Horticulture Crop Production
Level-III

Based on March 2018, Version 3 Occupational standards

Module Title: Implementing Post-harvest handling Program

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LG # 86	LO #1- Prepare for implementation of post-harvest operations

Instruction sheet-1

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 *OHS hazards,* assessing risks, implementing controls and reporting.
- Selecting, using and maintaining suitable *safety* and *PPE*.

This guide will also assist you to attain the learning outcomes 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 on tools, equipment and machinery
- Identify *OHS hazards,* assessing risks, implementing controls and reporting.
- Select, use and maintain suitable *safety* and *PPE*

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets

7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Identifying *Post-harvest operations*

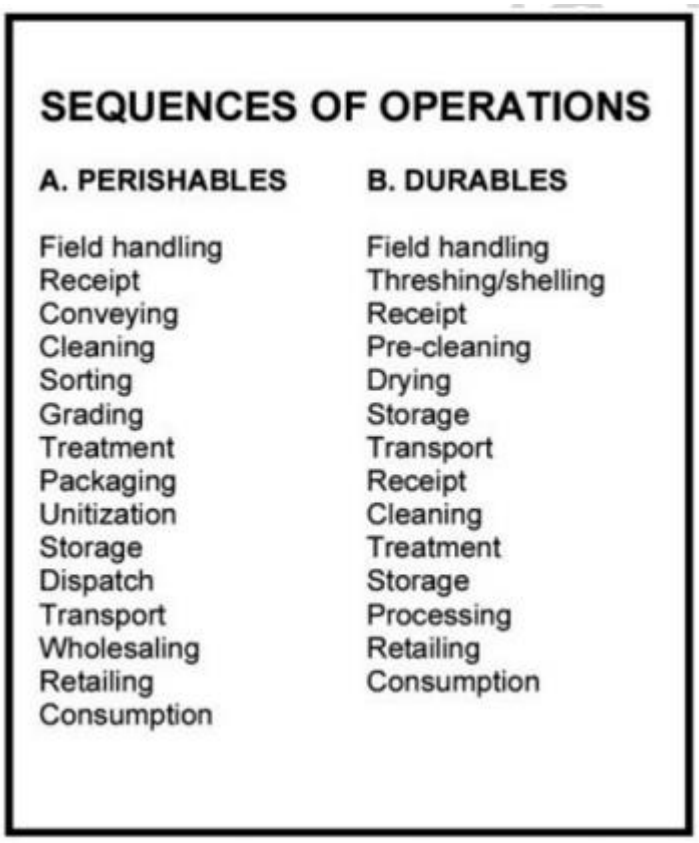
1.1. Introduction

Post harvest handling is the stage of crop production immediately following harvest, including cooling, cleaning, sorting and packing. The instant a crop is removed from the ground, or separated from its parent plant, it begins to deteriorate. Postharvest treatment largely determines final quality, whether a crop is sold for fresh consumption, or used as an ingredient in a processed food product. The most important goals of post-harvest handling are keeping the product cool, to avoid moisture loss and slow down undesirable chemical changes, and avoiding physical damage such as bruising, to delay spoilage.

Figure 1.1 maintaining qualities of crops makes profitable

Post-harvest operations tend to link to one another to form handling systems. The following discussion progresses through the handling system from immediately after harvest to the point of consumption or other use of produce (Table1.1)

