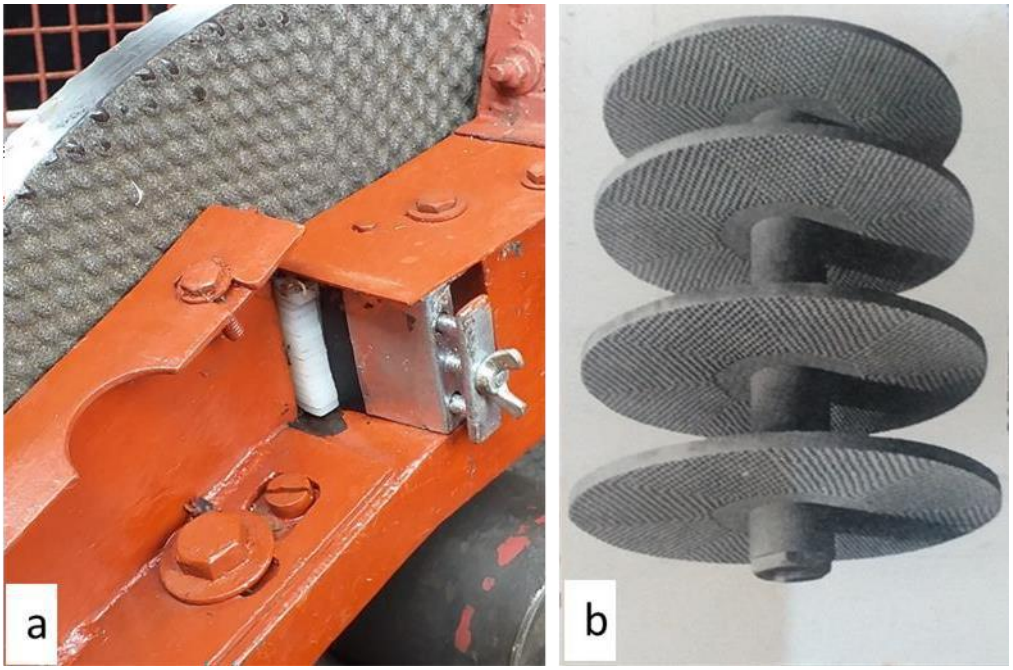


Figure 8.3: Disc pulper showing adjustment points (a) and well sprayed discs (b)

For the hand pulpers, the cherry is squeezed between the rotating member and the stationary one where the clearance between the two members is carefully adjusted so that the beans pulped pass through unbroken (crashed or nipped). Figure 9.1

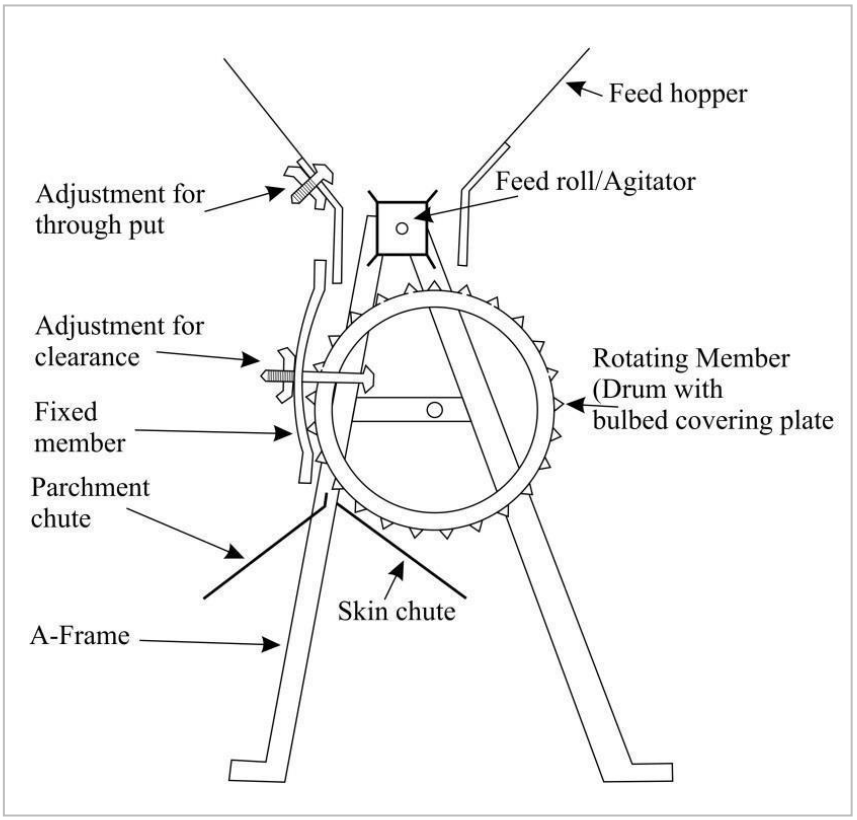


Figure 8.4: Disc pulper set-up

The settings depend on the average cherry size, its condition and the moisture content. The following maintenance procedures are also recommended;

- Regular cleaning to remove traces of skins and other dirt
- Maintenance of correct tension on belt and chain drives (motorised pulpers)
- Lubrication of moving parts
- Punched bulbs on pulping drum surface should be checked and if worn out, be replaced.
- Broken or worn out parts should be regularly replaced
- Should be stored in covered place to keep corrosion to a minimum

Figure 8.5: Well-maintained machinery

Ecopulpers – Demucilager

The eco-pulper is operated with little or no water during the pulping process, and removes the mucilage from the coffee bean mechanically, omitting the need for fermentation and washing. To carryout maintenance and adjustments for the eco-pulpers, it is important to use manufactures manual for maintenance and service. It is also recommended to have a technical team or service provider for maintenance and service.

Aagaard Pregrader

The Aagaard pregrader grades the parchment into parchment I, II and lights. Main areas that require attention are as indicated in Table 9.2

Table 8.2: Aagaard pre-graders faults, their possible causes and remedies

Fault or Symptom	Possible Cause	Remedy
Skins passing out with heavy coffee.	(a) Water velocity too slow (b) Water volume low (c) Grading screen too deep in the water.	(a) Close up the slot slightly making sure it is parallel throughout its length. (b) Open the volume control valve (c) Raise screen on the cradle adjusting nuts.
Heavy coffee being passed through the second outlet.	(a) Water velocity too high (b) Grading screen too near the water surface (c) Dividing plate between 1st and 2nd compartments wrongly placed.	(a) Open the slot slightly making sure it is parallel throughout its length (b) Lower the screen on the cradle adjusting nuts (c) Place so as it slopes backwards to the pulper
Eddies in the grading section being set up	(a) Water velocity too high (b) Water velocity regulating slot not parallel throughout its length (c) Cradle not level	(a) Open the slot (b) Adjust the slot correctly (c) Adjust the cradle on its adjusting nuts
Second grade coffee (medium density) being passed through with heavy coffee.	(a) Dividing plate between 1st and 2nd compartments wrongly placed. (b) Water velocity too slow (c) Water volume too low	(a) Place so as it slopes forward to the repulpser (b) Close up the slot slightly making sure it is parallel throughout its length (c) Open the volume control valve.
"Elephant" beans being passed over with the lights.	(a) Screen size too small (4th section)	(a) Fit new screen (4th section)
"Seconds" outlet clogs up	(a) Seconds outlet door too much closed	(b) Open till coffee flows freely.

Note that the elevator chain must not be too slack or rapid wear will result; but on the other hand, if it is too tight coffee will not be lifted.

Washing channels, fermentation tanks and soak tanks

These are mainly concrete and stone works with recommended the acid resistant paints. At the end of each pulping season:

- Check and where necessary repair plaster, concrete and stone work
- Make sure that surfaces in contact with coffee are smooth, if necessary, paint them
- Check all gates and lids for leaks
- Paint all not galvanized ironmongery

Figure 8.6: Poorly maintained fermentation tanks with no roof

Possible areas of improvements may include:

- A roof over the fermentation tanks to protect the fermenting parchment from rain and sunshine
- Better drainage facilities
- Water-tight tanks to soak parchment
- Coffee conveyor channel from the end of the final washing channel to the skin drying area. These could be channels or pipes.

The recommended paints for use in coffee factories are the acid-resistant paints which do not taint the coffee. They include, Epilec – U- Pox, Rust – oleum, Leruch, and chlorinated rubber paint.

Figure 8.7: Well painted fermentation tanks

Skin-drying trays and skin-drying tables

At the end of each pulping season:

- Check the number of available and serviceable trays and tables
- Calculate the requirements for next season and if necessary make new trays
- Treat all timber with a wood preservative

Possible improvements could be construction of metal skin drying tables. The initial cost is high but little or no maintenance cost.

Figure 8.7: Skin drying tables sloping down from the soak tanks

Sun drying tables

At the end of each pulping season:

- Treat all timber with a wood preservative
- Replace all broken timbers
- Tighten the tensile wire and flatten the chicken wire where necessary
- Have the recommended covering materials
- Cut the grass and other growths under the tables
- Calculate the drying tables required for the coming season
- Take measures to roll up the covering material
- Consider constructing metal sun drying tables

Stores

When the last coffee consignment of parchment has been delivered to the Mills:

- Treat all timber with wood preservative
- Check roof construction for broken timber, leaking roof and repair if necessary
- Check all plaster, concrete and stone work for cracks and repair if necessary

- Repair/replace hinges and locks
- Repaint doors and frames
- Place wooden pallets to improve ventilation
- Consider controlled ventilation
- Calculate capacity required for next season and enlarge the store accordingly

Skin pit

- Empty the skin pit frequently, at least once a month depending on the volume of coffee pulped.
- Make an earthen wall around the skin pit to prevent skins from flowing out onto the surrounding area
- Build a proper skin separation tower with a proper water disposal
- Construct a road to the skin pit for easy skin collection by farmers

Figure 8.9: Skin tower (a) and pulp left to accumulate at the skin tower (b)

Soak pits or lagoons

Soak pits should be constructed to prevent coffee waste and effluent from going into the river. They should be located away from Parchment handling and storage structures.

