Horticultural Crops Production

Level III

Learning Guide –72

Unit of Competence: Implement Post-Harvest Handling

Module Title: Implementing Post-Harvest Handling

LG Code: AGR HCP3 M17LO1- 72

TTLM Code: AGR HCP3 TTLM 0120V1

LO1:- Prepare for implementation of post-harvest operations

Instruction sheet	Learning Guide 72

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Identifying post-harvest operations
- Selecting materials, tools, equipment and machinery
- Carrying out pre-operational and safety checks
- Identifying and controlling OHS hazards
- Selecting suitable safety and personal protective equipment

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Identify post-harvest operations
- Select materials, tools, equipment and machinery
- Carry out pre-operational and safety checks
- Identify and control OHS hazards
- Selecting suitable safety and personal protective equipment

Learning Instructions

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheets 1-5”.
4. Accomplish the “self-checks 1-5” in page -5, 8, 11, 17 and 19 respectively.

Information Sheet-1	Identifying post-harvest operations

1.1. Introduction to postharvest handling

What is post-harvest? Postharvest is the time between removal of the produce from the plant and consumption. Harvesting removes the produce from its natural supply of water and nutrients so, after harvest the physiological processes that occur in the harvested produce are ripening and deterioration. Harvested produce may also be affected by pathological infections and abiotic disorders. All these processes affect the shelf life / storage life, nutritional value and eating quality of fresh produce, so it is important to understand how to manage these processes during the postharvest handling, treatment, packaging and storage of harvested crops.

What is postharvest handling? Postharvest handling is the practice of creating suitable condition for fresh produce (vegetables and fruits) after harvesting and before marketing.

Objectives of postharvest handling practice are to:-

- Maintain quality,
- Less reduction of produce
- Enhancing value of harvested agricultural produce, through endeavor to meet the requirements of market and consumption
- Gain more benefits
- Therefore leading agricultural production into good investment and benefit circle, and sustainable developing path.

❖ **Importance of postharvest handling practice**

The important role of postharvest handling practice/methods is to:-

- Achieve food security through less reduction without brings additional land in to cultivation.
- Meet consumers' requirements with nutritional and tasty food through good quality maintenance.
- Have quite better return of capital when farmers can sell their stored produce during the off- season or in bigger markets with higher prices.

- Stressing competitive power in international market to increase exports and gain more benefits.
- Promote of food industries and creation of new employment potential
- To reduce the problems of refuse disposal and consequent pollution.

❖ Perishable crops and durable crops

What makes perishable crops more sensitive for postharvest loss as compared to durable crops?

Table: 1.1. Difference between perishable and durable crops

Perishable crops	Durable crops
High moisture content Usually 50-90%	Low moisture content usually10 – 15 % or less
Large unit size 5g-5kg	Small unit size typically <1g
Very high respiration rate	very low respiration rate
Soft texture which easily damage	Hard texture not easily damage
perishable, a few days in shelf life	stable, several years in shelf life

The great advantage of postharvest technology for horticultural crops due to the facts those horticultural crops are:-

- Highly perishable
- Contain high moisture
- Seasonally
- Delicate nature

Postharvest operation include

Postharvest operations of horticultural crops may include transporting from the field to storage facilities, sorting, trimming, washing, grading, packaging, labeling and storage. Operations that may be used include:

- Trimming
- Washing and polishing
- Hydration
- Curing and drying
- Size grading
- Grading for visual appearance (damages, stage of maturity, colour, shape, etc.)
- Waxing
- Pest management (dipping and fumigation)
- Ripening
- Cooling
- Storage (dry storage and cold storage).

Self-Check- 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. Explain the term postharvest handling?(2points)
2. Identify all postharvest operations?(2points)

Note: Satisfactory rating – 4 points Unsatisfactory - below 4 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-2	Selecting materials, tools, equipment and machinery

1.2. Materials, tools, equipment and machinery

Materials may include preservatives, chemicals, gases, cleaning agents, packing materials and containers, labels adhesives and performs .Tools, equipment and machinery may include: tractors, trailers ,light trucks, forklifts, snips, knives, gloves, containers, grading machinery, washers, brushes, dryers, chemical applicators, gassing chambers, labeling devices, packing tools, scales, pallets hand trolleys and lifting aids, cool-rooms and dedicated storage facilities. The tools, machinery and equipment that will be needed will depend on several factors including:

- The type of produce
- The operations to be carried out
- The scale of farm operations and
- The tools, machinery and equipment available on the farm. Usually the tools, machinery and equipment to be used will be specified in the enterprise work procedures. Some examples are shown below:-

Table 1:1 Select tools, machinery and equipment use for postharvest operation

Task	Tools, equipment and machinery that may be needed
Trimming	Sharp knives or scissors or guillotine
Fruit ripening	Thermometer, humidity meter, penetrometer, refractometer
Grading	Rulers, calipers or grading rings
Packing	Packaging selected, weighing scales
Moving produce	Suitable containers, pallets and fork lift
Stores and cold rooms	Thermometer, humidity meter, ethylene detector, eskimo suits
Pest management	Appropriate PPE, (see product label), and measuring, mixing and application equipment, insectocutors, netting and bait stations

Self-Check- 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. List tools, machinery and equipment use for postharvest operation? (2 points)

Note: Satisfactory rating – 2 points Unsatisfactory - below 2 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-3	Carrying out pre-operational and safety checks on tools, equipment and machinery

3.1. Preoperational and safety checks on tools, equipment and machinery

The pre-operational and safety checks required will depend on the type of tools, equipment and machinery concerned.

Table: 3.1. General guidelines for basic safety check:

Typical equipment in use	Basic safety checks required
Knives and other cutting equipment	Blades must be sharp and intact. This ensures that produce is not damaged and that there is less risk of the blade slipping and injuring the operator.
Electrical equipment and cables	Check for loose connections and frayed cables. Do not run cables over places where people walk. Switches and sockets should be of a waterproof type.
Moving parts on machinery, e.g. cutting blades, drive belts and cogs	Safety guards should be in place whenever the equipment is switched on.
Emergency stop button	Check that this works and if not get it repaired immediately
Machinery parts and alignment	Check to see that there are no loose parts and the parts are aligned correctly. Metal fragments entering in the produce are a food safety hazard and uneven wear of machinery parts will shorten the effective working life of the parts concerned.
Cold rooms and ripening rooms	Check that the door can be opened from the inside.
PPE & Pest management equipment	Check PPE is clean and intact, and the respirator. Filters are of the correct type and still active. Check application equipment is in good working order and not leaking.

	Calibrate as necessary.
Weighing scales, thermometers and other sensing equipment	Check battery life. Check calibration.
Check for broken light bulbs and for signs of vermin	Produce contaminated with broken glass must be removed from the food chain. Vermin must be reported to the manager.

Self-Check- 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. List four pre-start checks to be carried out on tools or machinery or equipment used in postharvest operations? (3 points)
2. State why each check is important? (3 points)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-4	Identifying and controlling OHS hazards

4.1. OHS hazards identification and mitigation measure

Risk assessment is a routine operation and significant risks identified should be addressed promptly and mitigated or the problem reported to supervisor. Obviously, the risks present in the pack house and storage areas used for postharvest operations depend in the site and type of produce and operations being undertaken. Some problems are however, commonly associated with postharvest operations and the examples shown in the table below are a useful guide on which to base a risk assessment.

Table 4.1 Hazards identification and mitigation measure

Hazard	Risk	Actions needed to mitigate the risk
Heavy items to be lifted, e.g. Crates of produce.	Back injury	✓ Train workers in safe lifting and ensure that safe lifting is practiced. ✓ Limit the size / weight of filled produce containers, guideline < 20Kg / person / lift ✓ Use lifting and carrying aids, e.g. trolleys and fork lift.
Moving vehicles	Crashes with workers	✓ Use trained drivers and apply speed limits ✓ Segregate workers and moving vehicles ✓ Erect signs warning that vehicles / fork lifts are working in that area
Wet floors	Slip and fall injuries	✓ Workers to wear suitable footwear ✓ Erect warning signs ✓ Improve drainage and or mend leaks
Incorrect electrical fittings and frayed cables	Electric shock	✓ Report the problem to the line manager ✓ Problem to be corrected by the electrician. ✓ Check how the cable was damaged and address the issue
Working in	No able to	✓ Access ways to be kept clear

enclosed spaces. Cold rooms, ripening rooms and stores	get out quickly if a problem occurs	✓ Exit routs and doors to be signed clear ✓ Doors can be opened from the inside ✓ Fire drill practiced (in large packing facilities)
Dusts and microbial spores from rotting produce	Respiratory infection	✓ Minimize the source of the dust ✓ Wear a dust mask ✓ Dampen the dust to facilitate clean up
Machinery with Moving parts	Physical injury	✓ Safety guards to be kept in place ✓ Turn the machine off and disconnect from the power supply before attempting to unjam or repair
Persistent & loud noise	Hearing loss	✓ Wear ear protection
Sharp knives	Cuts	✓ Train staff in correct use of the knife ✓ Train staff in First Aid and provide First Aid Equipment.

4.2. Food safety

Every farmer has a legal and moral responsibility to ensure that produce offered for sale for human consumption is safe to eat. Food poisoning can be a result of eating contaminated food and can result in symptoms of varying severity; stomach cramps, vomiting and diarrhea and in vulnerable groups, (The old, the very young and those with impaired immunity), actual death.

Risks to food safety can be minimized if basic good agricultural and good hygiene practices are followed in production and throughout the postharvest handling operations. Risks to food safety are divided into three categories:

- Physical risks
- Biological risks and
- Chemical risks.

❖ Physical risks

Physical risks are physical items and materials (foreign bodies), that should not be present in the food and will have harmful effects on humans when ingested; e.g. broken glass, metal fragments, pieces of jewellery, finger nails, plasters, buttons, soil and hair. Practical precautions that can be implemented to reduce these risks in postharvest management of fresh fruit and vegetables are:

- Remove soil by washing or discarding soiled produce
- Check the condition of machinery and knives before use to minimize the risk of metal fragments contaminating the produce and check again after use to see that the equipment is still intact.
- Use glue or sticky tape not metal staples to construct cardboard cartons
- Check packed produce for contamination by passing it through a metal detector. (This equipment is used in large packing facilities)
- Check the hands of personnel working in the handling and packing of produce before they start work; Jewellery should be removed, and nails trimmed
- Pack house workers should cover their hair
- Use blue plasters to cover wounds and check that the plaster is still in place at the end of the shift

Biological risks

Biological risks are certain types of bacteria, fungi and viruses that have the potential to cause food poisoning, either directly or by the production of chemical toxins. Examples of food poisoning organisms that can be found on fresh produce include: Coli, Salmonella, Listeria, Clostridium, Shigella and Hepatitis.

Common causes of contamination are:

- Contact with animal and human faeces
- Vermin; rodents, cockroaches, birds and flies
- Use of contaminated water to wash produce
- Produce being handled by infected workers

Practical precautions that can be implemented to reduce these risks in postharvest management of fresh fruit and vegetables are:

- Establish and implement hygiene rules for workers involved in postharvest handling and packing of produce.