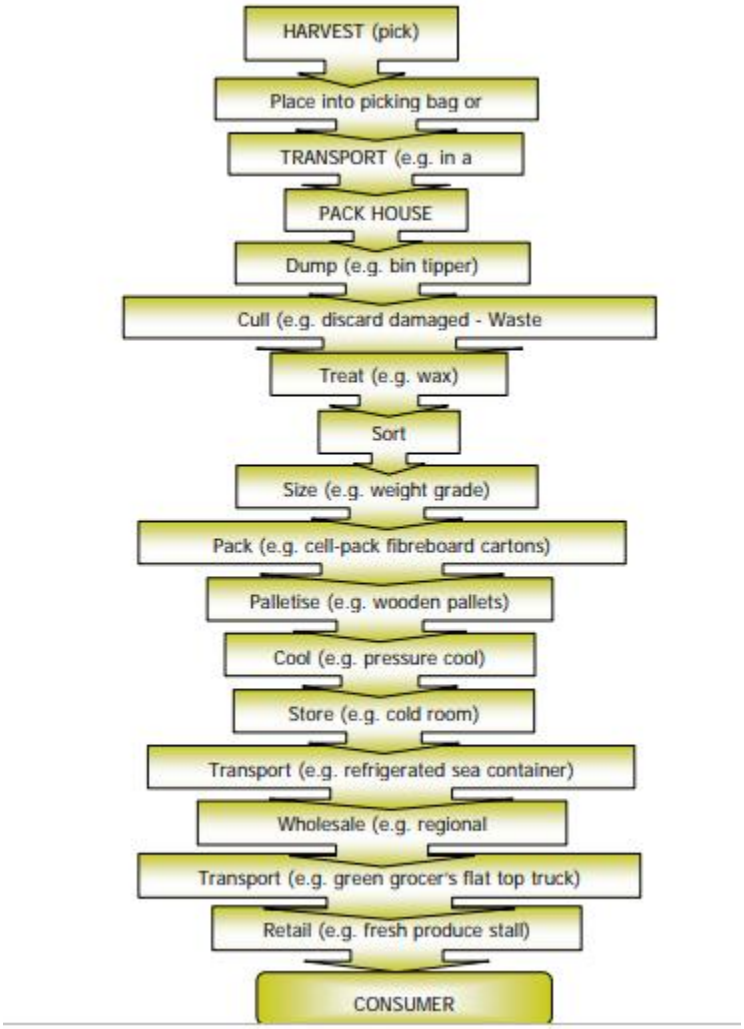
Table 1.1 Generalized post-harvest handling schemes for perishable and for durable crops.



SEQUENCES OF OPERATIONS

A. PERISHABLES	B. DURABLES
Field handling	Field handling
Receipt	Threshing/shelling
Conveying	Receipt
Cleaning	Pre-cleaning
Sorting	Drying
Grading	Storage
Treatment	Transport
Packaging	Receipt
Unitization	Cleaning
Storage	Treatment
Dispatch	Storage
Transport	Processing
Wholesaling	Retailing
Retailing	Consumption
Consumption	

Figure 1.2 Post harvest operations


HARVEST (pick)
Place into picking bag or
TRANSPORT (e.g. in a
PACK HOUSE
Dump (e.g. bin tipper)
Cull (e.g. discard damaged - Waste
Treat (e.g. wax)
Sort
Size (e.g. weight grade)
Pack (e.g. cell-pack fibreboard cartons)
Palletise (e.g. wooden pallets)
Cool (e.g. pressure cool)
Store (e.g. cold room)
Transport (e.g. refrigerated sea container)
Wholesale (e.g. regional
Transport (e.g. green grocer's flat top truck)
Retail (e.g. fresh produce stall)
CONSUMER

Post-harvest handling or management is the stage immediately following the harvest. It determines the final quality of product. Postharvest management of durables/field crops includes the following activities:

Post-harvest losses incurred by farmers are estimated at about 10%, cereal losses can be as high as 13% - 15%. These losses impact greatly on household food vulnerability and cash income (livelihood). In general, post-harvest losses can be minimized by proper post-harvest management practices. These losses can easily be explained using the food pipeline.