Figure 8.10: Soak pit

The coffee waste and effluent water can also be used for irrigation in farms around the factory to grow other crops.

General site maintenance

At the end of each pulping season; repair and improve the roads if necessary.

- Consider the improvement of the factory layout, especially the drying area layout.
- Study the drainage of rainwater and if necessary dig short cuts, draining channels, etc.
- Cut the grass where necessary, plant shrubs and trees and trees to prevent erosion.

8.6 Occupational safety and health at work place

Occupational Safety and Health (OSH) is a discipline concerned with protecting and promoting the safety, health and welfare of people engaged in work or employment. It is the science of anticipation, recognition, evaluation and control of hazards arising in or from the workplace. The goals of occupational safety and health programs include fostering a safe and healthy work environment. It is a multi-disciplinary activity targeting four basic aspects:

- Protection and promotion of worker's health by preventing and controlling occupational diseases, accidents and injuries;
- Development and promotion of healthy and safe work and work environments;
- Promotion of physical, mental and social well-being of workers; and
- Enabling workers to conduct socially and economically productive lives and to contribute positively to sustainable development.

Thus, it is imperative for organizations to implement policies, legal aspects of occupational safety and health, and procedures to ensure the safety and health of employees within the workplace.

Classification of OSH hazards

A hazard refers to any agent, situation or condition that can cause an occupational illness or injury. It may produce serious and immediate (acute) effects or long-term (chronic) problems that affect all or only part of the body. OSH hazards include:

- Mechanical hazard - any hazard involving a machine or process. Equipment and facilities if not properly installed and maintained may pose mechanical hazards. They include situations resulting in slips, trips and falls such as wet and slippery floors, poor constructions and finishing of structures and no guards on movable parts.
- Physical hazards - comprise of extremes of temperatures, pressures, noise, vibration and radiation. All these can be harmful to workers if not properly controlled
- Chemicals - may include chemicals used in agro production, post-harvest treatment or in processing factories. Chemicals should be put in designated chemical stores.
- Ergonomics risk factors - due to the nature of their work. Examples are found in jobs requiring repetitive, forceful, or prolonged exertions of the hands; frequent or heavy lifting, pushing, pulling, or carrying of heavy objects; and prolonged awkward postures. Extent of risk depends on intensity, frequency and duration of activities.
- Biological hazards - refer to biological substances that pose a threat to the health of a worker. This can include waste products or microorganism.

- Psychological hazards – this may be as a result of working alone, drug and alcohol abuse, stress as well as economic factors.

Figure 8.11: Guard rails on movable parts

OSH safety equipment

The following equipment should be available at the coffee factory:

- Personal protective equipment (PPE) - refers to protective barriers/ device or clothing that is worn by a worker in order to prevent any part of his or her body contact with a hazard at the place of work. Selection of PPE's will be done according to specific work areas.
- Fire extinguishers- are designed to fight different classes of fire. Every factory shall develop SOP on fire which shall include portable fire equipment and fire drills.
- Safety showers - provision of facilities for emergency body shower, eye/face wash
- Spill kits - where applicable for handling chemicals spills.
- First Aid Kit – the factory shall provide first aid facilities for staff and ensure adequate numbers of trained first aiders.
- Buildings and structures should be user friendly to ensure safety of workers
- All moving parts of machines should have safety guards
- Safety signage and labels - every facility shall develop and display directional signage and labels at strategic areas, safety signs for various hazards, and fire safety signs and labels. The factory act if available should also be displayed. Staff should be trained on signage and labels

There should also be regular training on OHS and medical check-ups particularly on staff exposed to the OHS hazards.

Figure 8.12: Safety signage and lables

8.7 Coffee factory hygiene

Factory hygiene describes a system of sanitary principles to preserve health. It involves maintaining a clean manufacturing environment and minimising the risks of food contamination. The following should be observed:

Factory Site

- Ensure that the factory site is free from sources of pollution e.g.
  - Dusty roads
  - Industrial effluents e.g. smoke
  - Polluted water sources and waste dumping grounds.
- Factory should be sited in well-drained soil devoid of loose soils and water that may contaminate the coffee.
- Ensure thorough cleaning of all areas of the factory to avoid contamination
- The parchment stores should be sited away from pesticides stores
- Ensure that the equipment location allows accessibility, adequate maintenance and cleaning and effective disposal of waste products.

Disposal of Waste (Pulp and Water)

- Pulp disposal area and wastewater pits should be located away from Parchment handling and storage structures.
- Soak pits should be located away from water bodies e.g. Dams and rivers to avoid water pollution.
- Use recommended improved seepage pit for disposing waste water
- Adopt waste pulp dewatering system as a means of pulp management and control
- Install re-circulation of water flow and mucilage recovery process in the factory

Personal hygiene

- Health status/Illness – all factory workers should have regular medical check-ups and should not work when they have certain illnesses such as diarrhoea, vomiting serious coughing and discharges
- Personal cleanliness – factory workers should be clean, not use strong perfumes, uses protective clothing and should always wash their hands before handling coffee.
- Personal habits – factory workers should avoid smoking, spitting, chewing, coughing and other unhygienic behaviour when handling coffee
- Coffee factories should have a first aid kit
- Factory should be well-fenced to keep off animals.

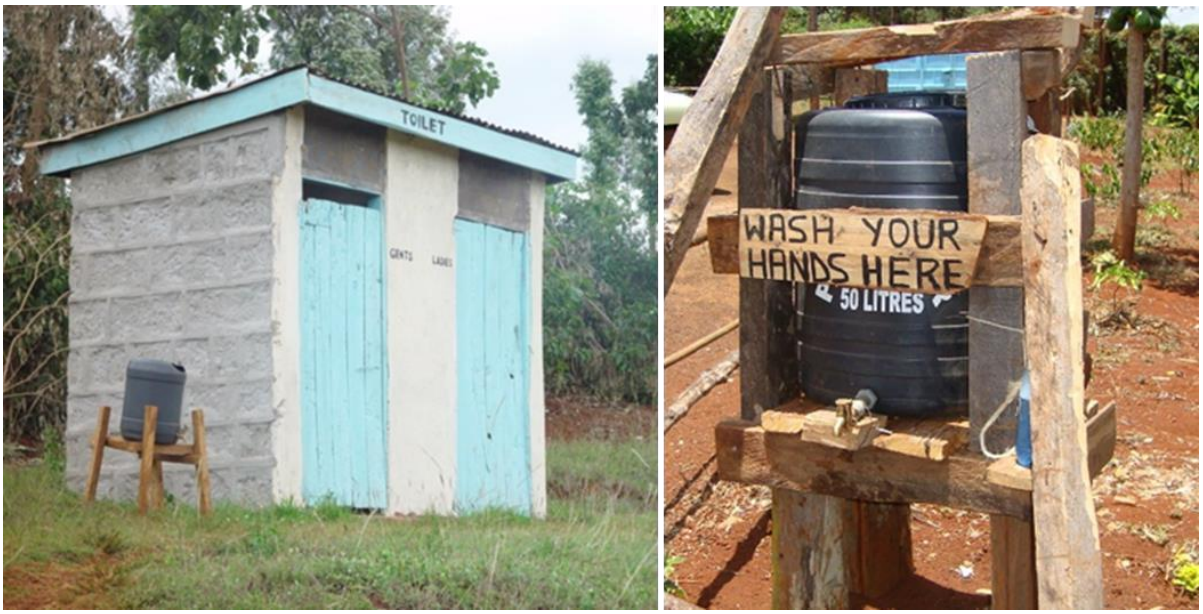


Figure 8.13: Well maintained toilet and with provision hand washing facility

MODULE 9: RECORD KEEPING IN A COFFEE WET MILL

9.1 Introduction

Coffee Wet mill managers need to maintain proper records for future reference, standardization of operations and lot separation. Lot separation is key in product traceability and in managing incidences where coffee from particular farms are known to have specific problems. For instance, some farms might have been notedto have high incidences of berry borer infestation or specific nutrient deficiencies. Such a crop should be harvested separately and the batch handled as a separate lot from pulping to storage.