- Explain the farm hygiene procedures to workers and supervise their actions to ensure that the rules are followed at all times.
- Workers who show signs of gastric problems (vomiting, diarrhea or frequent toilet visits) should not be allowed to work with produce.
- All workers must wash hand and or use hand sanitizer before entering the grading and packing area.
- Open wounds on the hands must be covered with clean blue plasters issued by the pack house.
- Water used for washing produce must be of potable standard, (Safe to drink) Where water reuse is practiced, filtration and chlorination will be necessary.
- Packaging should be stored in clean storage facilities that are only used for packaging.
- Produce that is heavily soiled should be discarded and lightly soil produce washed.
- Vermin of all types must be excluded from the packing area and a monitoring and control system implemented.
- Keep produce cool.
- Disinfect work surfaces that come into contact with produce using food grade disinfectant at the recommended strength at the start of each work shift.
- Use produce containers only for edible produce, (Not as rubbish bins or for seating and storage of personal belongings) and clean the containers regularly

Chemical risks

Chemical risks to food safety for fresh horticultural produce include:

- Pesticide residues from crop spraying before harvest or from postharvest treatment of product to prevent storage rots and insect attack in storage
- Cleaning chemicals and disinfectants used for cleaning the pack house
- Rat poison
- Chemicals found in non-food grade packaging
- Refrigerants, printing inks used on packaging

Practical precautions that can be implemented to reduce these risks in postharvest management of fresh fruit and vegetables are:

- Check the spray records for each batch of produce delivered to the pack house to confirm that the harvest interval (PHI) for pesticides applied to the crop has been observed.
- Use only registered pesticides products acceptable to the client for postharvest treatment of products and follow the label instructions.
- Use only food grade cleaning products and disinfectants on surfaces that come into contact with the produce and follow the label instructions
- Store all cleaning products and disinfectants securely in a designated area outside the grading and packing area and the packaging store.
- **DO not** use rat poison in the pack house and in areas used for product storage.

All Farmers should implement appropriate precautions to ensure that the produce sold for human consumption is safe to eat. In your role as a development officer you should provide advice for farmers about 'safe food'. This advice is relevant to the responsible male and female members of the household as produce consumed in the household and sold comes from the commercial fields and the home garden and orchard.

You may also be able to work in cooperation with the community health worker who also has messages about food hygiene in the home.

- In commercial farms the rules and procedures for food hygiene and handling produce are usually documented and available for staff reference. If you are working in supervisory management in these farms you should be aware of the enterprise rules and work procedures and ensure that the rules and procedures are known, understood and implemented by all the workers in your team.

Self-Check- 4	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. List hazards or risk which occurs during postharvest handling?(3 points)
2. List actions needed to mitigate the risk? (3 points)
3. Define food safety(3 points)
4. List the three types of food safety hazards(3 points)

Note: Satisfactory rating - 12 points and Unsatisfactory - below 12 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-5	Selecting suitable personal protective equipment (PPE)

5.1. Safety equipment and PPE

The definitive requirements for safety equipment and PPE required should be identified in the OSH risk assessment. For guidance however, the most common requirements for postharvest operations are shown in the table below.

Table: 5.1. PPE use for postharvest operation program

Items required	Notes - Justification and or use
Work boots and leather gloves	Routine work involving manual handling of heavy items.
Gumboots, water proof apron and rubber gloves	Cleaning produce containers and work areas.
Warning signs, e.g.: Slippery floor Keep out (Fumigation) Fork Lift in operation Exit route and exit door	Worker information Place in appropriate areas where the signs are easily visible. Provide signage in English and local language. Explain to all workers.
Fire extinguisher	Packaging store
Boots, overall, spray suit, rubber gloves & respirator	Provide in accordance with label recommendations for pesticide application
Sit stand workstations	Needed in the grading hall for workers involved in grading and packing where there is limited opportunity to move around the work area.

Remember:

The Employer has a responsibility to:

- Provide a safe work environment and
- Provide the PPE that is necessary for the work to be done safely and the Employee has a responsibility to:
- Wear and care for safety equipment and PPE provided
- Report safety hazards and work with due regard to his/her own safety.

Self-Check- 5	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. List the PPE needed for postharvest handling? (3 points)
2. List the responsibility of employer to minimize risks (2 points)

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Reference

1. Kader, A.A. (ed). 2002. Postharvest Technology of Horticultural Crops (3rd Edition). UC Publication 3311. University of California, Division of Agriculture and Natural Resources, Oakland, California 94608. p. 535.
2. Kitinoja, L. 2013. Returnable Plastic Crate (RPC) systems can reduce postharvest losses and improve earnings for fresh produce operations. White Paper No. 13-01. The Postharvest Education Foundation. La Pine, Oregon USA. p. 26.
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4. Pantastico, Er. B. 1980. FAO/UNEP Expert Consultation on Reduction of Food Losses in Perishable Products of Plant Origin. (6 May 1980, FAO,, Rome). p. 54.
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Horticultural Crops Production

Level III

Learning Guide –73

Unit of Competence: Implement Post-Harvest Handling

Module Title: Implementing Post-Harvest Handling

LG Code: AGR HCP3 M17LO2- 73

TTLM Code: AGR HCP3 TTLM 0120V1

LO2:- Co-ordinate post-harvest work

Instruction Sheet	Learning Guide 73

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Identifying enterprise work team and coordinating tasks
- Undertaking post-harvest operations
- Maintaining clean, safe and hygienic work area

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Identify post-harvest operations
- Select materials, tools, equipment and machinery
- Carry out pre-operational and safety checks
- Identify and control OHS hazards
- Selecting suitable safety and personal protective equipment

Learning Instructions

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheets 1-3”.
4. Accomplish the “Self-checks 1-3” in page -25, 36 and 39 respectively.

Information Sheet-1	Identifying enterprise `work team and coordinating tasks

1.1. Enterprise work procedures

Enterprise works procedures are developed and documented by the farm management team and describe how tasks are to be carried out on the farm. In relation to postharvest procedures; methodology and standards are based on the type of produce, farm circumstances, (scale of operation and equipment available), industry good practices and client or market requirements.

1.2. Identify the enterprise work team required and coordinate tasks

Many postharvest operations require skilled operators and a multi-disciplinary team to complete all the necessary operations efficiently and on time. Typically, in a commercial farm pack house facility, team members are selected and allocated tasks in accordance with the following guidelines:-

- **Moving produce into storage and loading transport** needs operators who are fit and strong as heavy lifting is involved. The team leader must have sufficient literacy to read labels, complete records and update the stores stock inventory.
- **Sorting and grading** needs workers who handle produce gently, have a good eye for detail and can work quickly. These workers are often but not exclusively female.
- **Scale operators** need good literacy to be able to keep records.
- **Personnel allocated to quality control** need a very good understanding of the quality and size grades to be implemented. They also need the confidence to reject produce and return it for repacking and sufficient literacy to keep records.
- **Personnel involved in pest management** need to have received training in the safe and correct use of pesticides.
- **Supervisors** need good organizational and people management skills to ensure that targets are met, and standards maintained. Some supervisors hold diploma certificates and others have ‘learnt on the Job’ and been promoted internally.
- **Equipment and cold store maintenance and electrical work** is done by dedicated specialists, often from outside the company.

Many of these people will learn the necessary skills 'In house' so the management and supervisory team need to actively engage in organizing and providing training.

In addition to allocating tasks to suitably skilled and experienced workers, achievement of targets and maintaining the timeliness of operations to preserve the cold chain requires that the correct numbers of workers are allocated to each task. Either the grading and packing teams do not keep up with the supply of produce to the pack house so the cold rooms get too full. Or the grading and packing teams do not meet the total needed for the market or client requirements for the day. Not enough workers allocated to individual tasks can result in wasted time and produce piling up at the bottlenecks; e.g.

- Too few people bring produce to the graders means that the grading workers stand idle.
- Too few people weighing produce means that produce builds up at the weighing table, mistakes are made, and the cold chain is broken (produce heats up due to the delay).

Over time pack house management gains experience about work rates that can be achieved for the various tasks and the numbers of people to allocate to each task. Therefore, at the start of each day the management and supervisory team will review the targets for the day and agree on task allocation. Thereafter it is the role of the supervisors to ensure that the agreed work rates are achieved and any delays that will result in targets not being met are reported promptly to the line manager.

Self-Check- 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. List team members selection and allocation guidelines?(3points)
2. What results happen if not enough workers allocated to tasks?(3points)
3. Define Enterprise work procedures?(3points)

Note: Satisfactory rating - 9 points Unsatisfactory - below 9 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-2	Undertaking post-harvest operations

2.1. Postharvest operations

Postharvest operations are the operations carried out during the postharvest period, e.g. transport, grading, trimming, cooling, packing, labeling, storage, etc. The range of activities will depend on the type of produce and the requirements of the target market. Typically, operations may include any or all of the following:

- Removal of field heat and prevention of 'solar gain'.
- Transporting harvested produce from the field to post-harvest processing or storage facilities and from the pack house to the market.
- Sorting and grading
- Treatment, e.g. drying, washing, waxing
- Storage
- Packing and labeling.

In small farms, the farmer will decide what to do based on traditional practices and personal experience. In your role as a development agent you may be required to give guidance regarding best practices or new technologies.

In commercial farms, enterprise work procedures describe how to do the various operations / tasks on the farm and methodology to be used is based on industry good practice. In some farms these procedures are handed down by 'word of Mouth' but now in most large commercial farms the procedures are documented to ensure that all operators know what to do and that work is done using the correct procedures. Your supervisor or line manager will be able to provide advice and guidance about the procedures to use and your role will be organizing activities and ensuring that all the enterprise work procedures are followed correctly by yourself and your team.

Market plan; the market plan identifies where the produce is to be sold and what the requirements are for the target market. Requirements are based on experience, Industry Practices and informal discussion with buyers.

The market plan identifies where the produce is to be sold. The requirements of the client and the target market will determine the standards to be used for various postharvest operations, e.g**.** Size and quality of produce accepted, stage of ripeness, size and type of packaging to be used. For some markets these requirements may be defined in law but for others buyer preference dictates the price and farmers respond to their requirements to secure good price. For contract sales, client requirements will be listed in the contract. Small farmers will liaise 'face to face' with the buyer and standards and price will be agreed in these meetings.

Market contract: this is an agreement with a specific client and describes in detail the type of produce and packaging that is to be used: Requirements may include, permitted pesticide use, grade specifications (size and quality), packaging to be used, storage and delivery temperatures and time of delivery.

In a commercial farm the owner of manager will meet with the buyers and the pack house manager will be informed of the standards to be used for produce grading and packing. These requirements will then be explained to all Supervisors and Quality assurance staff involved and this team will be responsible to explain to workers and ensure that the required standards are achieved.

Postharvest operations are the operations carried out during the postharvest period, typically, operations may include any or all of the following:-

2.1.1. Trimming

Trimming involves the removal of excess leaves, stalk and roots. This can improve the appearance of the produce, facilitate packing and reduce the amount of unsalable material transported to market. Produce that is trimmed includes:-

- Cabbage,
- Carrots,
- Beetroot and
- Onion (after drying). Trimming is usually done in the field before transport to the handling and storage area.

2.1.2. Washing and polishing

Washing is done primarily to remove soil and improve the appearance of the produce. Examples of produce that is washed include:

- Root vegetables,

- Tomatoes,
- Apples,
- Courgettes,
- Green beans
- And spinach.

Water that has been used for washing will be rich in soil, plant nutrients and organic matter and may also contain soil borne pests and diseases. This water should therefore be disposed into a constructed wetland or spread onto waste land but not directly returned to the cropped fields or open water sources. After washing, produce must be surface dried before packing and/or storage to reduce the risk of pathogen attack and rotting. Some products e.g. Apples, may be polished during the drying process to enhance their appearance.

2.1.3. Hydration

Some produce, e.g. flowers, leafy green vegetables and vegetables harvested before full maturity, are very susceptible to dehydrations during the harvesting process. These types of produce may be rehydrated by dipping in cold water or standing in water during the first stage of the postharvest handling process. Washing must be done with clean (Potable) water to avoid contamination of the produce with soil, chemicals and food poisoning bacteria and viruses during the washing process.

2.1.4. Drying and Curing

Drying simply means the removal of water. In postharvest handling this may be surface drying after washing, partial drying as in allowing the necks of onions to dry in the field prior to harvesting and storage or sun drying herbs, seeds or fruit for storage. Curing is a natural process where there is a change in the cell structure of the outer tissues that can occurs in the drying process of some types of produce, e.g. the hardening of the outer skin as occurs on onions and potatoes that are ‘dried’ before storage.

2.1.5. Sorting and Grading

Produce can be sorted and graded based on many different parameters determined by the type of produce, whether for immediate sale or storage and the target market / client requirements.