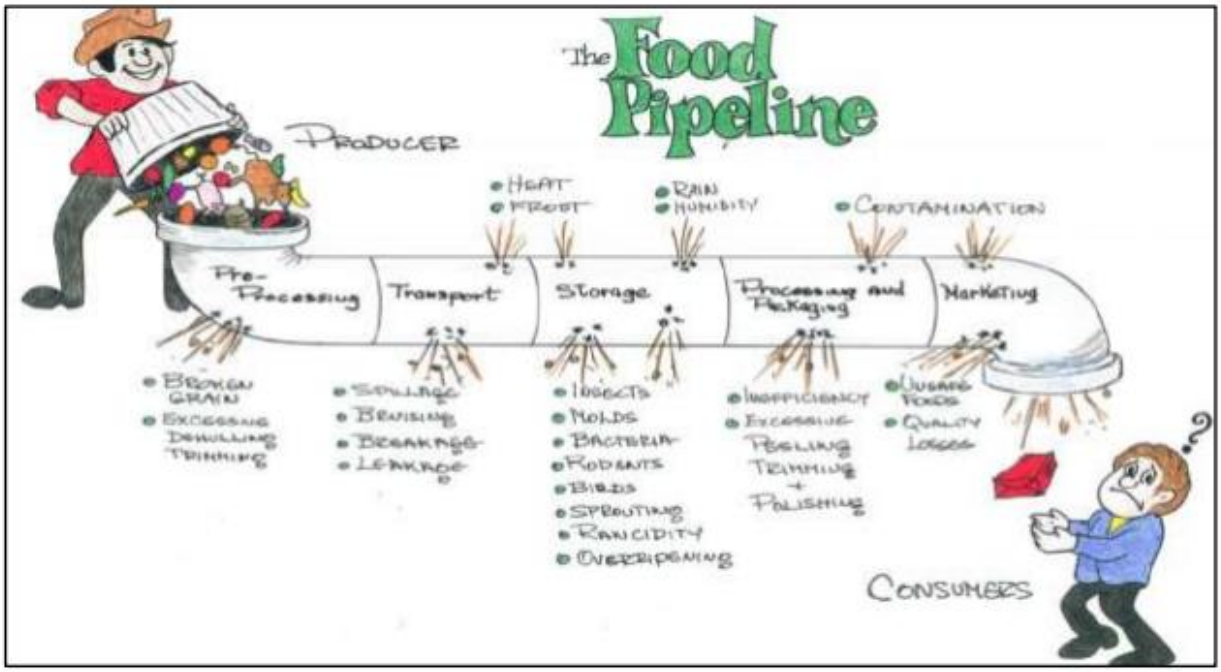


Figure 1-3 the food Pipeline (Source: Bourne, 1977, mimeo)

The identification of the different post harvest operations depends on the enterprise work procedures like: ssupervisors oral or written instructions, Post-harvest program or production schedule, marketing plan , enterprise sops, specifications, routine maintenance schedules, work notes; industry best practice guidelines on quality, food safety and hygiene; product labels and MSDS, manufacturers service specifications and operators manuals, waste disposal, recycling and re-use guidelines, and OHS procedures.

The marketing plan encompasses:

Quality of plant produce (and various grades) 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. Client preferences may also specify packaging materials, containers, filling techniques, labelling and storage requirements from field to client such as the cool chain concept.

Self-check – 1	**Written test**

Name…… ID…… Date…….
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short answer questions (10 points)

1. What is post harvest handling? (3pts)
2. What is the importance of post harvest handling? (2pts)
3. How can we minimize post harvest losses? (2pts)
4. Identify the post harvest operations for horticultural crops and durable crops(3pts)

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

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

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

2.1. Introduction

Having the right tools, materials and equipments, knowing how to use them and management decisions relating to their selection, choice of practice, market availability, and availability of storage facilities among others are essential factors which can affect operations and production profits in several ways. To maintain quality and efficiency, it is necessary to have comprehensive knowledge of tools, materials and equipments and implement performance.