9.2 Importance of keeping records

- Assists in lot separation and product traceability
- Provision of data for planning, monitoring operations and measuring performance
- Helps maintain farmer's data
- Tracks Performance trends; coffee production and quality
- Used to assess credit worthiness
- Tracks farmer's cherry deliveries
- Maintains operational costs
- Tracks water usage and waste disposal
- For out turn tracking
- Helps in critical process timing; fermentation, soaking, drying, standard tanks
- Gives information to potential coffee buyers
- Tracking of factory stocks

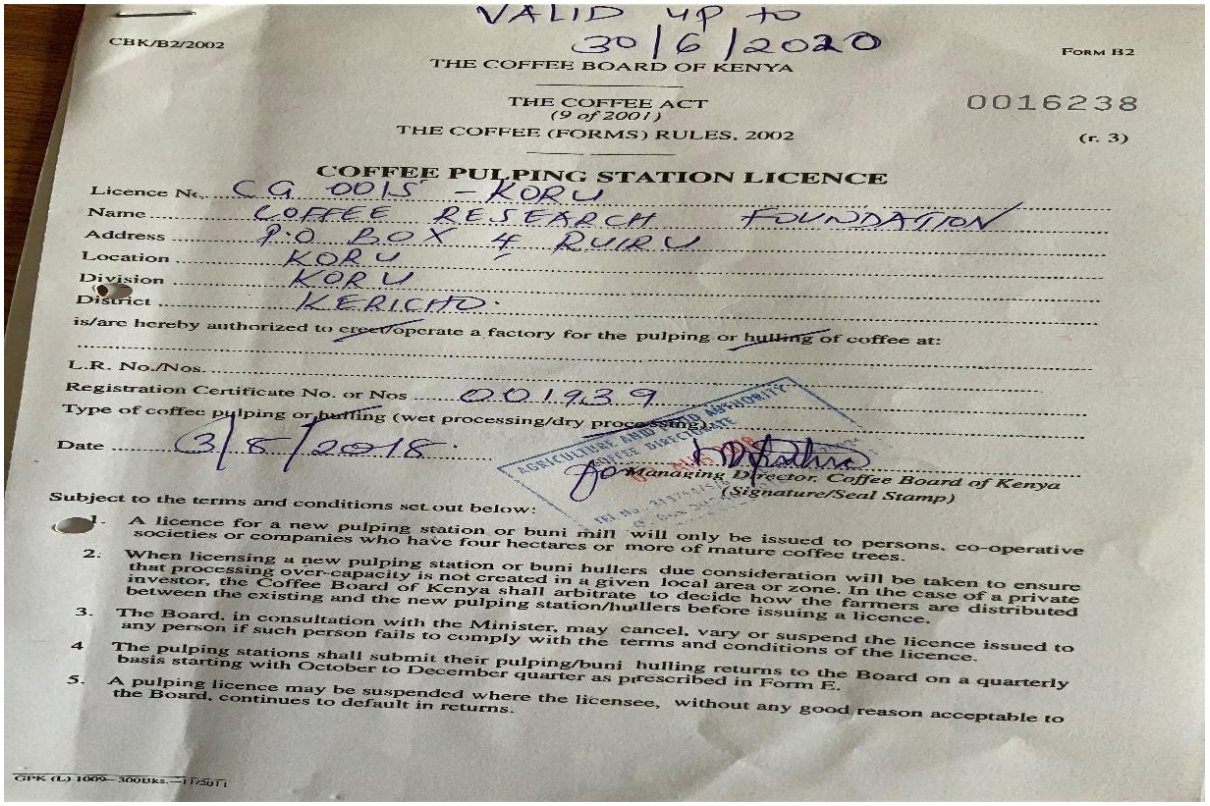
9.3 Important wet mill records

- Wet mill operating license
- Coffee milling agreement
- Farmer details
- Wet mill cherry intake records
- wet mill cherry processing records
- Parchment drying record
- Parchment stores records
- Booking for milling
- Parchment delivery acknowledge receipt
- Milling report
- Water consumption records
- Activities records
- Process flow chart
- Health and safety procedure manual
- Operating procedure manual

Wet Mill Operating License

A wet mill is required to register with the relevant authorities for purposes of regulation and monitoring of compliance. Generally, a wet mill operating license should have the following details:

i) Name of the society
ii) Name of the wet mill
iii) Date of registration
iv) Location of the wet mill
v) Address
vi) Area of the factory premises
vii) Number of members
viii) Total Number of coffee trees
ix) Total acreage of coffee trees



CBK/B2/2002

VALID UP TO 30/6/2020

FORM B2

THE COFFEE BOARD OF KENYA

THE COFFEE ACT
(9 of 2001)
THE COFFEE (FORMS) RULES, 2002

0016238

(r. 3)

COFFEE PULPING STATION LICENCE

Licence No. CG 0015 - KORU
Name COFFEE RESEARCH FOUNDATION
Address P.O BOX 4 RUIRU
Location KORU
Division KORU
District KERICHO.

is/are hereby authorized to erect/operate a factory for the pulping or hulling of coffee at:

L.R. No./Nos.
Registration Certificate No. or Nos 001939
Type of coffee pulping or hulling (wet processing/dry processing)
Date 3/8/2018.

for Managing Director, Coffee Board of Kenya
(Signature/Seal Stamp)

Subject to the terms and conditions set out below:

1. A licence for a new pulping station or buni mill will only be issued to persons, co-operative societies or companies who have four hectares or more of mature coffee trees.
2. When licensing a new pulping station or buni hullers due consideration will be taken to ensure that processing over-capacity is not created in a given local area or zone. In the case of a private investor, the Coffee Board of Kenya shall arbitrate to decide how the farmers are distributed between the existing and the new pulping station/hullers before issuing a licence.
3. The Board, in consultation with the Minister, may cancel, vary or suspend the licence issued to any person if such person fails to comply with the terms and conditions of the licence.
4. The pulping stations shall submit their pulping/buni hulling returns to the Board on a quarterly basis starting with October to December quarter as prescribed in Form E.
5. A pulping licence may be suspended where the licensee, without any good reason acceptable to the Board, continues to default in returns.

GPK (L) 1009—300Bks.—11/50Tl

Figure 9.1: Sample of a coffee pulping station license

Coffee milling agreement

It is important for a wet mill to sign contracts with partners like dry millers and marketing agents for purposes of setting terms and adhering to the same

Farmer Details

The details of all farmers who deliver coffee to a certain washing station must be captured as they help in zoning, allocation of picking days as well as assisting in traceability.
Important farmers' details include:

i) Name and membership number
ii) Farm location
iii) Address/ telephone
iv) Date of membership
v) Total coffee acreage
vi) Total number of coffee trees
vii) Number of trees per variety

MUTHEKA FARMERS COPERATIVE SOCIETY

FARMER DETAILS

Name	Location	Member No	No. of trees	Varieties	
				Ruiru11/Batian	SL28/SL34/K7
Clement Gitau	Gichoja	0810	600	200	400
Sarah Kungai	Kiriichu	0811	500	150	350
Alex Mwenji	Kiriichu	0812	550	70	480
Peter Mumbi	Mariene	0813	1,100	310	790
Philemon Kamau	Kaaria	0814	1350	550	800
Angela Wambui	Gichoja	0815	1400	400	1,000
Naomi Kagwe	Kaaria	0816	800	50	750
Leah Ungari	Kiriichu	0817	950	450	500
Bridget Nyaanga	Kiriichu	0818	1200	300	900
Eric Kamau	Mariene	0819	1050	450	600
Margaret Thuita	Mariene	0820	650	200	450
Daniel Mwenji	Kaaria	0821	900	400	500
Martin Kamuti	Gichoja	0822	770	270	450
Njoki Mumbi	Kiriichu	0823	1200	200	1,000
Priscilla Njoki	Mariene	0824	850	360	490

Figure 9.2: Sample farmer details records

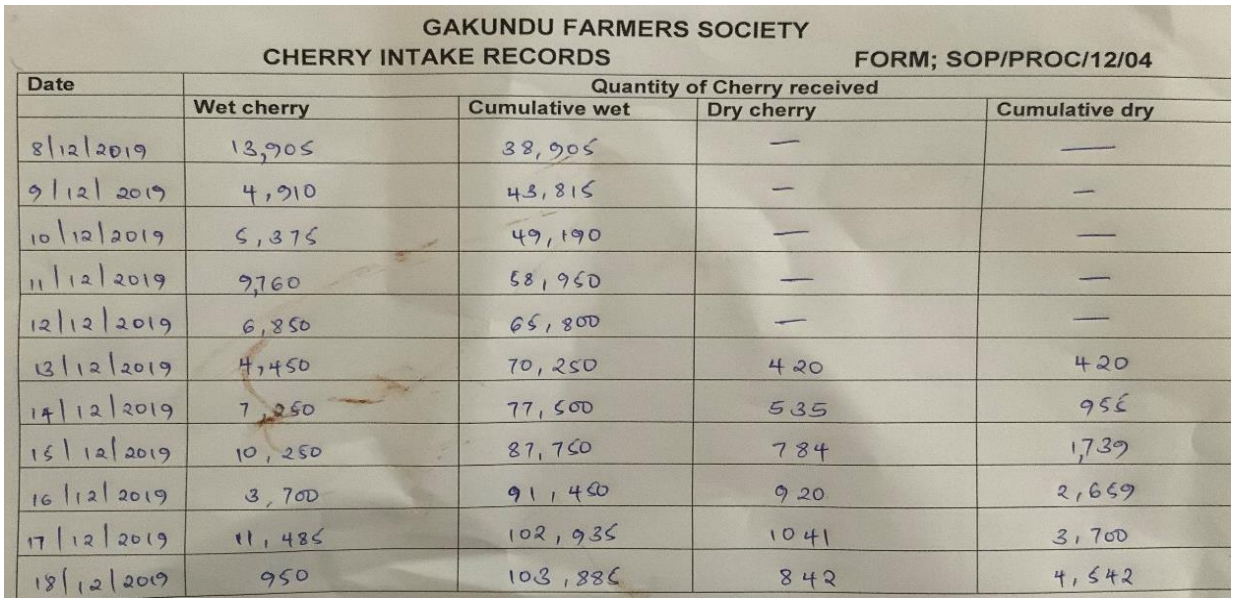
Wet mill cherry intake records

Cherry intake records gives the quantities of wet and dry cherry received on daily basis and the cumulative. It gives at a glance the progress of the mill in addition to assisting to assess the credit worthiness of the mill.

Table 9.1: Sample of Individual farmer cherry delivery records

Name of the farmer……...Member No…….