2.1.6. Waxing

Waxing involves the application of a food grade wax to the outside of fruits after harvest to prevent dehydration during transport and storage. Examples of produce treated with wax include apples and citrus. Currently this practice is not used in Ethiopia.

2.1.7. Ripening of fruits is a natural process that occurs on the plant prior to harvest. Some types of fruit, e.g. strawberry are allowed to ripen on the plant before harvest but others, e.g. tomato are harvested 'green' that means harvested when the produce has reached maturity but is not yet ripe. During the ripening process starch is converted to sugar and enzyme action causes the cell walls to soften. This makes the produce sweeter and improves the eating quality. Unfortunately, during ripening the produce also becomes softer so is more susceptible to physical damage during handling and the shelf life is reduced. The rate of ripening of fruits is affected by temperature and ethylene production and control of these factors can be used to manage the rate of ripening during the postharvest period.

2.1.7.1. Ethylene

Ethylene is a gas that is produced naturally by plant tissue during the ripening process.

The effect of ethylene on harvested produce may be either to:

- Promote ripening or to
- Cause wilting, yellowing and premature aging (senescence) in sensitive produce.

Different types of crops produce ethylene in different amounts. Plants can be divided into two groups according to their natural pattern of respiration and ethylene production during ripening;

- Non-climacteric plants maintain a low rate of respiration and ethylene production throughout their ripening process which should be completed on the plant.
- Climacteric plants show an increase in respiration and produce large amounts of ethylene and heat during their ripening process. These products ripen in response to ethylene and can be harvested under ripe and ripened during the postharvest process. Ethylene is also produced naturally by plant issue that is physically damaged or decaying. In all cases, ethylene production is greatest at warm temperatures. Ethylene can be a useful tool in the management of fruit ripening after harvest, but ethylene can also be a problem as it can cause storage disorders, yellowing, wilting and senescence in sensitive types of produce.

Climacteric and non-climacteric fruits should be stored separately. Examples of climacteric types of produce are; onion, tomato, apples, bananas and papaya. Examples of non-climacteric types of produce are; cut flowers, leafy green vegetables, strawberries and citrus. To minimize the effects of ethylene, the concentration of ethylene in the storage area can be reduced naturally by good ventilation and air circulation and maintaining a cool temperature. Cut flowers or bananas for export a synthetic plant growth regulator can be applied to inhibit the production and effects during transport and storage. Ethylene is also present in vehicle exhaust fumes so vehicle use should be kept to a minimum in areas where fresh produce is handled and stored.

To enhance the ripening of produce, e.g. banana, papaya and avocado, ethylene concentration in the storage area (ripening room) can be increased by maintaining a warm temperature and minimum ventilation. This process needs careful management and monitoring as the eating quality and shelf life of ripe fruit deteriorates rapidly after the ripening process is complete and the natural rate of respiration decreases.

Ethylene may also enhance the development of microorganism and thus may cause increased decay and spoilage of the produce. In general, ethylene in storage may be detrimental for fruits, vegetables and flowers, as it may induce physiology disorder or hasten ripening in certain commodities. As silver (Ag) was found to be an inhibitor of ethylene action, its salts are used to protect flowers from the deleterious effects of ethylene during commercial operations. Endogenous ethylene production rates increase at maturity after harvest or as the results of physical injury, decease, high temperatures (up to 30), and water stress. On the other hand, production is reduced by storage at low temperature, reduce O_2 levels (<8%), and elevated CO_2 levels (<2%) around commodity.

Adverse effects of exposure to Ethylene

Figure: 2. 1. Adverse effect of ethylene on produce

2.1.8. Cooling

This is the lowering of produce temperature either removal of field heat after harvest or removal of heat generated by respiration during postharvest handling and storage.

Cooling may be achieved by use of a **field shelter, dipping in cold water or hydro-cooling, vacuum cooling or use of a refrigerated cold store**. Cooling slows down the physiological processes relating to ripening, senescence and decay so is / can be used for all types of fresh produce to extend the shelf life and conserve the eating quality and nutritional value of the produce. Cooling occurs when produce is placed in an environment with a lower temperature, e.g. when placed in the shade in the field or stored in a cool shed or refrigerated cold store or washed in cold water. In this case cooling occurs due to contact

with cold air or water. In the case of air cooling, the rate of cooling is improved by a large area of the produce being exposed to the cool air and by good air circulation around and through the stacks of produce. Cooling also occurs when water is evaporated from the surface of the produce or from the environment immediately around the produce. This process is called 'evaporative cooling' and works because heat energy is needed for evaporation and this heat is taken from the produce.

Cold chain: cold chain is a logistics operation where the produce is cooled immediately after harvest and the cool (cold) temperature is maintained throughout the whole of the postharvest period from harvest to final sale. A cold chain or cool chain is a temperature-controlled supply chain that is used for high value, highly perishable fresh produce. In Ethiopia cold chain is used for flowers and vegetables for export, primarily to Europe. In the cold chain process, each stage of the postharvest process is completed in a facility that is temperature controlled. Temperature fluctuation and breaks in the cold chain where condensation will form on the cold produce and deterioration will occur must be avoided or where unavoidable, kept a short as possible.

- **Natural shade or a simple field shelter short term storage**

Facilitates a little natural cooling but its real benefit and primary purpose is protecting the harvested from the sun (solar gain).

- Is most effective when produce is harvested when it is cool
- Is only suitable for short term storage (few hours max.)

- **Small scale evaporative cooling**

Cooling box, (Double walled box with sand placed in the cavity between the walls) or small shelter (made with charcoal contained between wire mesh walls). Cooling is provided when the sand or charcoal is kept wet and evaporation occurs. Cooling is most effective when produce is harvested when it is cool and the facility is not overfilled. OK for storage of fresh produce for a few days.

Figure :2.2. Field cooling

❖ **Refrigerated cold stores and transport**

Refrigerated cold storage and refrigerated transport is used on large scale commercial farms for high value fresh produce, e.g. flowers and vegetables for export or high end local sales.

Temperatures used vary between 2^{o}C and 10^{o}C depending on the type of produce and the stage of the post harvest process. Efficient operation requires that the door is kept closed and produce is arranged so that the cold air passes through the stacks of produce. Most products can be kept at low temperature in these stores for several weeks but in practice storage is usually only for a few hours or days to facilitate maintenance of the cold chain during the postharvest period.

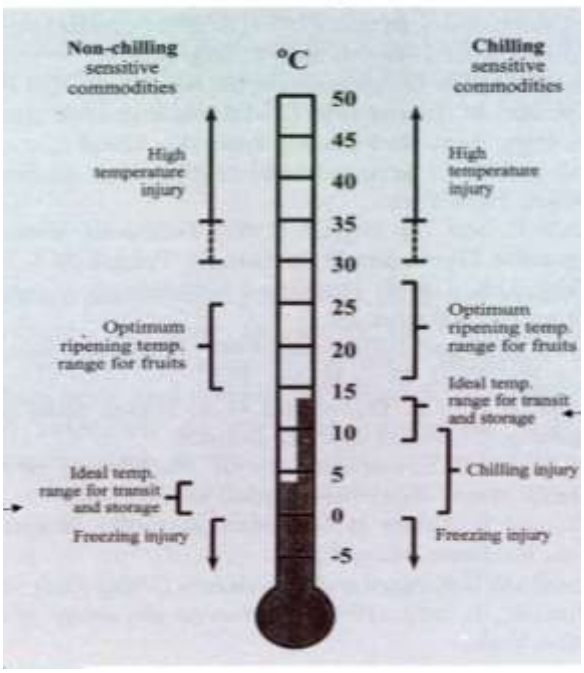

Figure :2.3. Refrigerator cooling

Vacuum Cooling

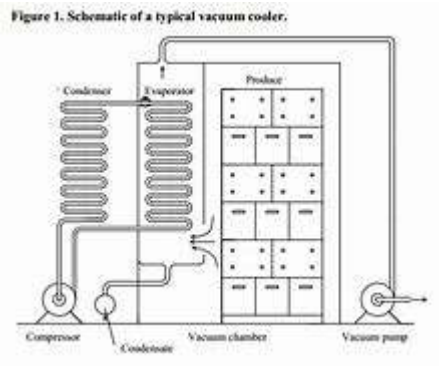

Figure:2.4. Vacuum cooling

Hydrocooling

Figure :2.5. Hydro-cooling

Table: 1.2. An outline of a typical cold chain is shown below.

Stages in a typical cold chain for green beans for export
✓ Harvested produce is placed in a field shelter and is removed to the pack house within 2 hours of harvest. ✓ Produce is transported to the pack house in a covered vehicle and placed in the receiving cold store at 6-8^{o}C for several hours before grading and packing. ✓ Cooled produce is taken into the grading hall of the pack house for grading and packing. Only small volumes are removed at any one time to ensure that the produce does not spend a long time on the grading tables where the temperature will rise. ✓ Maximum time allowed for grading and packing is 40 minutes. ✓ Grading hall temperature is maintained at 16^{o}C. ✓ Packed produce is returned to the 'export' cold room and stored there for several hours to allow the produce temperature and the cold room temperature to equilibrate to 6^{o}C. ✓ Produce is transported to the airport in a refrigerated truck ✓ At the Airport the produce is placed in the cold room to await loading on to the plane. ✓ Temperature in the cargo hold of the plane is set to 2-60C according to the types of produce to be transported. ✓ On arrival in Europe, refrigerated transport and storage is used at each stage of the distribution chain up to the point where the produce is offered for retail sale to the consumer.

2.2. Pest management

Pest management during the storage process is essential to minimise spoilage and losses during storage. The need for treatment will depend on the type of produce and the intended length and method of storage. Pest management practices implemented will use a combination of methods (IPM), designed to minimise produce losses and spoilage whilst minimising the use of pesticides.

❖ **Integrated pest management (IPM) practices that are in use includes:**

- Sorting produce before storage to remove visible infected produce. In some farms only produce with infections below a stated threshold level in the crop will be stored.
- Cleaning pack house and storage facilities regularly and when the facility is empty to kill residual insects and disease spores. Hard surfaces may be wiped using a food grade disinfectant. Empty stores may be fumigated. Correct waste management practices will also help to reduce the incidence of vermin in and around the packing and storage facilities.
- Fumigation of produce; now only practiced in a small number of circumstances fumigation of some fruit, usually only fruit for export for control of fruit fly which is a quarantine pest in some countries.

Dipping produce, in fungicides to control storage pathogens is still permitted for some fruit and vegetables e.g. citrus. Use only fungicides that have a label recommendation for application by postharvest dipping, follow the recommendations for application rate and time of exposure and ensure that the produce is dry before placing in store. Collect the drain water and the remains of the dipping solution and dispose using methods that do not damage the environment.

Some examples of postharvest diseases shown below

Botrytis allii /B aclada Neck rot onions

Botrytis cinerea Strawberry

Colletotrichum/Anthrachnose Mango

Figure: 2.2. Postharvest disease

Self-Check- 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. List and discuss all postharvest operations?(4points)
2. Define waxing?(2points)
3. Differentiate climacteric and non-climacteric fruit?(4points)
4. Define cold chain?(4points)
5. List types of cooling storage?(4points)

Note: Satisfactory rating 18 points Unsatisfactory – below 18 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-3	Maintaining clean, safe and hygienic work area

3.1. Maintaining work safety

A Clean, safe and hygienic work area for postharvest operations is essential for:

- Worker safety and
- Protecting edible produce from contamination

Operator safety and food safety are important in all farming operations, but the procedures needed are often influenced by the scale of operation and the requirements of the target market.

Small farmers should be encouraged by their development agent to:

- Prevent contamination of harvested produce by covering the ground where harvest produce will be placed or using clean containers.
- Remove organic wastes; e.g. crop trash, reject produce, animal manure and domestic waste should also be removed from the areas where produce is sorted, packed and store to reduce the risk on vermin which could eat and contaminate the produce.