Table 2.1.Tools, machines or equipments of processing horticultural crops

Tools, machines or equipments	Purposes/Uses
Autoclave	For sterilizing / heating the food.
Blenders	For mixing of the ingredients.
Blanchers	For blanching of fruits and vegetables to inactivate enzymes that cause deterioration in colour and flavour during drying and subsequent storage. Blanching may be carried out using water or steam.
Bottle filling machine	For filling the bottles automatically.
Bottle sterilizers	For sterilizing the bottles.
Bottle washing machine	For cleaning and washing of bottles. Bottle washers may be of bristle, hydro or soaker type or a combination of these.
Brew equipment / Fermentors	For brewing of beverages.
Butter churns	Use for butter production.
Butyrometers	For measuring the fat content in milk
Butter pats	Used to knead and form butter. It also removes excess moisture and produces a uniform texture.
Cabinet drier	For drying of food items.
Canning equipment	Aid in canning process which involves filling the food into can, fitting the lid and heating the can in a retort to sterilizer the food.
Cap sealing machine	For sealing the bottles
Can opener	For opening of cans
Carbonating equipment	Makes carbonated drinks using high-pressure carbon dioxide.
Centrifuges	Separation of substances like cream, honey and juices using the principle of centrifugal force.
Cheese moulds, presses and kits	For making cheese.
Chopper	For chopping fruits and vegetables.
Cleaners	To wash and clean fruits and vegetables, remove chaff and other impurities from grain.
Cooling tank	For cooling food materials
Crown corking machine	For sealing the bottles
Curd making equipment	For making and storing curds. Specially designed for curd to avoid whey corrosion.
Cutting, slicing and dicing equipment	For cutting, slicing and dicing various food products.
Deaerators	For removal of air present in fruit juices

Decorticators (shellers)	For decortications/shelling of maize, groundnuts, cashew nuts, peas, walnuts, cocoa, coffee, sunflower, etc.
Destoner	Separates grain mass
Dryers	For drying and dehydration.
Enrobers	Used to coat foods in chocolate, butter or other coating materials.
Evaporators	For evaporation of water.
Exhaust box	For removal of air in cans
Expellers	For expression of oil from oilseed sand nuts.
Extruding machines	Used for making extruded products such as snack foods from cereals.
Filling machines	Filling of liquid and solid materials into containers and pouches.
Fillers, sieves and strainers	Used for filtration, sieving and straining of oils, juices, powders/flours etc.
Flaking and splitting machine	For making rice flakes and dhal splits.
Formfill and seal machine	For packaging of the liquid and semi solid foods
Freezer	for freezing of food materials
Fryers	For frying.
Grating equipment	For grating various food materials.
Grills	For grilling of meat, fish and other products.
Heater and hotplates	For heating water and other items.
Homogenizers	To form a stable emulsion form two immiscible liquids.
Ice-cream making equipment	For ice-cream making.
Incubators	To hold food items at a preset temperature.
Jelmeter	For testing the pectin content in fruits/food.
Lactometers	For measuring the lactose content in milk
Kneaders	For mixing the ingredients.
Measuring cylinders/jugs	For measuring of raw and finished food products.
Mills and grinders	For grinding cereals, pulses, spices, sugar etc. Will also reduce liquid suspensions to a finer particle size.
Mincers	For grinding met for sausages and patties.
Mixers	For mixing various ingredients into a homogeneous mixture.
Moulds and baking units	Used in bakery production.