Date	**Cherry deliveries**			
	Wet cherry	**Cumulative wet**	**Dry cherry**	**Cumulative dry**



GAKUNDU FARMERS SOCIETY
CHERRY INTAKE RECORDS FORM; SOP/PROC/12/04

Date	Quantity of Cherry received			
	Wet cherry	Cumulative wet	Dry cherry	Cumulative dry
8/12/2019	13,905	38,905	—	—
9/12/2019	4,910	43,815	—	—
10/12/2019	5,375	49,190	—	—
11/12/2019	9,760	58,950	—	—
12/12/2019	6,850	65,800	—	—
13/12/2019	4,450	70,250	420	420
14/12/2019	7,250	77,500	535	955
15/12/2019	10,250	87,750	784	1,739
16/12/2019	3,700	91,450	920	2,659
17/12/2019	11,485	102,935	1041	3,700
18/12/2019	950	103,885	842	4,542

Figure 9.3: Sample cherry intake records

Wet mill cherry processing records

This gives details of all the processing stages from pulping up to storage of dry parchment. It shows the batch number, duration of every stage, the depth of the tanks where applicable in addition to the final storage quantities and points in the main store.

GAKUNDU FARMERS SOCIETY

COFFEE PROCESSING RECORD SHEET **Form; SOP/PROC/12/05**

Date received 11/12/2019 Amount kg 11,489 Batch/Lot No 023

Name of operator ALEX MWAURA

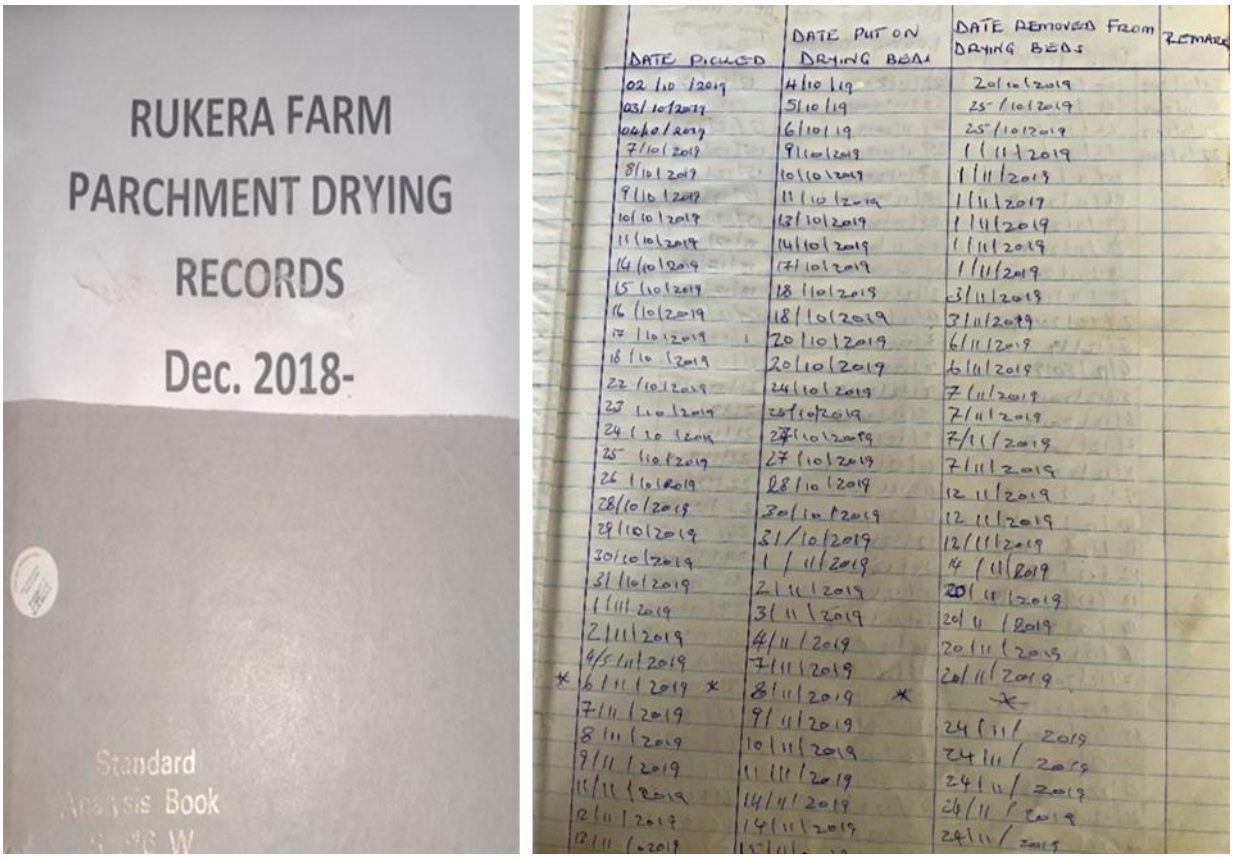
Activity	Date/time started		Date/time completed		Depth in metres W/A	Moisture content W/A	Remarks
	Date	Time	Date	time			
Pulping	11/12/2019	4:08 Pm	11/12/2019	8:25 Pm	0.85 m	78%	
Fermentation	11/12/2019	8:42 Pm	12/12/2019	9:45 Pm	—	—	
Intermediate washing	12/12/2019	11:05 Am	12/12/2019	12:20 Pm	—	—	
Final washing	12/12/2019	3:45 Pm	12/12/2019	4:50 Pm	—	—	
soaking	12/12/2019	4:50 Pm	13/12/2019	3:16 Pm	0.78 m	58%	
Skin drying	13/12/2019	3:45 Pm	13/12/2019	6:13 Pm	—	50%	
Final drying No. 038	14/12/2019	8:25 Am	24/12/2019	11:30 Am			Experienced dull weather
Conditioning bin No. C2	24/12/2019	11:45 Am	28/12/2019	10:22 Am			
Store point No. B1	28/12/2019						Amt: 2297kgs
Transportation to mill	29/12/2019						

Key; W/A where applicable

Figure 9.4: Sample coffee processing record sheet

Parchment drying records

Shows the flow of the parchment from the date of drying commencement up to when its fully dried and taken to the store

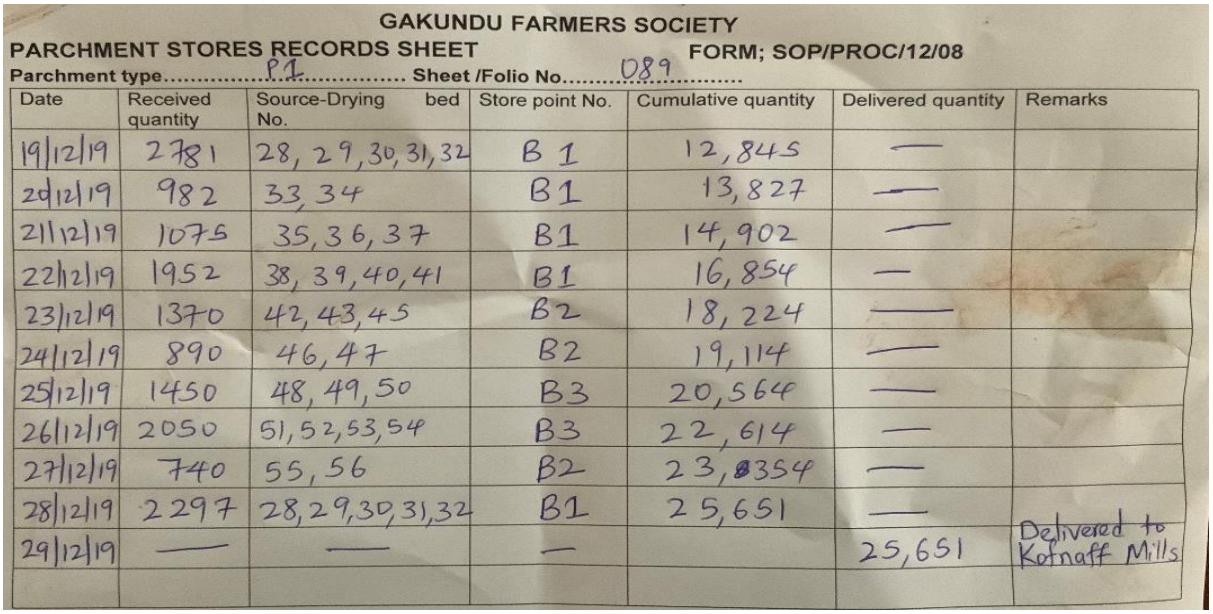


DATE PICKED	DATE PUT ON DRYING BEDS	DATE REMOVED FROM DRYING BEDS	REMARKS
02/10/2019	4/10/19	20/10/2019	
03/10/2019	5/10/19	25/10/2019	
04/10/2019	6/10/19	25/10/2019	
7/10/2019	9/10/2019	1/11/2019	
8/10/2019	10/10/2019	1/11/2019	
9/10/2019	11/10/2019	1/11/2019	
10/10/2019	13/10/2019	1/11/2019	
11/10/2019	14/10/2019	1/11/2019	
14/10/2019	17/10/2019	1/11/2019	
15/10/2019	18/10/2019	3/11/2019	
16/10/2019	18/10/2019	3/11/2019	
17/10/2019	20/10/2019	6/11/2019	
18/10/2019	20/10/2019	6/11/2019	
22/10/2019	24/10/2019	7/11/2019	
23/10/2019	25/10/2019	7/11/2019	
24/10/2019	27/10/2019	7/11/2019	
25/10/2019	27/10/2019	7/11/2019	
26/10/2019	28/10/2019	12/11/2019	
28/10/2019	30/10/2019	12/11/2019	
29/10/2019	31/10/2019	12/11/2019	
30/10/2019	1/11/2019	14/11/2019	
31/10/2019	2/11/2019	20/11/2019	
1/11/2019	3/11/2019	20/11/2019	
2/11/2019	4/11/2019	20/11/2019	
4/11/2019	7/11/2019	20/11/2019	
* 6/11/2019 *	8/11/2019 *	*	
7/11/2019	9/11/2019	24/11/2019	
8/11/2019	10/11/2019	24/11/2019	
9/11/2019	11/11/2019	24/11/2019	
11/11/2019	14/11/2019	24/11/2019	
12/11/2019	14/11/2019	24/11/2019	
13/11/2019	15/11/2019	24/11/2019	