In a commercial fresh produce pack house facility, more comprehensive measures are necessary:-

- All workers in the pack house and stores should receive training in safe working practices and hygiene.
- There should be a cleaning procedure and cleaning schedule for:
  - ✓ Produce containers, cold stores, dry stores and the grading and packing areas
  - ✓ Products used for cleaning should be ‘food grade’, used in accordance with label recommendations and stored securely in a designated area
  - ✓ Cleaning activities should be recorded
- Machinery and equipment used in the postharvest process must be cleaned at the end of each shift. Remember to turn machinery and equipment off and disconnect from the electric supply before attempting to dismantle and clean items.
- Waste materials; damaged packaging, reject produce, liquid wastes must be removed from the postharvest handling and storage area promptly to prevent produce contamination and to remove trip hazards.

- Workers should be provided with dust coats and head covering and workers personal belongings and food should be stored securely outside the work area
- Hand washing facilities must be provided at the entrance to the work area and at the toilet facility
- Toilets and canteen facilities must be kept clean at all times.

Self-Check- 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. List the importance of maintaining work safety? (2points)
2. List waste materials produced during postharvest handling? (2points)

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

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Horticultural Crops Production

Level III

Learning Guide –74

Unit of Competence: Implement Post-Harvest Handling

Module Title: Implementing Post-Harvest Handling

LG Code: AGR HCP3 M17LO3- 74

TTLM Code: AGR HCP3 TTLM 0120V1

LO3:- Implement post-harvest treatments

Instruction sheet	Learning Guide 74

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Grading and labeling harvested produce
- Identifying and disposing produce not meet specifications
- Selecting post-harvest treatments
- Conforming handling techniques and environmental requirements
- Establishing economical and methodical post-harvest practices
- Cleaning and maintaining tools, equipment and machinery

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Grade and label harvested produce
- Identify and dispose produce not meet specifications
- Select post-harvest treatments
- Conform handle techniques and environmental requirements
- Establish economical and methodical post-harvest practices
- Clean and maintain tools, equipment and machinery

Learning Instructions

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1- 6”.
4. Accomplish the “Self-check 1-6,” in page -48, 51, 63, 66, 69 and 71 respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1” in page -72.
6. Do the “LAP test” in page – 73 (if you are ready).

Information Sheet-1	Grading and labeling harvested produce

1.1. Grading of harvested produce

Grading is the grouping or sorting of the harvested crops based on some standards to eliminate all unsatisfactory products. The separation of harvested products from the bulk into different categories, on the basis of size, color, shape, etc. is called grading. Grading is done based on some specified standards, such as size, color, shape, texture, varieties, maturity, blemishes and etc. It can be done visually or mechanically.

Factors to be considered in grading: - harvested products are graded into different categories on the basis of following quality parameters:-

- Uniformity in size, shape, color and ripeness.
- Uniformity in appearance.
- Variety.
- Seed content.
- Moisture content.
- Good visual appearance (absence of visual defects).

The importance of grading are:

a) To eliminate all unsatisfactory items (defects)
b) To increase the quality and storage life of the harvested products
c) To attract markets and obtain high sell price
d) To minimize contamination of the product from pests and disease.

Produce can be sorted and graded based on many different parameters determined by the type of produce, whether for immediate sale or storage and the target market / client requirements.

Grading for the local market;- in Ethiopia most customers are mainly concerned about price but good appearance, size and freedom from rotting, signs of aging and physical damage will also be considered by the buyer.

Grading for contract sales; the requirements and standards for grading will be described in detail in the contract. Requirements are often higher than the legal minimum standard and typically include:

- Removal of all produce that is physically damaged or infected with pests and diseases

- Removal of produce that is not true to type (misshapen, wrong color, etc.)
- Removal of produce that is dirty
- Inclusion only of produce of the stated acceptable size and stage of maturity.

Size may be expresses as length and or diameter. Stage of maturity may be expresses as stage of bud opening, color, sugar content, presence of seed development, etc.

Grading for export; produce needs as a minimum to conform to the grading standards of the receiving country.

Grading for storage; removal of all produce that is physically damaged or infected with pests and diseases is critical to reduce the risks of pathogen related deterioration during storage. Small produce and produce with a low sale value may also be removed and sold immediately to make the storage operation more cost effective.

Grading for processing; grade requirements will depend on the type of produce and the intended use of the produce. Freedom from soil and from pests and diseases will be important but size and shape are usually not important. For some produce, the acceptable stage of maturity and minimum sugar content will also be specified in the contract. In Ethiopia grading is usually done by hand based on visual inspection and selection / rejection. Rulers and grading rings may be used to confirm size and pictures are useful for explaining color, disease, trueness to type and stage of maturity to workers. In more industrialized countries grading may be done mechanically. Mechanical grading is more reliable but requires specialist machinery and maintenance so is only cost effective on a large scale.

The market plan and or the contract with the client will list the client specifications for the produce to be graded and packed for the client or the target market.

Specifications may include some or all of the following:

- Quality of produce that is acceptable, such as variety, shape, size, weight, length, colour, maturity, moisture content, ripeness, texture, skin condition, blemishes, bud count and health which are subject to seasonal and market forces.
- The client may also specify the packaging materials, type of containers, filling techniques, labelling and storage requirements from field to client such as the cool chain concept.

❖ **The grading operation also needs good supervision:**

The consequences of mistakes in grading can be serious:

- Inclusion of sub-standard produce will upset the client and can result in reduced or cancelled orders for future sales.
- The inclusion of damaged or diseased produce may result in rotting during transport and distribution again leading to a dissatisfied client loss of reputation and loss of future sales.

The role of the supervisor of the grading operation requires the supervisor to:

- Explain and demonstrate to the grading team
  - ✓ The product specifications (pictures and produce samples are helpful for this task).
  - ✓ How to present and or pack and label their graded produce.
  - ✓ How to handle the produce to minimise physical damage.
  - ✓ How to organise their work station to prevent reject produce and graded produce becoming mixed.
- Make follow up and observe the work of the graders closely to see that the instructions have been understood and are being implemented
- Check that batched of produce are kept separate and are labelled
- Record the pack out rate (total produce weight and weight of produce that meets the client specifications), for each batch of produce
- Liaise with the quality controller when problems with the grading arise
- Report to the manager when the produce grade out percentage is lower than expected or the work is behind schedule.

Note: Each client may request different standards and for each parameter there will be a specification and a tolerance limit, usually 5%. This means that if the desired length is 9+/-0.5cm only 5% of the sample can be bigger .9.5 cm or smaller, 8.5cm. This will need careful explanation to the workers each time there is a change in specification. Samples of graded work will be checked by the quality controller and if the grading is not accurate, the worker concerned must be cautioned and the produce will need to be re-graded and re-packed.

Figure: 1.1. Grading of produce

1.2. Labelling of harvested produce

- Labelling happens are several stages of the process:
  - After harvest produce is given an identity label
  - At grading and primary packing stage, a ‘point of sale label will be added
  - If units of produce are packed into a box after primary packing, the box must be labelled and finally
  - If the produce is palletised to facilitate delivery the pallet must be labelled

The information that is required on the label will depend on the target market and client requirements.

Requirements for information may include any or all of the following:

- Type of produce and variety / cultivar
- Net weight and size grade of the produce
- Country of origin (exported produce)

Name and contact details of the producer

- Applicable certifications
- Best before or use by date.

Tracking and tracing

These are important processes in the management of fresh produce and many clients will require commercial producers to have a system in place:

Tracking: tells you where any batch of produce is within the postharvest handling and storage operation

Tracing: enables you to identify the origin of the produce and the treatments that have been applied to the produce. This is important for knowing the marketable yield from each plot and for payment of produce suppliers to the packing facility. A tracing can also be used to identify which worker completed the work in question.

Note: Tracking and tracing is only possible when produce labelling and recording keeping is accurate and kept up to date.

Self-Check-1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. Define grading?(2points)
2. List the factors consider during grading?(2points)
3. List the requirements information may include during labelling?(2points)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-2	Identifying and disposing produce not meet specifications

2.1. Identification and disposal of reject produce

Produce that does not meet specifications for the client or the enterprise grading standard is referred to as reject produce.

Table: 2.1. The type of reject produce

Grade parameter	Possible problems		
Size	too big or too small	too fat or too thin	too long or too short
Shape	Irregular	curved	not true to type
Ripeness	too ripe or too green	unevenly ripe	mixed stages of ripeness
Maturity	over mature	not mature enough	
Damaged	bruised or squashed	cracked or russet marked	wind or hail damaged
Infected	Rotting	insect damaged	quarantine pest

Workers must be careful not to mix reject produce with the produce grades for the target market.

- Each worker's work station should be kept clean and have clearly defined areas for Incoming produce, Graded Produce and Reject Produce.
- Reject produce must be removed promptly and regularly from the Area used for Grading.

Workers must also be careful not to mix with contaminate reject produce, trimmings and plant trashes with other waste materials, e.g. plastics, strapping material, staples, etc. as this will make the onward disposal more difficult. After removal from the operation area, the rejected produce, produce trimmings and other organic trashes must be handled, stored and disposed in accordance with the farm/enterprise environmental procedures.

- **In practice the reject produce may be:-**
  - Re-graded for sale at a lower price to clients with lower grade specifications, e.g. Local market instead of export. Many of the reasons for rejection are cosmetic so a large proportion of rejects are perfectly ok for human consumption.
  - Used for animal feed (edible crops only).
  - Mixed with other organic materials and composted then used for soil amelioration.

In some farms, the management will conduct periodic reject analysis to establish the exact causes of rejection. This information can be used to target actions to improve production and postharvest handling and thereby reduce the reject percentage in the future.

Remember: - the production cost for a reject is the same as for an item of produce that is sold so reducing the reject percentage will increase the financial return to the farm.

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What is reject produce? (1 point)
2. List type of produce rejected? (2 points)

Note: Satisfactory rating – 3 points and Unsatisfactory - below 3 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-3	Selecting post-harvest treatments

3.1. Postharvest Treatments

There are many different treatments that can be applied in the postharvest period **to extend the shelf life, maintain the nutrient value or eating quality and enhance the appearance of produce.**

3.1.1. Treatments to reduce microbial contamination

Over the past few years, food safety has become and continues to be the number one concern of the fresh produce industry. This guide is based on the following principles:-

- Prevention of microbial contamination of fresh produce is favored over reliance on corrective actions once contamination has occurred;
- In order to minimize microbial food safety hazards in fresh produce, growers, packers, or shippers should use good agricultural and management practices in those areas over which they have control;
- Fresh produce can become microbiologically contaminated at any point along the farm-to-table food chain. Human and/or animal faeces are the source of microbial contamination of fresh produce;
- Whenever water comes in contact with produce, its quality dictates the potential for contamination. The potential of microbial contamination from water used with fresh fruits and vegetables must be minimized;
- The use of animal manure or municipal bio solid wastes as fertilizers should be closely managed in order to minimize the potential for microbial contamination of fresh produce; and
- Worker hygiene and sanitation practices during production, harvest, sorting, packing, and transport play a critical role in minimizing the potential for microbial contamination of fresh produce."

Clean water containing an appropriate concentration of sanitizers is required in order to minimize the potential transmission of pathogens from water to produce, from healthy to

infected produce within a single lot, and from one lot of produce to another, over time. Waterborne microorganisms, including post-harvest plant pathogens and agents of human illness, can be rapidly acquired and taken up on plant surfaces. Natural plant surface contours, natural openings, harvest and trimming wounds and scuffing can provide points of entry as well as safe harbor for microbes. The concentration of sanitizer is important in some pre-harvest water uses (such as spraying pesticides or growth regulators) and in all post-harvest procedures involving water, including washing, cooling, water-mediated transport (flumes), and post-harvest drenching with calcium chloride or other chemicals**.**

3.1.2. Treatments to minimize water loss

Transpiration, or evaporation of water from the plant tissues, is one of the major causes of deterioration in fresh horticultural crops after harvest. Water loss through transpiration not only results in direct quantitative losses (loss of saleable weight), but also causes losses in appearance (wilting, shriveling), textural quality (softening, flaccidity, limpness, loss of crispness and juiciness), and nutritional quality. Transpiration can be controlled either through the direct application of post-harvest treatments to the produce (surface coatings and other moisture barriers) or through manipulation of the environment (maintenance of high relative humidity). Treatments that can be applied to minimize water loss in fruits and vegetables include:-

- Curing of certain root vegetables, such as garlic, onion, potato, and sweet potato.
- Waxing and the use of other surface coatings on commodities, such as apple, citrus fruits, nectarine, peach, plum, pomegranate, and tomato.
- Packaging in polymeric films that act as moisture barriers.
- Careful handling to avoid physical injuries, which increase water loss from produce.
- Addition of water to those commodities that tolerate misting with water, such as leafy vegetables.