Ovens	For cooking, roasting and baking.
Packaging equipment	Packaging of different food materials.
Pans and kettles	For cooking, coating, etc. of food items.
Pasta machines	For making pasta foods.
Peeling equipment	Used for peeling and coring of fruits and vegetables.
Presses	For extraction of oil, juices, pulp, etc.
Pressure cookers	For cooking of food.
Puffing machines	For puffing grains like cereals and pulses.
Pulpers and juicers	Used for the extraction of pulp and juices especially fruits and vegetables.
Pulverizer	simple machine that grinds without stone.
Refractometer	For checking the TSS (Bx) in fruits and its product
Refrigerator	For cooling and preservation of food.
Roasting equipment	For roasting coffee, cocoa, cashew nut, peanut, soybean, etc.
Rolling equipment	To roll pastry and pasta. Papad is also made.
Salometer	For testing the salt content in food.
Sealing machine	For sealing the polyethylene bags.
Shrink film packaging machine	For packing the food materials.
Steam boiler	To produce steam with high temperature
Steam jacketed kettles	To concentrate the raw extracted pulp and for cooking of food items
Sorting equipment	Used for grading food items on the basis of size, density or shape, colour sorters are also available.
Spray drier	For drying the liquid food items
Squeezer	For squeezing the juice.
Threshers	For threshing grain and oilseed crops.
Thermometers	For checking the temperature during processing
Tin containers	For canning of food in containers.
Vacuum packaging machine	For packing the food materials under vacuum condition.
Water softener	For removal of hardness of water
Weighing machine	For weighing the food ingredients.
Wooden laddles	For stirring

2.2. TOOLS AND EQUIPMENTS USED IN THE PREPARATION OF BAKERY PRODUCTS

Tools, machines or equipments	Purposes/Uses
Weighing Machine	For weighing materials and finished products.
Baking Oven	For baking the food items
Flour Mixer	For mixing the batter or dough for cakes, breads, bun and pastries.
Dough Divider	For dividing the bread dough in the correct proportion and with equal weight.
Rounder	For handing up the out dough before putting it into moulder.
Cake mould	The batter or dough is put into the mould and baked
Bread Slicer	For slicing the bread to very thin slices.
Bread Packing or Wrapping Machine	Automatic packing machines are used for wrapping the bread or cake
Sealing machine	For sealing the polythene bags and other bags etc.
Cake Decoration Tools	For icing the cake and for other decoration

Post Harvest machineries for field crops

- ✓ Power thresher
- ✓ Winnowing machines
- ✓ Husk fired furnace dryer
- ✓ Agricultural waste fired
- ✓ Grader
- ✓ Polisher
- ✓ Conveyors
- ✓ Trailers
- ✓ Light trucks
- ✓ Forklifts

Materials

- ✓ Chemicals
- ✓ Gases
- ✓ Cleaning agents
- ✓ Packaging materials and containers
- ✓ Labels, adhesives and proformas.

Tools and equipment

- ✓ Snips, knives, gloves, brushes
- ✓ Silos
- ✓ gassing chambers, labelling devices, packing tools, scales, pallets
- ✓ Cool-rooms and dedicated storage facilities

Post harvesting equipment – need to be well maintained, cleaned and prepared

Self-check – 2	**Written test**

Name…… ID…… Date…….

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

Test I: Short answer questions (10 points)

1. What are the tools, materials and equipments used for post harvest handling of crops?

2. Why tools, materials and equipments are selected?

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

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 3- Carrying out Pre-operational and safety checks

“Food safety begins on the farm: A grower’s guide”

The typical causes and sources of food safety problems during production and postharvest handling fall into the following three major categories.

Physical Hazards: Examples of physical hazards which may become imbedded in produce during production handling or storage are such things as:

- fasteners (staples, nails, screws, bolts)
- pieces of glass
- wood splinters

Chemical Hazards: Examples of chemical hazards which may contaminate produce during production handling or storage are such things as:

- pesticides, fungicides, herbicides, rodentacides
- machine lubricants from forklifts or packing line equipment
- heavy metals (Lead, Mercury, Arsenic)
- industrial toxins
- compounds used to clean and sanitize equipment

Human Pathogens: There are four main types of human pathogens associated with fresh produce:

- soil associated pathogenic bacteria (*Clostridium botulinum*, *Listeria monocytogenes*)
- feces associated pathogenic bacteria (*Salmonella spp.*, *Shigella spp*., *E. coli* O157:H7 and others)
- pathogenic parasites (*Cryptosporidium, Cyclospora*)
- pathogenic viruses (Hepatitis, Enterovirus).