Figure 9.5: Sample parchment drying records

Parchment stores records

Gives details of the parchment received in the main store indicating date, amount received and from which drying beds, store point where it is stored plus cumulative quantities



GAKUNDU FARMERS SOCIETY

PARCHMENT STORES RECORDS SHEET FORM; SOP/PROC/12/08

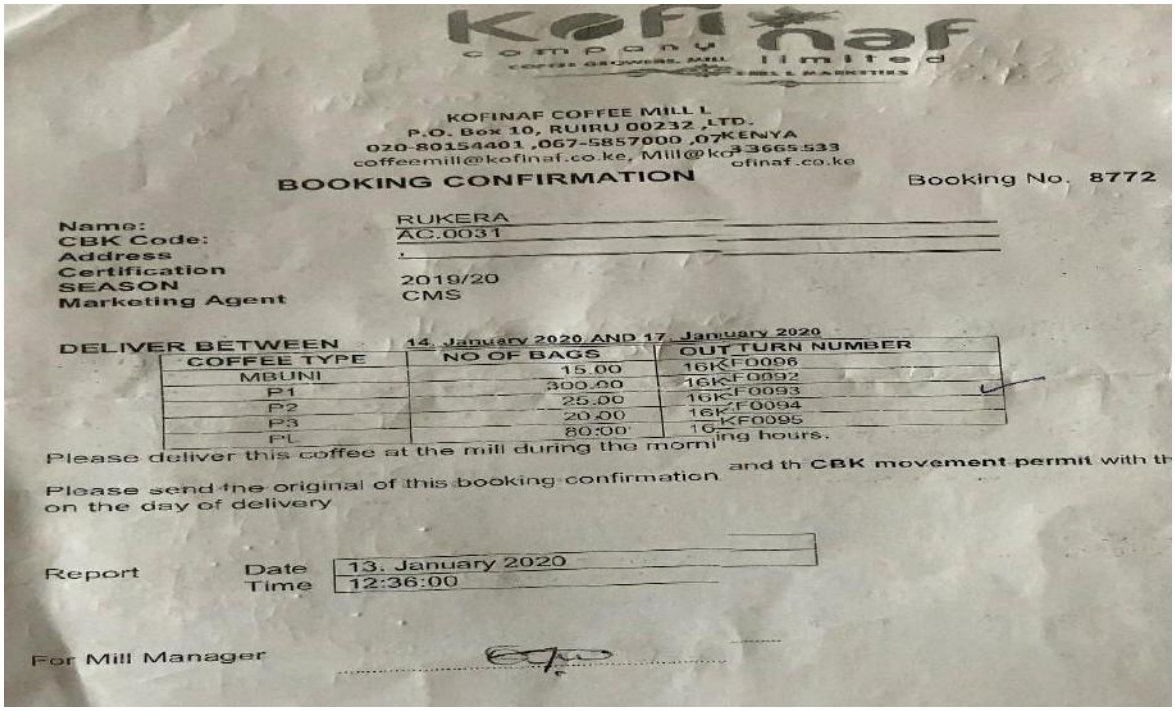
Parchment type..... P1 ..... Sheet /Folio No..... 089 .....

Date	Received quantity	Source-Drying bed No.	Store point No.	Cumulative quantity	Delivered quantity	Remarks
19/12/19	2781	28, 29, 30, 31, 32	B 1	12,845	—	
20/12/19	982	33, 34	B1	13,827	—	
21/12/19	1075	35, 36, 37	B1	14,902	—	
22/12/19	1952	38, 39, 40, 41	B1	16,854	—	
23/12/19	1370	42, 43, 45	B2	18,224	—	
24/12/19	890	46, 47	B2	19,114	—	
25/12/19	1450	48, 49, 50	B3	20,564	—	
26/12/19	2050	51, 52, 53, 54	B3	22,614	—	
27/12/19	740	55, 56	B2	23,8354	—	
28/12/19	2297	28, 29, 30, 31, 32	B1	25,651	—	
29/12/19	—	—	—		25,651	Delivered to Kofnaff Mills

Figure 9.6: Sample parchment stores record sheet

Booking for milling

When the coffee is ready for delivery to mills, booking is done to give the date and quantities to be delivered to the contracted miller. It gives the expected date of delivery, coffee type, quantities and out turn numbers for each coffee type. For traceability purposes, the Manager needs to record the corresponding batch/lot number for each out turn number



kofinaf company limited

KOFINAF COFFEE MILL L
P.O. Box 10, RUIRU 00232 ,LTD.
020-80154401 ,067-5857000 ,07KENYA
coffeemill@kofinaf.co.ke, Mill@ko 3665533
ofinaf.co.ke

BOOKING CONFIRMATION Booking No. 8772

Name: RUKERA
CBK Code: AC.0031
Address .
Certification
SEASON 2019/20
Marketing Agent CMS

DELIVER BETWEEN 14. January 2020 AND 17. January 2020

COFFEE TYPE	NO OF BAGS	OUT TURN NUMBER
MBUNI	15.00	16KF0096
P1	300.00	16KF0092
P2	25.00	16KF0093
P3	20.00	16KF0094
PL	80.00	16KF0095

Please deliver this coffee at the mill during the morning hours.
Please send the original of this booking confirmation and th CBK movement permit with th on the day of delivery

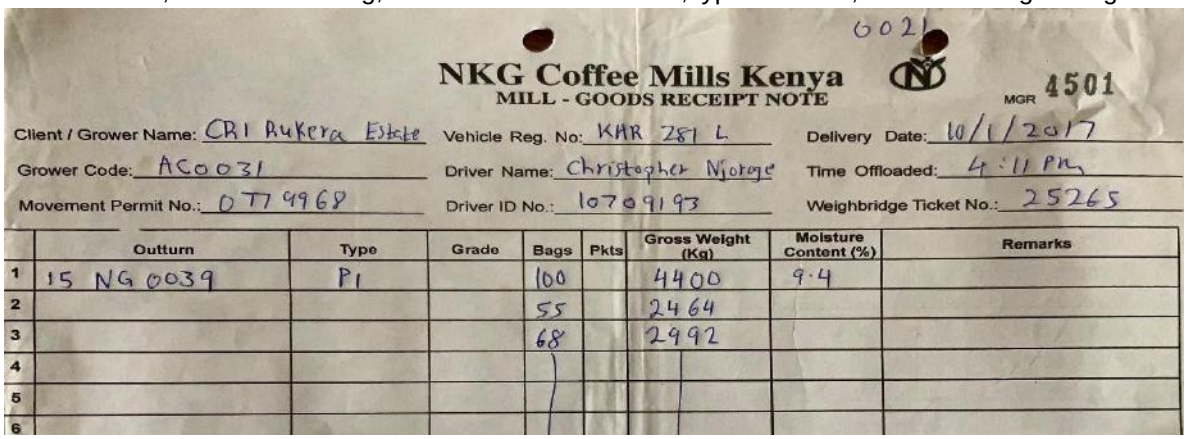
Report Date 13. January 2020
Time 12:36:00

For Mill Manager

Figure 9.7: Sample confirmation records

Parchment delivery acknowledge receipt

Once the parchment is delivered at the mills, a receipt is issued showing the wet mill code, vehicle number, driver's name, time of offloading, allocated outturn number, type of coffee, number of bags and gross weight.