3.1.3. Treatments to reduce Ethylene damage

The promotion of senescence in harvested horticultural crops by ethylene (1 ppm or higher) results in acceleration of deterioration and reduced post-harvest life. Ethylene accelerates chlorophyll degradation and induces yellowing of green tissues, thus reducing the quality of leafy, floral, and immature fruit-vegetables and foliage ornamentals. Ethylene induces abscission of leaves and flowers, softening of fruits, and several physiological disorders.

Ethylene may increase decay development of some fruits by accelerating their senescence and softening and by inhibiting the formation of antifungal compounds in the host tissue. In some cases, ethylene may stimulate the growth of fungi, such as Botrytis cineria on strawberries and Penicillium italicum on oranges. The incidence and severity of ethylene-induced deterioration symptoms is dependent upon temperature, time of exposure, and ethylene concentration. The yellowing of cucumbers can, for example, result from exposure to either 1 ppm ethylene over 2 days or to 5 ppm ethylene over 1/2 day at 10 °C. Ethylene effects are cumulative throughout the post-harvest life of the commodity. Treatment of ornamental crops with 1-methylcylopropene (1-MCP), which is an ethylene action inhibitor, provides protection against ethylene damage. The commercial use of this product at concentrations of up to 1 ppm on apples, apricots, avocados, kiwifruit, mangoes, nectarines, papayas, peaches, pears, persimmons, plums, and tomatoes was approved by the United States Environmental Protection Agency. The use of 1-MCP will no doubt be extended to several other fruits and vegetables, and to use in other regions.

To minimise the effects of Ethylene, the concentration of Ethylene in the storage area can be reduced naturally by Good ventilation and air circulation and maintaining a cool temperature. In some specialist cases e.g. Cut flowers or Bananas for export a synthetic plant growth regulator, 1-MCPA, (1-methylcycopropene), can be applied to inhibit the production and effects during transport and storage. Ethylene is also present in vehicle exhaust fumes so vehicle use should be kept to a minimum in areas where fresh produce is handled and stored.

3.1.4. Treatments for decay control

A major cause of losses in perishable crops is the action of a number of microorganisms on the commodity. Fungi and bacteria may infect the plant organ at any time. “Latent” infections, in which fungi invade fruit tissues shortly after flowering, become apparent only at the onset of ripening. Post-harvest rots frequently occur as a result of rough handling during the marketing process and are caused by a wide array of microorganisms. The grey mold botrytis cineria is a very important cause of loss in many commodities (such as grapes, kiwifruit, pomegranates, raspberries, and strawberries), and is an aggressive pathogen, even at low temperatures. Virus infection frequently lowers the quality of perishable commodities, usually as a result of visual deterioration, although viruses may also affect flavor and composition. Curing is a post-harvest treatment that facilitates certain

anatomical and physiological changes that can prolong the storage life of some root crops. Sanitation practices include treatment to reduce populations of microorganisms on equipment, on the commodity, and in the wash water used to clean it. Water washes alone are effective in removing nutrients that allow microorganisms to grow on the surfaces of produce as well as in removing inoculums of post-harvest pathogens. The addition of sanitizers to water dumps and spray or dip washes, reduces inoculum levels of decay-causing organisms from fruit surfaces, inactivates spores brought into solution from fruit or soil and prevents the secondary spread of inoculums in water.

Treatments for decay control include:-

- Heat treatments, such as dipping mangoes in water at a temperature of 50 °C, for 5 minutes in order to reduce subsequent development of anthracnose;
- Use of post-harvest fungicides, such as imazalil and/or thiabendazole on citrus fruits;
- Use of biological control agents, such as “Bio-Save” (Pseudomonas syringae) and “Aspire” (Candida oleophila) alone or in combination with fungicides at lower concentrations on citrus fruits;
- Use of growth regulators such as gibberellic acid or 2, 4-D to delay senescence of citrus fruits;
- Use of 15-20 percent CO_2 in air or 5 percent O_2 on strawberries, cane berries, figs, and pomegranates; and (6) use of SO_2 fumigation (100 ppm for one hour) on grapes.

3.1.5. Treatments for insect control

Fresh fruits, vegetables and flowers may harbor a large number of insects during postharvest handling. Many of these insect species, in particular fruit flies of the family Tephritidae (e.g. Mediterranean fruit fly, Oriental fruit fly, Mexican fruit fly, Caribbean fruit fly) can seriously disrupt trade among countries. The identification and application of acceptable disinfestations treatments including irradiation will greatly facilitate globalization of trade in fresh produce. Criteria for the selection of the most appropriate disinfestations treatment for a specific commodity include cost, the efficacy of that treatment against insects of concern, safety of the treatment as well as the ability of that treatment to preserve and maintain produce quality. Currently approved quarantine treatments, other than irradiation, include certification of insect-free areas, use of chemicals (e.g. methyl bromide,

phosphine, and hydrogen cyanide), cold treatments, heat treatments, and combinations of these treatments, such as methyl bromide fumigation in conjunction with cold treatment. The use of alternative treatments, such as fumigants (carbonyl sulphide, methyl iodide, sulphuryl fluoride) and insecticidal atmospheres (oxygen concentrations of less than 0.5 percent and/or carbon dioxide concentrations ranging between 40 and 60 percent) alone or in combination with heat treatments, and ultraviolet radiation, are currently under investigation. These treatments are not, however, broad-spectrum treatments and are potentially phytotoxic when applied to some commodities.

Detrimental effects of irradiation on fresh produce may include loss of green color (yellowing), abscission of leaves and petals, tissue discoloration, and uneven ripening. These detrimental effects may not become visible until after the commodity reaches the market. The effects of irradiation must therefore be tested on individual commodities, prior to large-scale commercialization of the irradiation treatment**.**

3.1.6. Treatments designed to manipulate the environment around produce

3.1.6.1. Controlled atmosphere

Controlled atmosphere may directly inhibit pathogen growth or indirectly inhibit decay by delaying ripening and senescence.

Low O_2 – for many commodities, CA storage includes 2-5% O_2 (lower levels enhance anaerobic respiration).

However, only lower oxygen levels below 1% significantly reduce pathogen growth.

High CO_2 – high CO_2 levels (10-15%) are used in CA storage of some commodities (strawberry, figs, and cherry). These high CO2 concentrations also inhibit pathogen growth.

3.1.6.2. Modified atmosphere storage

When used as supplements to keeping fresh horticultural perishables within their optimum ranges of temperature and relative humidity, controlled atmospheres (CA) or modified atmospheres (MA) can serve to extend their post-harvest-life. Optimum oxygen and carbon dioxide concentrations lower respiration and ethylene production rates, reduce ethylene action, delay ripening and senescence, retard the growth of decay-causing pathogens, and control insects. CA conditions which are not suited to a given commodity can, however, induce physiological disorders and enhance susceptibility to decay. Several refinements in CA storage technology have been made in recent years. These include the creation of nitrogen-on-demand by separation of nitrogen from compressed air through the use of

either molecular sieve beds or membrane systems; use of low (0.7 to 1.5 percent) oxygen concentrations that can be accurately monitored and controlled; rapid establishment of CA, ethylene-free CA, programmed (or sequential) CA (such as storage in 1 percent O_2 for 2 to 6 weeks followed by storage in 2-3 percent O_2 for remainder of the storage period), and dynamic CA where levels of O_2 and CO_2 are modified as needed based on monitoring specific attributes of produce quality, such as ethanol concentration and chlorophyll fluorescence.

The use of CA in refrigerated marine containers continues to benefit from technological and scientific developments. CA transport is used to continue the CA chain for commodities (such as apples, pears, and kiwifruits) that had been stored in CA immediately after harvest. CA transport of bananas permits their harvest at a more advanced stage of maturity, resulting in the attainment of higher yields at the field level. In the case of avocados, CA transport facilitates use of a lower shipping temperature (5°C) than if shipped in air, since CA ameliorates chilling injury symptoms. CA in combination with precision temperature management allows insect control without the use of chemicals, in commodities destined for markets that have restrictions against pest endemic to exporting countries and for markets with a preference for organic produce. The use of polymeric films for packaging produce and their application in modified atmosphere packaging (MAP) systems at the pallet, shipping container (plastic liner), and consumer package levels continues to increase. MAP (usually designed to maintain 2 to 5 percent O_2 levels and 8 to 12 percent CO_2 levels) is widely applied in extending the shelf-life of fresh-cut fruits and vegetables. Use of absorbers of ethylene, carbon dioxide, oxygen, and/or water vapor as part of MAP is increasing. Although much research has been done on the use of surface coatings to modify the internal atmosphere within the commodity, commercial applications are still very limited due to inherent biological variability of commodities. At the commercial level, CA is most widely applied during the storage and transport of apples and pears. It is also applied to a lesser extent on kiwifruits, avocados, persimmons, pomegranates, nuts and dried fruits. Atmospheric modification during long-distance transport is used for apples, avocados, bananas, blueberries, cherries, figs, kiwi-fruits, mangoes, nectarines, peaches, pears, plums, raspberries and strawberries. Technological developments geared toward providing CA during transport and storage at reasonable cost (positive benefit/cost ratio) is

essential if the application of this technology to fresh fruits and vegetables is to be expanded.

Figure: 3.1 Retail displays of fresh cut fruits

Although MA and CA have both been shown to be effective in extending the post-harvest life of many commodities, their commercia

application has been limited by the relatively high cost of these technologies. There is however a few cases in which a positive return on investment (cost/benefit ratio) can be demonstrated. In a comparison of losses due to decay during retail marketing of strawberries shipped in air and those shipped in an environment consisting of 15 percent CO_2-enriched air (modified atmosphere within pallet cover), the use of modified atmosphere was observed to reduce losses by 50 percent (an average of 20 percent losses was sustained in strawberries shipped in air vs. 10 percent losses in those shipped by MA). Use of controlled atmosphere (CA) during marine transportation can extend the post-harvest-life of those fruits and vegetables that would normally have a short post-harvest-life potential, thereby allowing the use of marine transportation instead of air transport for the shipment of such produce. In terms of cost and benefit, savings realized with the use of marine transportation are much greater than is the added cost of CA service.

Figure: 3.2 Modified atmosphere packaging of strawberries (carbon dioxide-enriched air delays fungal growth.

3.1.7. Drying and curing treatment

3.1.7.1. Drying simply means the removal of water. In postharvest handling this may be surface drying after washing, partial drying as in allowing the necks of onions to dry in the field prior to harvesting and storage or sun drying herbs, seeds or fruit for storage.

3.1.7.2. Curing is a natural process where there is a change in the cell structure of the outer tissues that can occurs in the drying process of some types of produce, e.g. the hardening of the outer skin as occurs on onions and potatoes that are ‘dried’ before storage. Remember when drying Irish potatoes for storage that this must be done in the dark. Exposure to light during the postharvest process causes potatoes to ‘go green’, and green Irish Potatoes are poisonous!

Table: 3.1. Conditions for curing root, tuber, and bulb crops

Crops	Temperature (°C)	Relative humidity %	Duration (days)
Cassava root	30-40	90-95	2-5
Onion and garlic bulbs	30-45	60-75	1-4
Potato tubers	15-20	85-90	5-10
Sweet Potato roots	30-32	85-90	4-7
Yam tubers	32-40	90-100	1-4

Figure: 3.3. Curing of onion

On the farm the selection of which post-harvest treatments to use will be made in accordance with the requirements of the harvested produce, the enterprise integrated pest management strategy and the marketing plan. In a commercial farming situation, your line

manager will either make these documents available for reference or will discuss the requirements directly with you. In a small farmer situation, the farmer will decide what treatments to apply based on experience, traditional practice and discussion with the buyer. In your role as a development agent, DA, you will be expected to give advice as necessary about relevant Industry best practices and appropriate new technologies.