Many of these pathogens are spread via a human (or domestic animal) to food to human transmission route. Handling of fruits and vegetables by infected field-workers or consumers, cross contamination, use of contaminated irrigation water, use of inadequately composted manure or contact with contaminated soil are just a few of the ways that transmission of human pathogens to food can occur.

While produce quality can be judged by outward appearance on such criteria as color, turgidity and aroma; food safety can not. Casual inspection of produce cannot determine if it is in fact safe and wholesome to consume. Management of growing and postharvest handling conditions are paramount in preventing the contamination of fresh produce by physical hazards, harmful chemicals and human pathogens.

Food safety on the farm

Practices related to these four simple principles can reduce the risk that produce may become contaminated on the farm.

Clean soil

- Avoid the improper use of manure.
- Compost manure completely to kill pathogens, and incorporate it into soil at least two weeks prior to planting.
- Keep domestic and wild animals out of fields to reduce the risk of fecal contamination.
- Provide portable toilet facilities* near the field.
- Prevent run-off or drift from animal operations from entering produce fields.
- Do NOT harvest produce within 120 days of a manure application.

Clean water

- Test surface water that is used for irrigation for fecal pathogens on a regular basis, especially if water passes close to a sewage treatment or livestock area.
- Keep livestock away from the active recharge area for well-water that will be used for irrigation.

- Keep chemicals away from the active recharge area for well-water that will be used for irrigation.
- Filter or use settling ponds to improve water quality.
- Where feasible, use drip irrigation to reduce crop wetting and minimize risk.
- Use potable water for making up chemical pest management sprays.

Clean surfaces

- Tools and field containers must be kept clean. Wash and sanitize these items before each use.

Clean hands

- Workers who harvest produce must wash their hands after using the toilet.
- Provide soap, clean water and single-use towels in the field and insist that all workers wash their hands before handling produce.

Minimizing pathogen contamination during postharvest handling

- **Employee hygiene**

Gloves, hairnets and clean smocks are commonly worn by packinghouse employees in export oriented packing sheds. The cleanliness and personnel hygiene of employees handling produce at all stages of production and handling must be managed to minimize the risk of contamination. Adequate bathroom facilities and handwash stations must be provided and used properly to prevent contamination of produce by packinghouse employees. Shoe or boot cleaning stations may also be in place to reduce the amount of field dirt and contamination which enters the packing shed from field operations. Employee training regarding sanitary food handling practices should be done when an employee is hired and reviewed before they begin work each season.

- **Equipment**

Food contact surfaces on conveyor belts, dump tanks etc. should be cleaned and sanitized on a regular scheduled basis with food contact surface approved cleaning compounds. A 200 parts per million sodium hypochlorite (bleach) solution is an excellent example of a food contact surface sanitizer. Sanitizers should be used only after thorough cleaning with abrasion to remove organic materials such as dirt or plant materials. Use of steam to clean equipment should be avoided since steam may actually cake organic materials and form a biofilm, which renders equipment almost impossible to sanitize. Steam may also aerosolize bacteria into the air and actually spread contamination throughout the packing house facility.

- **Packaging materials**

All packaging materials should be made of food contact grade materials to assure that toxic compounds in the packaging materials do not leach out of the package and into the produce. Toxic chemical residues may be present in some packaging materials due to use of recycled base materials. Empty packages such as boxes and plastic bags should be stored in an enclosed storage area to protect them from insects, rodents, dust, dirt and other potential sources of contamination. These actions protect not only against the potential loss of valuable materials but protects the integrity and safety of these materials.

- **Wash and hydrocooling water**

All water which comes in contact with produce for washing or hydrocooling must be safe to drink. Water should contain between 100 and 150 parts per million total chlorine and have a pH of between 6 and 7.5. Chlorine use prevents the potential for cross contamination of all produce in the washing or hydrocooling system, **it will not sterilize the produce**. Change the water in dump tanks and hydro-coolers regularly.