6021

NKG Coffee Mills Kenya
MILL - GOODS RECEIPT NOTE MGR 4501

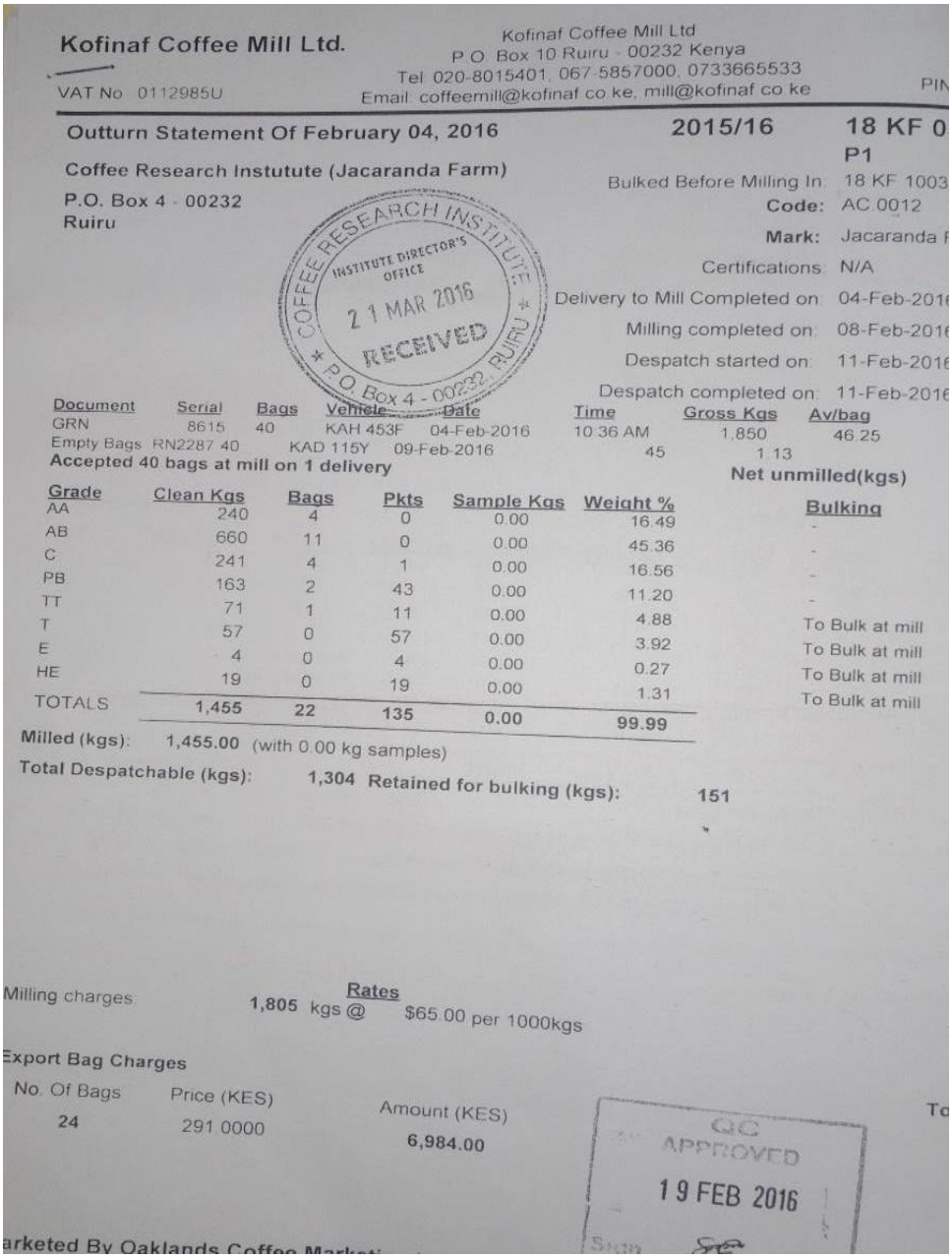
Client / Grower Name: CRI Rukera Estate Vehicle Reg. No: KAR 281 L Delivery Date: 10/1/2017
Grower Code: AC0031 Driver Name: Christopher Njoroge Time Offloaded: 4:11 PM
Movement Permit No.: OT7 9968 Driver ID No.: 10709193 Weighbridge Ticket No.: 25265

	Outturn	Type	Grade	Bags	Pkts	Gross Weight (Kg)	Moisture Content (%)	Remarks
1	15 NG 0039	P1		100		4400	9.4	
2				55		2464		
3				68		2992		
4								
5								
6								

Figure 9.8: Sample parchment delivery acknowledge receipt

Milling report

After milling the parchment, the mill issues a report showing quantities milled, grades, classes and milling loss. The Manager needs to interpret the data, come up with causes of any quality deviation plus remedies for each. The information is communicated to the producers and wet mill owners for purposes of coming up with a remedial plan.



Kofinaf Coffee Mill Ltd.

Kofinaf Coffee Mill Ltd
P.O. Box 10 Ruiru - 00232 Kenya
Tel 020-8015401, 067-5857000, 0733665533
Email: coffeemill@kofinaf.co.ke, mill@kofinaf.co.ke

VAT No 0112985U PIN

Outturn Statement Of February 04, 2016 2015/16 18 KF 0

P1

Coffee Research Instutute (Jacaranda Farm)

P.O. Box 4 - 00232
Ruiru

COFFEE RESEARCH INSTITUTE * P.O. Box 4 - 00232 RUIRU * INSTITUTE DIRECTOR'S OFFICE 21 MAR 2016 RECEIVED

Bulked Before Milling In: 18 KF 1003
Code: AC 0012
Mark: Jacaranda
Certifications: N/A
Delivery to Mill Completed on: 04-Feb-201
Milling completed on: 08-Feb-201
Despatch started on: 11-Feb-201
Despatch completed on: 11-Feb-201

Document	Serial	Bags	Vehicle	Date	Time	Gross Kgs	Av/bag
GRN	8615	40	KAH 453F	04-Feb-2016	10:36 AM	1,850	46.25
Empty Bags RN2287 40			KAD 115Y	09-Feb-2016	45	1.13	

Accepted 40 bags at mill on 1 delivery

Net unmilled(kgs)

Grade	Clean Kgs	Bags	Pkts	Sample Kgs	Weight %	Bulking
AA	240	4	0	0.00	16.49	-
AB	660	11	0	0.00	45.36	-
C	241	4	1	0.00	16.56	-
PB	163	2	43	0.00	11.20	-
TT	71	1	11	0.00	4.88	To Bulk at mill
T	57	0	57	0.00	3.92	To Bulk at mill
E	4	0	4	0.00	0.27	To Bulk at mill
HE	19	0	19	0.00	1.31	To Bulk at mill
TOTALS	1,455	22	135	0.00	99.99	

Milled (kgs): 1,455.00 (with 0.00 kg samples)

Total Despatchable (kgs): 1,304 **Retained for bulking (kgs):** 151

Milling charges: 1,805 kgs @ Rates $65.00 per 1000kgs

Export Bag Charges

No. Of Bags	Price (KES)	Amount (KES)
24	291.0000	6,984.00

QC APPROVED 19 FEB 2016

arketed By Oaklands Coffee Market

Figure 9.9: Sample milling report

Water consumption records

Opening and closing meter readings plus cumulative amounts are recorded on daily basis. It helps in monitoring consumption and relating the amount to quantities processed. Monitoring helps cut down costs plus the amount of processing water released to the treatment lagoons. This can be used to work out water treatment capacities.

Table 9.2: Sample of water consumption records

Date	Opening meter reading m^3	Closing meter reading m^3	Total consumption m^3	Remarks

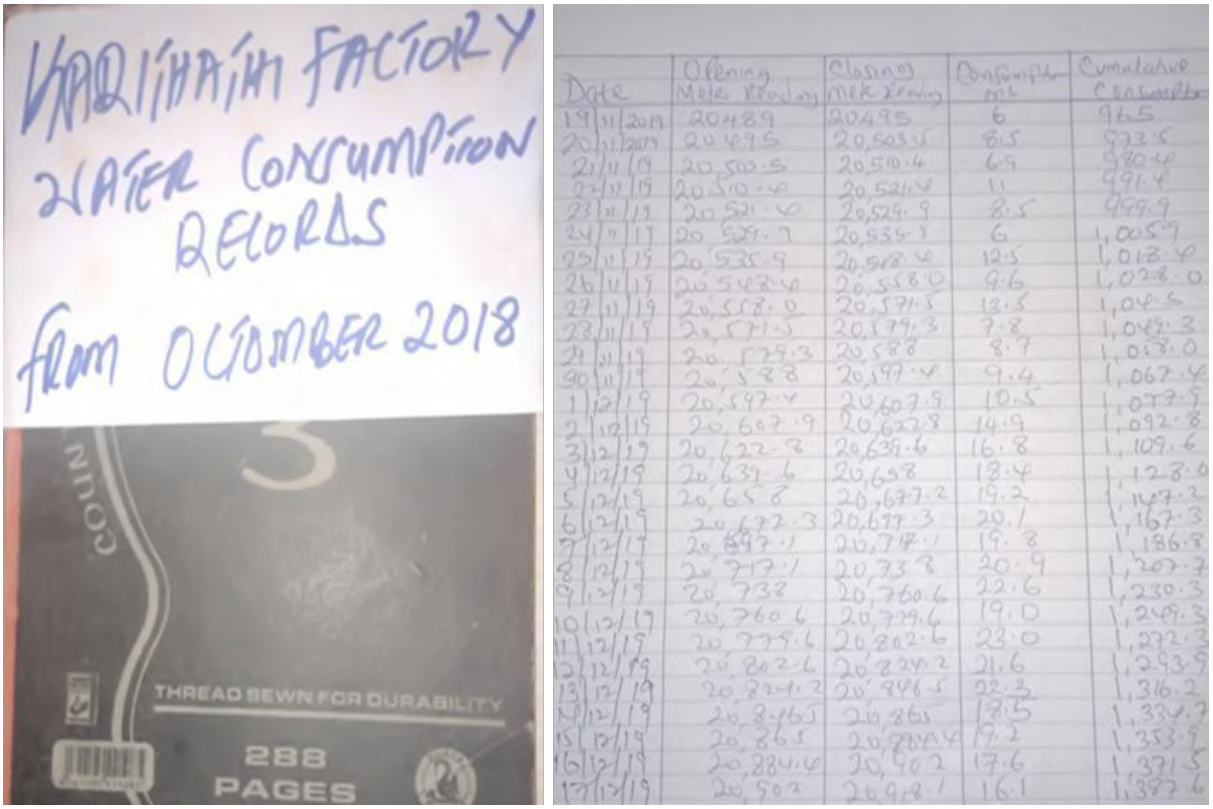


Figure 9.10: Water consumption records

Activities records

Activities/operations undertaken and the man-days involved are recorded every day. This monitors labour utilization and costs involved. Activity records may take the following format:

Table 9.3: Sample of Activities records

Date	Activity	Number of man-days	Cost per man-day	Total cost	Remarks

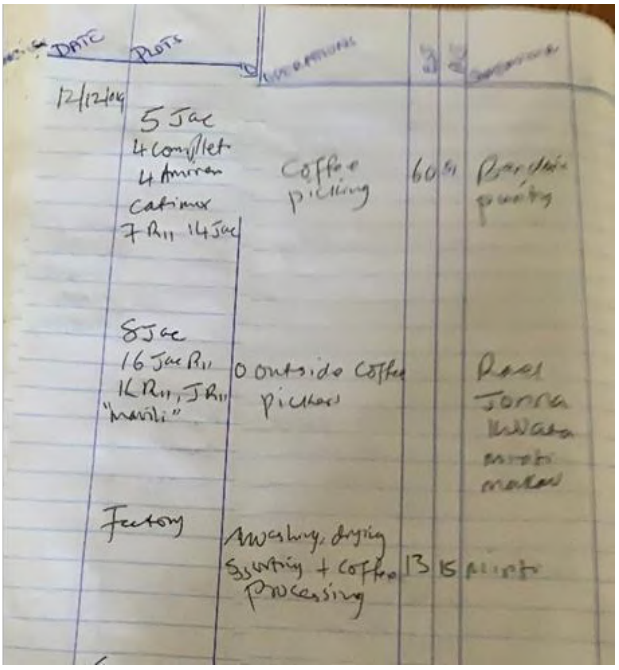


Figure 9.12: Sample of activities record

General purpose stores

This shows the inventory of items that are in the store and is used to monitor their utilization and to assist in timely procurement of items to ensure the flow of activities in the wet mill is not interrupted.