Table: 3.1. Some examples of the use of different postharvest treatments

Crop	Target Market	Treatments applied	Rational
Cabbage	Local	Trimming / Removal of outer leaves	✓ Improves appearance ✓ Reduces volume for transport ✓ Residue stays in the farm for soil amelioration
Tomato	Local	Sorting for size and ripeness Removal of diseased, insect infected and damaged fruit	Improved appearance Meets the expectation of the buyers and end users
Banana	Local & Export	Ripening	Fruit has longer shelf life and is less damaged during transport if it is ripened immediately prior to final sale
Green Beans	Export	Trimming (optional) Sorting for size and maturity Removal of diseased, insect infected and damaged pods	Sort and trim according to client requirement Remove damage and infected produce to reduce losses during transport
Onion	Local	Curing in the Field Sorting	Curing dries the neck and reduces the risk of rotting in the postharvest period. Sorting enhances the appearance of the produce
Carrot	Local	Washing	Removes soil and enhances the appearance of the produce

Self-Check 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. Define drying? (1point)
2. Define curing? (2points)
3. List type of postharvest treatments and explain them briefly? (4 points)

Note: Satisfactory rating – 7 points and Unsatisfactory - below 7 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-4	Conforming handling techniques and environmental requirements

4.1. Handling techniques and environmental requirements

There are some important considerations that apply in most situations: postharvest management, often referred to as postharvest technology is a multi-disciplinary approach which combines an understanding postharvest physiology, industry good practices and engineering technology to:-

- Minimize losses during the postharvest period
- Maximize the storage life of produce and
- Improve the appearance and marketability of produce
- Maintain or enhance the nutritional value and eating quality of produce offered to consumers
- Ensure that the food offered for sale is Safe for Human consumption

These objectives are achieved by the application and management of postharvest treatments and the use of appropriate storage conditions.

Pest management:-

- Consider all the IPM treatment options and use pesticides only as a last choice.
- If pesticide use is the only remaining option, use only products that are registered in Ethiopia for postharvest application to the target pest in the produce to be treated.
- Apply the treatment by the correct method and at the correct rate
- Use appropriate PPE and safe working practices
- Dispose of waste in accordance with the farm environmental and waste management procedures

Cleaning:

- Use only food grade products in pack houses used for edible products
- Follow label recommendations for rate of application
- Store cleaning product in a secure dedicated area outside of the product handling areas
- Keep cleaning equipment clean
- Follow the enterprise cleaning schedules

Cold chain:

- Monitor and record temperatures of storage facilities and products
- Minimize the time that produce is outside of the cold storage facilities
- Take appropriate action when the temperature falls outside of the acceptable limits

Timeliness:

- Be aware of the timelines for tasks and the deadlines for completion.
- Encourage workers to work at a rate that will meet the set deadlines
- Report problems promptly to allow time for a revised action plan and communication the client

Self-Check 4	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. List the importance of posh harvest management? (3points)
2. Discuss be aware of the timelines during postharvest operation(3points)

Note: Satisfactory rating – 6 points and Unsatisfactory - below 6 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-5	Establish economical and methodical post-harvest practices

5.1. Conforming handling techniques and environmental requirements

The characteristics of all postharvest work are that the work is:

- Labour Intensive
- Operating costs of pack house facilities are high
- Tasks must be completed in accordance with tight time lines and deadlines for completion
- The produce is perishable and easily damaged. Therefore, to ensure the smooth and efficient operation of facilities and tasks related to postharvest practices and to meet timelines, it is essential to:
- Organize the work so that there is a smooth flow from one stage of the process to the next
- Minimize the distances moved by the products and the number of times the produce is handled
- Allocate sufficient workers and equipment to each task to avoid bottle necks and a build-up of produce awaiting attention at any stage of the process
- Minimize the risk of contamination of ‘clean’ or ‘processed’ by incoming product, rejects and wastes by segregating the movement of these items
- Train workers to operate correctly, safely and at a reasonable rate
- Set reasonable targets
- Allocate responsibilities and establish clear lines of communication
- Develop and document realistic operating procedures
- Keep accurate written records
- Maintain a clean working environment and
- Review practices periodically to see what problems have arisen and what improvements can be made.

❖ Physical Damage to produce;- fresh produce is by nature delicate and perishable so is very susceptible to physical damage.

Physical damage to produce can result in:

- Direct loss as the product becomes un-saleable or only saleable at reduced price
- Indirect loss due to increase in fungal or bacterial infection and rotting during storage or transport

Table: 5.1. Causes and actions to reduce / prevent physical damages to produce

Cause of the physical damage	Actions to reduce physical damage
Workers fail to handle produce carefully Produce is bruised by handling: • Pinched with fingers or pierced with finger nails and jewellery • Dropped from great height when emptying picking bags, buckets, baskets, etc. • Filled crates are thrown, dropped or slid along the floor	Train workers Supervise activities closely and take action when produce is not being handled carefully Check workers hands before they start work Remove jewellery and trim finger nails Empty picking containers carefully are placing the container near to the receiving crate or the ground.
Produce is moved and handled many times	Plan work to keep the number of handlings and movement from one stage to the next to a minimum
Produce is squashed and bruised in the container Overfilling containers and stacking Using containers that are too deep	Set guidelines for the type of containers to use and the fill level for the containers
Stacks of produce collapse	Instruct worker to stack produce carefully to align the corners of the containers Limit the stack height Use containers that are stronger and do not soften in humid or wet conditions

Self-Check 5	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. List the characteristics of all postharvest work? (3points)
2. Write case and remedial action of physical damage of produce? (4points)

Note: Satisfactory rating – 7 points and Unsatisfactory - below 7 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-6	Cleaning and maintaining tools, equipment and machinery

6.1. Cleaning and maintenance of tools and equipment is essential

To preserve the life of the tools and equipment and to protect the produce

❖ **Cleaning:**

Plant sap and organic debris builds up on parts of tools and equipment that are in regular contact with produce, e.g. knives, rollers, hoppers, etc. This plant sap and organic debris will cause corrosion of metal parts, reducing the life of the equipment and the sharpness of the cutting blades. Unnecessary damage to produce occurs and the risk of injury to the operator increases when blunt tools are used. Produce may also be contaminated by the residues leaf on tools and equipment from previous use. Most commercial farms will have enterprise procedures for cleaning.

❖ **Maintenance:**

Maintenance of all pack house equipment should be carried out in accordance with the manufacturer recommendations, (consult the operators Handbook). When carrying out maintenance activities remember OHS.

- Turn the machine off and disconnect from the electricity before starting work
- Do not put your head and hands into moving machinery
- Replace the safety guards are cleaning
- Only work on tasks and machinery that you are authorized to work on
- Account for all tools and machinery parts on completion of the job
- Supervise external contractors to ensure that they observe the rules of the pack house.

Self-Check 6	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers

1. Write the importance of cleaning and maintaining tools, equipment and machinery? (3points)

Note: Satisfactory rating – 3 points and Unsatisfactory - below 3 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Operations Sheet 1	Grading and labeling of produce

Objectives are to:

- Ensure that you practice and acquire the skills needed to implement the postharvest handling for a range of crops and market outlets and
- To encourage you to apply and use their knowledge in a range of practical situations

Follow the following procedures, for correct grading and packing of produce on time and with minimum damage to the produce.

- Prepare materials, tools and equipment for sort or grade and label
- Grade the samples of produce provided in accordance with the standards and target market indicated by your Instructor
- Label the samples of produce provided in accordance with the standards and target market indicated by your Instructor
- Select the postharvest treatments to be applied to the produce that you have sorted and graded
- Rejected the damage produce
- select the disposal method(s) that can be used for this reject produce
- Clean the tools and equipment used
- Clean the work area when you have finished the activity
- Store tools and equipment

LAP Test	Practical demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: You are required to perform the following as directed

Task Make grading and labeling of mango fruits?

Reference

1. Kader, A.A. (ed). 2002. Postharvest Technology of Horticultural Crops (3rd Edition). UC Publication 3311. University of California, Division of Agriculture and Natural Resources, Oakland, California 94608. p. 535.
2. Kitinoja, L. 2013. Returnable Plastic Crate (RPC) systems can reduce postharvest losses and improve earnings for fresh produce operations. White Paper No. 13-01. The Postharvest Education Foundation. La Pine, Oregon USA. p. 26.
3. Moline, H.E. 1984. Postharvest Pathology of Fruits and Vegetables: Postharvest Losses in Perishable Crops. U.C. Bulletin 1914, University of California, Division of Agriculture and Natural Resources, Oakland, California 94608.
4. Pantastico, Er. B. 1980. FAO/UNEP Expert Consultation on Reduction of Food Losses in Perishable Products of Plant Origin. (6 May 1980, FAO,, Rome). p. 54.
5. Proctor, F.J. 1985. Post-harvest handling of tropical fruit for export. The Courier 92: 83-86.
6. http://postharvest.ucdavis.edu

7. http://www.postharvest.org

Horticultural Crops Production

Level III

Learning Guide –75

Unit of Competence: Implement Post-Harvest Handling

Module Title: Implementing Post-Harvest Handling

LG Code: AGR HCP3 M17LO4-75

TTLM Code: AGR HCP3 TTLM 0120V1

LO4:- Implement hazardous waste disposal guidelines

Instruction sheet	Learning Guide 75

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Reviewing waste disposal requirements and determining tasks
- Monitoring collection and disposal of waste
- Reporting business viability

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Review waste disposal requirements and determining tasks
- Monitor collection and disposal of waste
- Report business viability

Learning Instructions

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1- 3”.
4. Accomplish the “Self-check 1-3” **in** page -78, 80 and 82 respectively.

Information Sheet-1	Reviewing waste disposal requirements and determining tasks

1.1. Hazardous waste disposal operations

The types of waste generated by postharvest operations will depend on the type of produce and the target market.

The level of risk created by the waste generated will depend on the amount of waste and the situation in which the waste is generated. Each commercial farm should identify and document the types and amounts of waste generated and develop operational procedures for disposal that will:-

- Minimize the effects of the waste on the environment and
- Minimize the OHS risks to employees and the community around the produce handling and storage facility.

These waste management operational procedures should be included in the farm environmental policy and plan in the small farming sector, the development agent is responsible to provide guidance about waste management and to monitor practices to ensure that the environment and the safety of operators and the community is not compromised.

Table: 1.1. Some typical operational procedures are shown in the table below

Type of waste	Typical operational procedures
Damaged packaging & Damaged Crates	Minimize by careful handling and correct storage Cardboard can be burnt Plastic should be recycled where possible and otherwise buried
Waste produce and crop residue	Minimize by good crop husbandry and careful handling Remove from produce handling area promptly Use as Animal Feed (Edible crops only) or compost
Waste waters from produce washing	Drain into a constructed wetland or onto un-cropped land, not into the cropped field, the drainage system or the local river

Self-Check 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. List types of postharvest handling waste? (3points)

Note: Satisfactory rating – 3 points and Unsatisfactory - below 3 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-2	Monitoring collection and disposal of waste

2.1. Monitoring hazardous waste disposal

Monitoring waste disposal practices is essential to ensure that:-

- Unnecessary waste is prevented.
- Produce is not contaminated.
- The safety of operators is maintained.
- The local community is not adversely affected and
- The environment is protected.

❖ Management and supervisors are responsible to check that enterprise work procedures are adequate and implemented correctly.

Typical things to check are:-

- Produce waste is kept to a minimum by careful handling and correct grading.
- Waste is segregated to facilitate safe and correct disposal and to avoid risk to livestock feeding on the organic wastes.

Remember that plastic, thorns and metal staples can kill a cow!