The pre- and post-operation equipment inspection checklist

By taking the following steps each day pre- and post-operation, equipment owners and operators will prevent bad things from happening before they turn into costly downtime events, and will ensure that fleet managers can address concerns in equipment health and upkeep at times throughout the day with the least impact on productivity.

- Check tires, rims or undercarriage for damage or abnormal wear and clear away debris. Much like you or I don't operate at full capacity on a broken foot or while wearing shoes that are broken or don't fit, a machine can be hobbled by the inefficiencies of the tires or tracks it sits on. Identify and report any damage or potential damage.
- Check fluid levels – engine and hydraulic oil, diesel and diesel exhaust fluid (DEF), and coolant. Fluids are the lifeblood of each machine and require specified levels to operate properly. A sudden drop in fluid levels may point to any number of problems with the machine that require immediate attention (blown hoses, leaking filter, etc.).
- Clear any accumulated debris from around the radiator and other engine components. The engine is made of moving parts and belts that generate heat and friction – and systems designed to cool the engine compartment require room to breathe. It's important to check and remove any clutter or material from the jobsite that may have found its way into the engine compartment.
- Check the fuel, oil, air and other filters for signs of damage or leaking. Filters are often a quick and easy item to replace – and operating with properly working filters can prevent any number of problems with the machine.
- Check belts (alternator, fan, etc.). A worn and frayed belt is another wear item that is relatively easy to replace. If noticed before it fails, then the operator can communicate with the maintenance team to replace during scheduled downtime or the next PM to ensure it doesn't create unplanned downtime during the course of the work day.
- Identify greasing points and frequency. Every machine and every OEM is different – and keeping the machine properly greased is critical considering the power and friction created by these giant pieces of steel working together. It can

also help keep out moisture and abrasive materials from the jobsite that can work into joints and friction points if not properly greased.

- Check for leaking or pooled fluid around and under the machine. This is an easy indicator that something isn't right, and the source of that fluid should be identified and addressed/fixed before operation, and those fluids should be replaced.
- Check auxiliary hydraulic connections and pressure. Simply check the integrity of the coupling structure and that it hasn't been damaged. Newer equipment often includes pressure relieving quick disconnects – take the time to relieve the pressure when disconnecting attachments.
- Check for new signs of structural damage, scratches or dents on the machine. This is almost more important post-operation than it is pre-operation. Once done for the day, noticing and identifying any damage to the machine ensures that needed repairs are made before the next shift starts, and also allows the operator to identify how that damage occurred. Is there another structure on site that the machine came into contact with? Is there damage elsewhere on site that needs to be addressed? Similarly, if damage is noticed before a shift starts, and it was not there when the operator inspected it the day before, that pinpoints that something happened overnight or that there was possible unauthorized use of the machine.
- Check for damage on ground engaging tools (buckets, teeth, etc.). A machine's performance is affected greatly by the efficiency of how its working tools engage with the material it is digging into and moving. Worn or broken buckets and teeth lead to inefficient operation, greater fuel use, and greater wear and tear to the machine as a whole. Identifying and addressing these elements of the machine before they become problematic will make the operator more productive and efficient.
- Inspect the attachment mount-up to ensure proper connection. This includes checking that the coupler is flush and fully engaged (either via manual or automatic/hydraulic means), and that the hydraulic hoses (and electrical connections, if applicable) are properly connected.