Table 9.4: Sample of a general purpose store record

Item…… Sheet /Folio No……

Date	Received	Issued	Balance	Signed	Remarks

Wet mill operating procedure manuals

To enable continuity of operations even in absence of key personnel in the wet mill, it's important to develop procedure manuals for key operations such as coffee pulping, coffee fermentation, coffee grading, coffee drying, coffee storage. The manuals need to be written in a very simple language understandable by all. The procedure of developing the manuals include;

- Clearly and legibly label and document all the mill individual parts/points; gate valves, switches, pulper, ploughs, knives, discs, fermentation tanks, soak tanks, skin drying beds, final drying beds, parchment store points (1,2,3,4……).
- For every process, develop and document a step by step procedure of achieving the desired end points.
- Translate the procedure to the local dialect for ease of understanding by all the workers
- Convene a sensitization meeting for all workers to explain and demonstrate the procedure for each process
- Display each manual at a point where everyone can be able to see it
- Monitor and ensure compliance by all

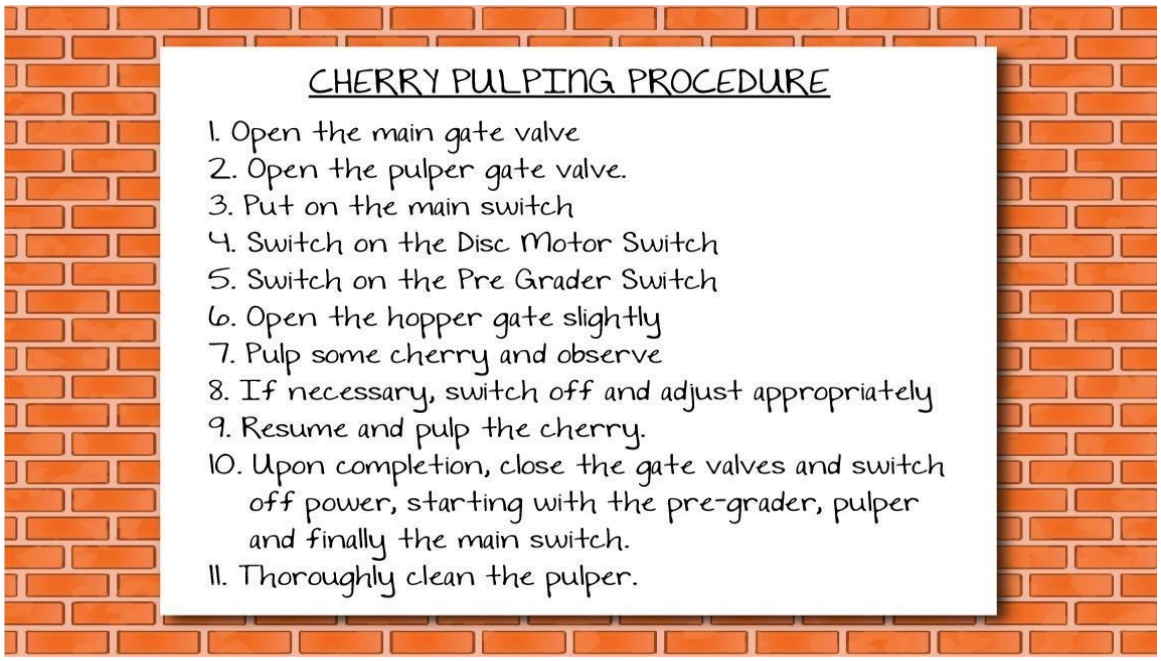


Figure 9.12: Sample process procedure

9.4 Record keeping and traceability

Traceability is very key in any food chain and helps to give a backward and forward step by step events and activities. It enables any actor along the chain to be accountable for any product spoilage/enhancement at their level of operations. Each actor should maintain records on the source, quantities, form and date of the raw materials received. They should also record the date, buyer details, quantities and quality parameters of the products they sell. Batch/ lot separation at the point of cherry intake and subsequent documentation of its movement will assist in traceability.

The records and documents discussed above will help the wet mill Managers and owners trace the movement of coffee from the farmer to the end consumer. In case of a problem, the specific actor would easily be identified and corrective measures taken accordingly. This would avoid cases of blaming all the actors along the value chain and possible blacklisting of a wet mill by International buyers

MODULE 10: INFORMATION MONITORING AND DISSEMINATION

10.1 Introduction

The productivity of the coffee tree is influenced by both internal (genetic) and external (edaphic) factors. Some of the edaphic factors that influence productivity include light, temperature, rainfall, humidity, soil nutrients, soil moisture, aeration and soil temperature among others. These in turn impacts on plant growth, flowering, fruit set, fruit drop, fruit ripening and bean disorders. The edaphic factors especially rainfall may also impact on drying, soil erosion and infrastructure thus affecting processing of final product.

Coffee processing and marketing processes need to be well communicated to all the actors within the value chain. The wet mill manager should synchronize coffee harvesting seasons with the coffee milling and buying activities to enable the buyers and marketers plan their operations. The managers also need to communicate with millers and marketers' details on quantities and grades available for the buyers. The coffee farmers alsoneed to know weekly coffee harvesting schedules to enable them deliver cherries at the right time and ensure a regular and continuous flow of coffee during the harvesting season. There are various communication channels options specific to the coffee production systems.

The module thus examines how weather affects coffee production and processing and importance of weather monitoring so as to predict various impacts on yields and quality and hence advice to farmers and wet mill managers. It also discusses the importance of communication with the various actors along the coffee value chain. The ultimate objective is to assist farmers make informed decisions to enhance efficiency, reduce the risks and derive economic benefits from the coffee production systems.

10.2 Information for farmers and marketers

Coffee berries ripen progressively and may be picked at intervals of 10-15 days' over a period of several months. The mill managers need to communicate through the available local communication channels including short message services the weekly coffee harvesting schedules to farmers in order to synchronize the various factory processes with harvesting. This will ensure a regular flow of cherry intake and parchment drying, to guarantee demands by buyers are met. The Millers, marketers and buyers also need to know the harvesting seasons to enable them plan their milling and marketing operations in line with consumer demands.

Table 10.1: A coffee harvesting schedule

Day	Coffee Picking Days	Pulping	Washing and drying
Monday	x	x	
Tuesday			x
Wednesday	x	x	
Thursday			x
Friday	x	x	
Saturday			

Table 10.2: Robusta Coffee harvesting seasons – Uganda

Region	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Central	x	Main Crop				x	x	Fly Crop			x	x
Masaka	x	Fly Crop				x	x	Main Crop			x	x
Eastern	x	Main Crop			x	x	x	Fly Crop			x	x
Western & S. Western	x	Fly Crop			x	x	Main Crop				x	x
Mid North	x	Main crop				x					x	x

Source: Robusta Coffee Handbook: 2019

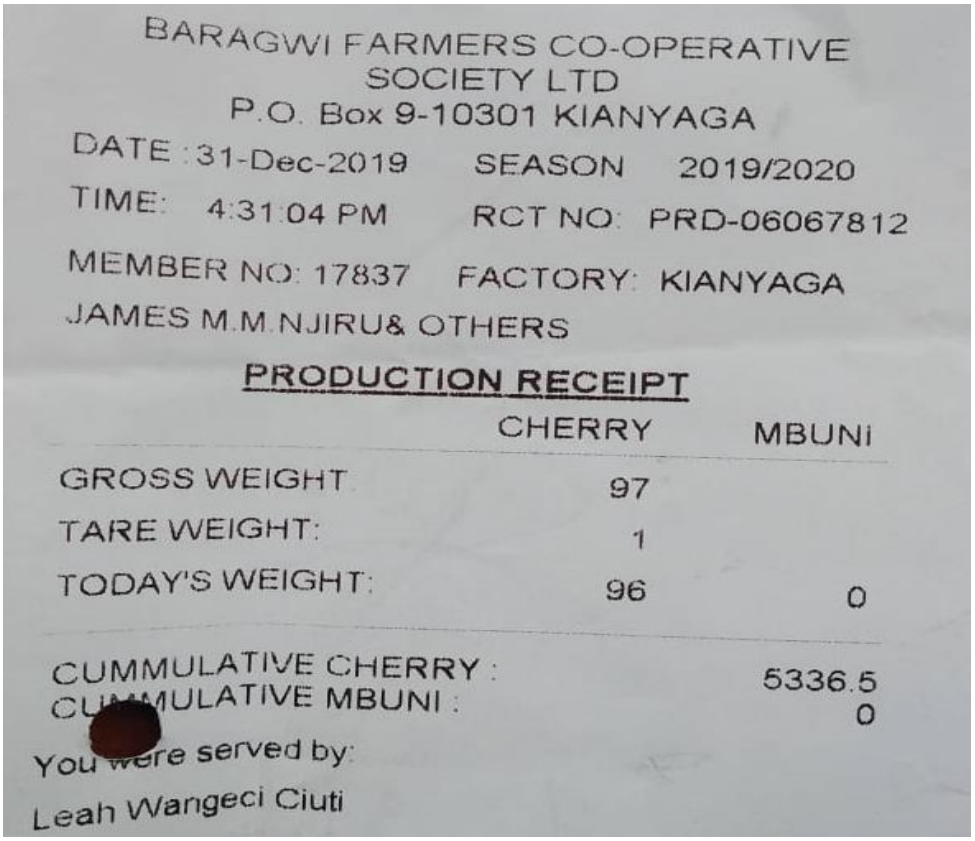
Buyers and marketers also need to have information on grading systems specific to the various millers. They should also know the various coffee grades available for sale. This is well articulated in Kenya where there are coffee sale catalogues with details on grades, number of bags and auction dates.