- Waste is removed promptly from the work area and pack house surrounds to avoid contamination of produce and attracting vermin.
- Operators follow the enterprise work procedures and minimise the risk to themselves, other workers, produce and the environment of dust or chemical contamination.
- The local community is not affected by vermin feeding on the waste or by smell and dust.
- Waste waters, pesticide residues and leachate from decomposing organic wastes do not enter water sources.
- Workers follow instructions and waste is not removed from site unless permission for this is given by management. In Ethiopia, the ministry for environment and the regional environment government officers will also monitor the discharge from commercial enterprises and operations that do not implement adequate procedures for waste management will be penalised.

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. List the advantage of monitoring waste disposal practice? (3points)

Note: Satisfactory rating – 3 points and Unsatisfactory - below 3 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-3	Reporting business viability

3.1. Report on waste disposal operations that could impact on business viability

Where monitoring shows that procedures are not followed or do not give adequate protection to produce, operators, the local community or the environment, problems identified should be reported to the responsible person in management. Examples of problems that should be reported include:

- Waste produce include, saleable produce or large amounts of physically damaged produce. This indicated that handling and grading is not being well supervised, and the lost produce will reduce the potential income from sales.
- Waste organic material being fed to cattle is contaminated with plastic packaging, metal fragments, sharp thorny or woody material or toxic plant material, e.g. Flower wastes or poisonous plant parts or weeds.
- Leachate from pesticide disposal or composting areas is entering water sources
- Dust, vermin and smell are affecting the local community.

Failure to address these issues may result in:-

- Loss of sales; clients are sensitive to poor publicity associated with produces and suppliers or
- Legal penalty; the Ethiopian Ministry of Environment has the power to close operations that cause serious pollution of the environment. When farms have experienced a problem with waste management, details should be recorded of:-
- The nature of the problem.
- The action taken and
- The follow up monitoring or testing to confirm that the problem has been corrected.

Self-Check 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Give three examples of problems associated with waste management that could affect business viability? (3points)

Note: Satisfactory rating – 3 points and Unsatisfactory - below 3 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Reference

1. Kader, A.A. (ed). 2002. Postharvest Technology of Horticultural Crops (3rd Edition). UC Publication 3311. University of California, Division of Agriculture and Natural Resources, Oakland, California 94608. p. 535.
2. Kitinoja, L. 2013. Returnable Plastic Crate (RPC) systems can reduce postharvest losses and improve earnings for fresh produce operations. White Paper No. 13-01. The Postharvest Education Foundation. La Pine, Oregon USA. p. 26.
3. Moline, H.E. 1984. Postharvest Pathology of Fruits and Vegetables: Postharvest Losses in Perishable Crops. U.C. Bulletin 1914, University of California, Division of Agriculture and Natural Resources, Oakland, California 94608.
4. Pantastico, Er. B. 1980. FAO/UNEP Expert Consultation on Reduction of Food Losses in Perishable Products of Plant Origin. (6 May 1980, FAO,, Rome). p. 54.
5. Proctor, F.J. 1985. Post-harvest handling of tropical fruit for export. The Courier 92: 83-86.
6. http://postharvest.ucdavis.edu
7. http://www.postharvest.org

Horticultural Crops Production

Level III

Learning Guide –76

Unit of Competence: Implement Post-Harvest Handling

Module Title: Implementing Post-Harvest Handling

LG Code: AGR HCP3 M17LO5-76

TTLM Code: AGR HCP3 TTLM 0120V1

LO5:- Implement packing and presentation requirements of produce

Instruction sheet	Learning Guide 76

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Reviewing packing and presentation requirements
- Conforming packing and presentation of produce
- Monitoring packing and presentation processes
- Recording packing and presentation processes

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Review packing and presentation requirements
- Conform packing and presentation of produce
- Monitor packing and presentation processes
- Record packing and presentation processes

Learning Instructions

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1-4”.
4. Accomplish the “Self-check 1- 4” in page -91, 94, 95 and 97 respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1,” in page -98.
6. Do the “LAP test” in page – 99(if you are ready).

Information Sheet-1	Reviewing packing requirements

1.1. Packing and presentation

The primary purpose of packaging for fresh produce is to facilitate the handling of the produce during the postharvest and marketing process.

Therefore, packaging must:-

- Be strong enough to stack and to provide protection for the produce throughout the postharvest and marketing process.
- Maintain the strength in wet or highly humid conditions.
- Be of appropriate size; large enough to contain the produce without squashing but small enough to ensure that space is not wasted.
- Be designed to allow air circulation around the produce and through stacks of produce when the containers are stacked or palletized in store and during transport.
- Facilitate labeling of the produce.
- Be attractive (point of sale packaging only).
- Be relatively cheap to buy and simple to assemble.
- Be made of food grade material (edible produce only).
- Be environmentally friendly: consider single use v returnable for reuse containers and suitability for recycling after use (material type and construction method are important here). The selection of what type of packaging to use will depend on the type of produce and the market / client requirements. Small scale farmers will select the packaging to use based on traditional practice, buyer requirements, cost and availability. In commercial farms the owner or manager will follow the same selection criteria and the decision will be noted in the farm market plan. For contract sales, the packaging to be used will be agreed and included in the contract.

Table: 1.1. Packaging categories

Packaging may be considered in three categories:		
Primary packaging: Used for produce, e.g. open box or crate, plastic bag or overwrapped punnet or Tray	**Primary packaging**	**Tertiary palletisation**

This facilitates handling and retail sale.		
Secondary packaging: Boxes or trays used to contain units of packed produce. This facilitates handling during transport.	Figure: 1.1. Plastic bag **Secondary packaging** 	Figure: 1.3. Palletisation
Tertiary packaging: Usually palletisation of produce in secondary packaging. Facilitates handling and transport of large volumes of produce.	Figure:1.2.Tray	

Table: 1.2. Common types of packaging in use in Ethiopia are shown below.

Wooden boxes and bulk bins Robust and suitable for re-use		

and recycling.

Suitable for stacking and can be designed with corner post for additional strength and air circulation.

Figure:1.4.wooden box

Figure: 1.5. Wooden bulk bin

Plastic crates and bulk bins

Robust and suitable for re-use.

Suitable for stacking and can be designed to allow air circulation.

Easier to clean than wooden containers

Figure: 1.6. Plastic box

Figure: 1.7. Plastic bulk bins

Figure: 1.8. Cardboard tra

Cardboard trays

Now usually made of waxed cardboard to prevent softening in humid environments. Designed to be made by folding and gluing to facilitate recycling. Raised triangular corners add strength and facilitate air circulation when stacked.

Plastic sacks

Often used in the small farmer sector for sale of produce to commercial and cheap to buy.

Figure: 1. 9. Plastic sacks

Plastic or polystyrene trays

Over wrapped with plastic film and plastic bags.

Used to facilitate retail sale, and are easy to label.

Condensation caused by temperature fluctuation can be a problem and lead to produce rotting quickly.

Use of micro-perforated plastic can reduce the problem of condensation.

Not biodegradable or recyclable so not good for the environment but are relatively cheap to buy. Must be made of 'food grade' material.

Figure: 1.10. Plastic tray

Figure: 1.12. Plastic tray

Figure: 1.13. Plastic tray

The Supervisor responsible for packing and presentation of produce is required to:

- Consult with the pack house manager to find out which batches of produce are to be packed for which Markets / clients and
- To consult with the pack house manager or refer to the enterprise Market Plan to confirm the Market or Client requirements for packaging, presentation and labelling of the produce concerned.

Check carefully:-

- ✓ The type and size of packaging to be used
- ✓ The size and weight of each unit to be packed
- ✓ The produce grade specifications to be used
- ✓ How the produce is to be presented and
- ✓ The type of label to use and the information required on the label.

- Arrange for the correct type, size and amount of packaging to be transferred from the packaging store to the grading hall or packing area.
- Arrange for the correct batch of produce to be moved from the storage area to the grading hall or packing area. Remember for produce where cold chain is important that the rate of delivery of produce to the grading hall must match the rate of packing and return of the packed produce to the cold room.
- Explain the grading and packing standards and specification to be used to the QC and workers who will pack the produce and confirm their understanding
- Confirm the target unit weight and allowance for transpiration loss to the QC and scale operators.
- Confirm the target for job completion and rate of work expected to the workers engaged in grading and packing.

Figure: 1.14. Packed onion

Self-Check 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. List the importance of packing produce? (3points)
2. List categories of packing? (3points)
3. List most common packing use in Ethiopia? (3points)

Note: Satisfactory rating – 9 points and Unsatisfactory - below 9 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-2	Conforming packing and presentation of produce

2.1. Packing and presentation of produce

Accurate packing neat presentation in the correct format and clear labelling are essential for marketing and client satisfaction. The supervisor responsible for packing is responsible to check and take action as necessary to ensure that:-

- The correct type and size of packaging is being used
- Produce that is being packed conforms to the size and quality standards required for the target client / market as stated in the enterprise market plan.
- Produce that is rejected does not conform to the size and quality standards required for the target client / market.
- Produce placement in the container (presentation), is neat and correct.
- Produce is weighed accurately (target weight plus the correct allowance for transpiration losses during transport).
- Produce is labelled correctly.
  - ✓ The label is of the correct type and is place accurately on the produce. In some pack houses inline labelling is done automatically.
  - ✓ Information included in the label is corrected complete and legible.

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Write the essentiality of accurate packing and neat presentation in the correct format and clear labelling? (7points)

Note: Satisfactory rating – 7 points and Unsatisfactory - below 7 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-3	Monitoring packing and presentation processes

3.1. Monitoring packing and presentation

Packing of produce is routine and often tedious work. Therefore, close supervision is necessary to ensure that standards are maintained throughout the day. In many enterprises, produce grading and primary packing is carried out as part of the same operation.

The supervisor needs to check that:-

- Workers observe the hygiene rules.
- Produce is handled carefully to avoid physical damages.
- Workers maintain a clean and organised work station where the work surface is cleaned as necessary and project produce and produce trimming are clearly segregated for the produce to be packed to avoid contamination of the packed produce.
- Reject produce and other wastes are removed promptly from the grading hall.
- The floor is kept dry and free from trip hazards.
- Different batches of produce, (from different fields or different farmers) are kept separate and recorded accurately.
- Grading standards are maintained. Problems are most likely to arise when the batch of produce is of low quality or the workers are tired (before lunch and at the end of the shift).
- Workers label their produce to facilitate traceability back to the worker.
- Work is running smoothly with no pile ups and when necessary cold chain is maintained.
- Workers focus primarily on the task rather than conversation with their neighbours.
- The work rate being achieved will meet the target time for job completion.
- Problems encountered should be rectified immediately or if this is not possible reported promptly to the line manager.

Self-Check 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Write the advantage of monitoring packing? (2points)

Note: Satisfactory rating – 2 points and Unsatisfactory - below 2 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-4	Recording packing and presentation processes

4.1. Records of produce packed

Records are an essential management tool for fresh produce. In commercial enterprises each batch of produce should be labelled at harvest and that identification should stay with the produce until final consumption of the produce. Data that must be recorded during postharvest operations will vary in detail and recording methodology between different product and Enterprises, but typical requirements are as follows:

- ✓ Produce entering the receiving area or receiving cold room should be recorded:
- ✓ Batch identity, amount and date. In large organisations the temporary storage location should also be recorded.

- Produce leaving the receiving area to be graded and packed should be recorded and a stock balance of ‘produce in store’ maintained.
- For each Batch of produce graded and packed, the date, total weight, weight packed and grade out percentage must be recorded. In some enterprises reject analysis is also carried out.
- Produce entering the despatch area or despatch cold room should be recorded: batch identity, amount and date. In large organisations the despatch storage location should also be recorded.
- Produce leaving the despatch area to be graded and packed should be recorded date, batch identity, amount and target market or client and a stock balance of ‘produce in store’ maintained.