Table 10.3: Coffee Sale Catalogue

Uganda Coffee grade screens	Kenya's main coffee grades
SCREEN 18:	**E:** 8.3 mm
ROBUSTA – SCREEN 15:	**AA:** 7.2 mm
ROBUSTA – SCREEN 12:	**AB:** 6.3 mm
ARABICA – BUGISU AA:	**TT:**
ARABICA – BUGISU A:	**PB:**
ARABICA – BUGISU PB:	**C:** 3.9 mm
ARABICA – BUGISU B:	**T:**
ARABICA – WUGAR:	
ARABICA – DRUGAR	

The coffee farmers should also know how much coffee they have delivered and their returns. This should be well communicated using agreed procedures and channels. In Kenyan coffee systems, both manual and electronic sale records are available. Short message services through various service providers using smart phones is also in use.

Figure 10.1: Manual Documentation of Cherry Delivery



BARAGWI FARMERS CO-OPERATIVE SOCIETY LTD
P.O. Box 9-10301 KIANYAGA

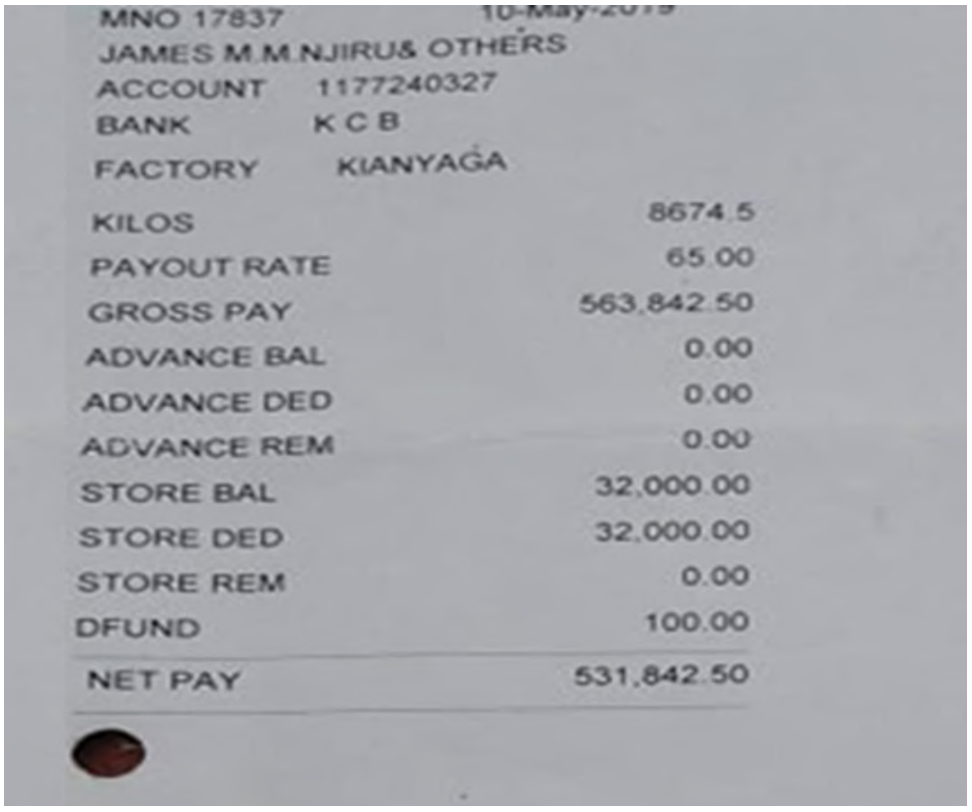
DATE :31-Dec-2019 SEASON 2019/2020
TIME: 4:31:04 PM RCT NO: PRD-06067812
MEMBER NO: 17837 FACTORY: KIANYAGA
JAMES M.M.NJIRU& OTHERS

PRODUCTION RECEIPT

	CHERRY	MBUNI
GROSS WEIGHT:	97	
TARE WEIGHT:	1	
TODAY'S WEIGHT:	96	0
CUMMULATIVE CHERRY :		5336.5
CUMMULATIVE MBUNI :		0

You were served by:
Leah Wangeci Ciuti

Figure 10.2: Electronic Documentation of Cherry Delivery



MNO 17837 10-May-2019
JAMES M.M.NJIRU& OTHERS
ACCOUNT 1177240327
BANK K C B
FACTORY KIANYAGA

KILOS	8674.5
PAYOUT RATE	65.00
GROSS PAY	563,842.50
ADVANCE BAL	0.00
ADVANCE DED	0.00
ADVANCE REM	0.00
STORE BAL	32,000.00
STORE DED	32,000.00
STORE REM	0.00
DFUND	100.00
NET PAY	531,842.50

Figure 10.3: Cherry Payslip

10.3 Weather Data

Weather is the state of the atmosphere at a specific time and place with respect to wind, temperature, cloudiness, moisture, humidity, pressure, etc.

10.4 Sources of Information

- Local National Weather Service will furnish weather forecasts and outlooks via radio and television
- Past weather records can be used to infer or forecast trends in weather patterns
- Indigenous knowledge - local people also have a lot of information about weather and are able to predict weather patterns and seasons

10.5 Weather forecasting

Weather forecasting entails provision of timely and effective weather information that allows individuals, organisations, or communities exposed to likely weather hazards to take action that avoids or reduces their exposure to risks. In agriculture the main focus is mainly on rainfall – amount, onset, cessations, and distribution, temperatures and humidity. These in turn has various impacts on growth, ripening, pests and post-harvest processes in coffee production (Table 10.4). This information needs to be disseminated to farmers to enable them make informed decision in their agronomy and processing practices.

Table 10.4 Impact of weather on coffee production and processing

Weather parameter	**Direct impact on the tree/processing factory**	**Indirect impact**	**Advice to farmers/wet mill managers**
• High temperature	- Above 23°C: Fruit ripening accelerates, leading to progressive quality loss - Above 25°C: Photosynthetic rate is reduced - Above 30°C: Tree growth is depressed - High temperatures can cause leaf, stem and flower abnormalities and abortion	- Pests and diseases may increase	- Farmers to monitor diseases and pests associated with high temperatures – e.g. Leaf rust, thrips etc. - Plant shade trees - Consider planting heat tolerant varieties
	- Parchment cracking during the white stage	- Poor quality coffee	- Cover or heap coffee and - Stir the coffee frequently (White stage)
Heavy rain, hail, strong winds	- Tree damage, increased fruit fall, especially near harvest - Increased flush growth	- Soil erosion, landslides, subsidence, wash-away of agrochemical applications - Damage to roads and other infrastructure increases costs	- Put in necessary soil and water conservation measures and repair of infrastructure - Shorten spray intervals as recommended and make use chemical stickers - Practice split application of fertilizers

		- Possible damage to waste management structures - Difficulties in coffee sun drying	- Carry out appropriate canopy management practices - Rehabilitate effluent delivery channels and disposal pits - Ensure proper factory maintenance including necessary water proof covering materials
Intermittent and unseasonal rain	- Greater flowering frequency - Different stages of crop	- Possible increase of some diseases - Difficulties in crop protection - High coffee processing costs - Post-harvest drying difficulties	- Close monitoring of pests - Spray before onset of rains - Put in place the necessary water proof covering materials
Prolonged rain	- May reduce flowering, affect fruit set, lower photosynthesis because of continual cloudiness - Increased flush growth	- Increased humidity may favour some fungal diseases - May increase mortality of some insect pests such as Coffee Berry Borer (CBB) - Upsurge of diseases especially CBD - Upsurge of weeds - Difficulties in coffee sun drying	- Farmers to closely monitor pests - Shorten spray intervals as recommended - Use chemicals with high efficacy - Use stickers - Use of chemicals in weeding - Carry out appropriate canopy management practices
Prolonged drought	- Weaker trees, wilting, increased mortality of young trees - The pulp sticks to the bean and impedes the pulping process of coffee.	- Stressed trees more susceptible to some pests - Low yields and poor quality coffee	- Put in water conservation measures e.g. Mulching, - Use of shade trees - Use appropriate irrigation systems e.g. Drip, water basins etc. - Use climate smart strategies - Consider dry processing
High Humidity	- Poor and prolonged drying - Storage problems	- Dangers of rewetting the parchment - Dangers of spoilage micro-organisms e.g. OTA	- Consider use of mechanical driers - Consider installation of conditioning bins

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