Self-Check 4	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Explain why a small holder farmer should keep records of the produce that is packed for market? (3points)

Note: Satisfactory rating – 3 points and Unsatisfactory - below 3 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Operations Sheet 1	Packing and presenting

Objectives are to:

- Ensure that you practice and acquire the skills needed to carry out or supervise the operations involved in packing and presenting produce and
- To encourage you to apply and use their knowledge in a range of practical situations.

Follow the following procedures, for correct packing and presenting of produce on time.

- Prepare materials, tools and equipment for packing
- Select suitable packaging for the produce and target market indicated by your Instructor
- Pack the produce
- Prepare a record of the packing operation
- Rejected the damage produce
- select the disposal method(s) that can be used for this reject produce
- Clean the tools and equipment used
- Clean the work area when you have finished the activity
- Store tools and equipment.

LAP Test	Practical demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: You are required to perform the following as directed

Task

Pack and record the mango fruits in accordance with Instruction provided by your instructor or located in the market plan?

Reference

1. Kader, A.A. (ed). 2002. Postharvest Technology of Horticultural Crops (3rd Edition). UC Publication 3311. University of California, Division of Agriculture and Natural Resources, Oakland, California 94608. p. 535.
2. Kitinoja, L. 2013. Returnable Plastic Crate (RPC) systems can reduce postharvest losses and improve earnings for fresh produce operations. White Paper No. 13-01. The Postharvest Education Foundation. La Pine, Oregon USA. p. 26.
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6. http://postharvest.ucdavis.edu
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Horticultural Crops Production

Level III

Learning Guide –77

Unit of Competence: Implement Post-Harvest Handling

Module Title: Implementing Post-Harvest Handling

LG Code: AGR HCP3 M17LO6- 77

TTLM Code: AGR HCP3 TTLM 0120V1

LO6:- Implement storage requirements of produce

Instruction sheet	Learning Guide 77

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Reviewing storage requirements
- Conforming storage and handling of produce
- Monitoring storage processes and facilities
- Recording storage processes and conditions

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Review packing and presentation requirements
- Conform packing and presentation of produce
- Monitor packing and presentation processes
- Record packing and presentation processes

Learning Instructions

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1-4”.
4. Accomplish the “Self-check 1- 4” in page -106, 108, 112 and 114 respectively.

Information Sheet-1	Reviewing storage requirements

1.1. Storage of produce

Storage: is understood to involve; cold storage, dry storage at ambient temperature, and in specialist cases modified atmosphere storage of produce that is in the same or similar state as it was at harvest.

Preservation: of fresh produce by freezing, canning, drying, salting, bottling, juicing and jamming, all procedures that change the state of the produce, is generally considered as processing not as postharvest treatment.

Storage of fruits and vegetables for human consumption has two major purposes:

- To provide produce for consumption out of season or when supplies are low. This is important for household food security.
- To extend the marketing period to times when the market price is higher.

The length of time that fresh produce can be stored depends on the type of produce and the storage conditions used.

❖ **Storage practices in Ethiopia**

Storage of fruits, vegetables and cut flowers in Ethiopia is limited to a few specialist circumstances:

- **Short term storage** to facilitate handling and marketing
  Storage may be in a refrigerated cold store, an evaporative cooling unit or a cool dry, well ventilated 'shed'.
- **Longer term storage** to enable marketing or consumption out of season when supplies are scarce, and the market price is higher. This practice is restricted to a few crops, e.g. Onion, Garlic and some root crops (Irish Potato)

Some examples are described below:

- **Leafy green vegetables and fruits can only be held in ambient temperature storage** i.e. in a clean cool 'shed', for a few days:

Dry storage: Dry storage are dedicated storage areas with good natural ventilation (chimney style), or fan assisted ventilation. Storage is usually at ambient temperature and humidity.

General guidelines are to:

- ✓ Store only healthy produce that is surface dry when placed in the store.
- ✓ Keep the produce cool and maintain good air circulation.
- ✓ Protect produce from sunlight.
- ✓ Keep climactic and non-climactic products in separate storage areas to minimize the effects of ethylene releases by the climactic products, e.g. tomatoes, onions, bananas, etc.

- ➢ **Leafy green vegetables, fruits and flowers can be stored in a refrigerated cold store** for longer periods of time provided:
  - ✓ The correct temperature and humidity are maintained
  - ✓ There is good air circulation
  - ✓ Climactic and Non-climactic products are placed in separate stores
  - ✓ Any diseased produce is removed from the store promptly

Table: 1.1. Storage methods of different produce

Type of Produce	Desired storage temperature	Storage method	Approximate length of storage recommended
Tomatoes	10 -12 ^{O}C	Refrigerated store	1-2 weeks
Green beans	6^{O}C	Refrigerated store	1 week
Head cabbage	Cool	Shade	1 day
Spinach	0-2 ^{O}C Cool	Refrigerated store	1 – 2 weeks few days
Banana Green	17-21 ^{O}C 13-16 ^{O}C	Ventilated dry store	A few days
Citrus	4-7 ^{O}C	Refrigerated store	Several weeks
Mango	10-13 ^{O}C	Ventilated dry store or refrigerated storage (Export only)	
Apple	1-4 ^{O}C	Refrigerated store	Several months

- ➢ **Root vegetables, onions, garlic can be dried to allow the outer layers to harden** then stored in a cool dry shed for several months. Storage may be as loose produce or in crates or bulk bins. Good air circulation around and through the stacks of produce is

essential and results are better when the humidity is low. Produce should be inspected regularly, and diseased produce removed. Vermin control is essential. The storage requirements for produce on the farm will be documented in:

- **The market plan and/or the contract with the client**
  - Check for
    - ✓ Storage condition, temperature, humidity
    - ✓ Produce condition, ripeness
    - ✓ Delivery date

Figure: 1.1. Cold storage

Figure: 1.2. Refrigerated transport storage

Figure: 1.3. Dry storage

Self-Check 1	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Define preservation? (3points)
2. List and discuss different storage system practice in Ethiopia?(3points)

Note: Satisfactory rating – 6 points and Unsatisfactory - below 6 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-2	Conforming storage and handling of produce

2.1. Conforming storage and handling of produce

❖ **General requirements for storage facilities:-**

- The facility is cleaned regularly to minimize the risk of pests and diseases.
- Vermin is excluded and the store is monitored for signs of vermin whilst in use.
- Storage facilities for edible produce are only be used for edible produce.
- Storage facilities are of sufficient size to house the expected amount of produce but still allow space for good air circulation and access.

❖ **General requirements for annual or pre-season maintenance:**

- Check the fabric of the building for leaks and access by vermin.
- Cold Store refrigeration units should be re-gassed in accordance with manufacturer's recommendations.
- Stores should be deep cleaned.
- Maintenance and cleaning records are maintained.

❖ **General requirements for management of storage facilities:-**

- Produce is clearly labeled to facilitate traceability and stock management.
- Records of what is in store are accurate and up to date and a stock balance is calculated at the end of each day.
- A FIFO (First in is First Out) system for each type of produce in store is operated.
- The environmental conditions in the store are monitored at least daily and action when conditions deviate for the target range. Conditions and actions taken are recorded.
- Product is handled carefully when loading and unloading the store to avoid unnecessary physical damage to the produce and the produce containers.
- Produce is stacked securely and not directly on the floor or against the walls. Remember to leave space for air circulation and access.
- Old stock and trashes are removed promptly to minimize disease risk and adjust the stock balance to show what stock has been removed for destruction
- Keep the floor clear and free from surface water and keep the door closed.
- Also check regularly that the door can be opened easily from the inside and take immediate action when this is not possible.

Self-Check 2	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. List different storage facilities? (3points)

Note: Satisfactory rating – 3 points and Unsatisfactory - below 3 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-3	Monitoring storage processes and facilities

3.1. Monitoring storage

Routine monitoring of the environment in the store and the condition of the produce in the store followed by implementation of appropriate action is essential to minimise postharvest losses for produce in the store.

- **Monitoring of the environment may involve:-**
  - Check of temperature. In some cold stores there is continuous monitoring by sensors linked to the farm computer. And in other situations, manual checking with a thermometer is necessary.
  - Check of humidity. This can be done automatically or manually as above. Humidity is particularly important in dry stores.
  - Check of ethylene concentration. This can be done automatically or manually as above and is particularly important when storing climacteric fruits.
- **Monitoring of the condition of the produce in store:-** involves inspection of the produce. This involved taking samples from a transect through the batch of produce and examining the sample. Look for loss of condition, sprouting and storage rots or insect infestation. Record what you find and the percentage of the sample that is affected.
- **Monitoring of store operation:- check for;**
  - The presence of rubbish, old produce, unauthorised materials (pesticides, tools, personal food, etc.).
  - Arrangement of produce in the store; access, safe stacking, air circulation, etc.
  - Careful handling of produce entering and leaving the store.
  - Observe work in progress.

Table: 3.1. Problem solving during storage

Typical Problem	Possible causes	Action
Cold store temperature is too high	✓ Workers have adjusted the thermostat ✓ Workers are leaving the door open ✓ Large volumes of warm produce are being placed in the store	✓ Investigate the cause of the problem and resolve the problem. ✓ If you are unable to correct the problem discuss with the manager and agree appropriate action.
Dry store temperature and / or humidity are too high	✓ Outside conditions are hot and humid ✓ Produce is producing heat and water by respiration and composting	✓ Discuss with the manager and increase ventilation ✓ Restack produce to expose the middle of the stack to cooler drier conditions ✓ Consider terminating the storage and selling the produce to minimise losses
Ethylene concentration is incorrect	✓ Temperature has risen and natural ethylene production has increased	✓ Discuss with the manager and Increase or decrease ventilation as necessary
Produce is deteriorating rotting insect attack softening yellowing	These conditions are usually related to: High temperature High Humidity Poor ventilation	Discuss with the manager and remove affected produce and restack produce to expose the middle of the stack to cooler drier conditions.

sprouting	Physical damage and overstaying the ideal storage period.	Consider terminating the storage and selling the produce to minimise losses
Workers are: Misusing the store Not stacking produce correctly Not handling produce carefully, etc.		This is your responsibility! Train, caution and reprimand the workers concerned as necessary and make follow up to confirm that the problem identified is corrected

If you are working with small farmers who experience these problems, it is usually too late to save the current produce but advice about how to prevent the problem in the future will be useful.

Self-Check 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. List monitoring operation of storage? (3points)
2. List problems occur during storage? (3points)

Note: Satisfactory rating – 6 points and Unsatisfactory - below 6 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Information Sheet-4	Recording storage processes and conditions

4.1. Recording and reporting storage activities

- **Data to be recorded will be determined by management and is likely to include:-**
  - Details of produce entering or leaving the store:- date, produce type, batch identity and source or destination.
  - Store environmental conditions:- temperature, humidity, ethylene concentration
  - Produce deterioration:- date, produce type, batch identity and source, nature of the problem and amount of produce affected.
- **Uses for the data recorded include:-**
  - Balance in store:- used to update plans for sales and marketing.
  - Date of entry of produce into the store:- monitoring produce age.
  - Environmental conditions:- evidence of due diligence and a useful indicator of conditions that could result in produce deterioration.
  - Produce deterioration and postharvest losses:- indicates what changes are needed to reduce losses in the future.

Deviation from any normal or agreed situation should be reported promptly to the manager. Prompt action by the manager may be needed to:-

- Adjust marketing arrangements and keep good relations with clients or to
- Prevent further postharvest losses.

Self-Check 4	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. List the important of storage recording? (3points)

Note: Satisfactory rating – 3 points and Unsatisfactory - below 3 points

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

You can ask your teacher for the copy of the correct answers

Reference

1. Kader, A.A. (ed). 2002. Postharvest Technology of Horticultural Crops (3rd Edition). UC Publication 3311. University of California, Division of Agriculture and Natural Resources, Oakland, California 94608. p. 535.
2. Kitinoja, L. 2013. Returnable Plastic Crate (RPC) systems can reduce postharvest losses and improve earnings for fresh produce operations. White Paper No. 13-01. The Postharvest Education Foundation. La Pine, Oregon USA. p. 26.
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6. http://postharvest.ucdavis.edu

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