- Inspect the operator compartment and clear away any debris or obstructions. Clutter can be distracting – and anything in the cab that ultimately prevents the full range of controls from being engaged is a hazard to operation.
- Check and set mirrors. This might seem obvious, but visibility is critical to jobsite awareness, safety and productivity. Having mirrors set to the operator's preference will make them a better operator.
- Familiarize yourself with the control style and change as needed. Most of today's machine's come with rather simple pattern selectors that allow the operator to use the control pattern that they are most familiar with. This will lead to greater productivity and greater operator satisfaction.
- Identify auxiliary/attachment controls. Each type and style of machine controls attachments differently – operators should identify how to properly work their attachment prior to attempting to use it.
- Start the engine and review console indicators and warnings. Today's machines are built to give the operator more feedback on the workings of internal systems than ever previously available. Take note of any flashing symbols or warning lights, check the owner's manual and consult with maintenance staff prior to operation.
- If equipped, check the rearview camera. Again – jobsite awareness and safety is paramount. If that rearview camera is otherwise obstructed or disabled, it handicaps the operator's ability to have full awareness of the worksite around him/her.
- Review all external surroundings from the cab. Know your work site, and the people and structures that exist inside your working envelope. This will ensure optimal jobsite safety and productivity.

Self-Check –3	**Written test**

Name…… ID…… Date…….

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

Test I: Short answer question (6 points)

1. How pathogen contamination during postharvest handling can be minimized?

2. What are the sources of food safety problems during production and postharvest handling operations?

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

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

Information Sheet 4- Identifying *OHS hazards* , assessing risks, implementing controls and reporting

The health and safety information here is designed to give students an understanding of the hazards, and the measures by which risks are controlled in the post harvest technology.

Electricity

Most post-harvest handling equipment utilizes some sort of electrical motor. Electrical outlets should provide adequate access without stringing electrical cords over long distances or through water. Outlets should be protected with a Ground-Fault Interrupter (GFI, or GFCI) switch, and be outfitted with a wet location in use cover to keep water from contacting outlets that have equipment plugged in. Most equipment runs on a 110-volt supply, although refrigeration and ice machines may require a 220-volt supply

Tractors

Tractors are used for many post harvest tasks, such as pulling chemical sprayers for fruit and vines. They are one of the main causes of workplace fatalities. The victims include operators falling from moving tractors or being crushed when a tractor rolls sideways or tips backwards. Frequently, accidents involve people being run over by tractors (often because they have fallen off while riding on the tractor).

Because tractors often work on soft or uneven ground, they must be fitted with roll-over protection. Many older tractors may not have this protection, which increases the risk for their operators.

Power take-off (PTO) shafts – which drive other machinery attached to the tractor – revolve at high speeds and must be securely guarded. They can easily entangle your clothing, hair or jewellery, causing serious injury or death. These shafts must be completely enclosed by a guard at all times while in operation.

You must never drive - or ride on - a tractor while undertaking work experience.

Agricultural bikes (ATVs)

Agricultural bikes are motorbikes with two, three or four wheels. Three and four wheelers are also known as 'all terrain vehicles' or ATVs. They are often used on fruit growing properties, sometimes in place of tractors, for jobs requiring that chemicals are applied in areas where tractors cannot be used.

They have a narrow wheel base and a high centre of gravity, so they can be unstable and have caused injuries and even fatalities.

Most agricultural bike injuries result from lack of training and experience, speed, uneven or unfamiliar ground, carrying a passenger or an unbalanced load, unsuitable protective clothing and unsafe driving.

Forklifts

Forklifts are used in post harvest to transport crates and other items, and to load vehicles. Operators must be licensed, and the weight of the load must always be within the forklift's load-carrying capacity.

Many forklift accidents involve pedestrians being struck by forklifts or their loads, so in areas where forklifts are used, care must be taken to keep pedestrian traffic at a safe distance from them.

Forklifts must never be used to elevate people unless fitted with a purpose-built work platform

Hazardous substances and dangerous goods

Hazardous substances (chemicals) are classified according to the harmful effects they can have on human health. These effects may be immediate (such as chemical spray drift causing stinging in the eyes) or long term (such as skin complaints like dermatitis arising from skin contact with chemicals).

Chemicals like weed killers and insect killers, widely used in the horticulture industry, are hazardous substances.

Dangerous goods are classified according to their potential immediate physical or chemical effects. These include explosion, fire, corrosion and poisoning. Petrol, liquid petroleum gas (LPG), aerosols and some fertilisers are all dangerous goods.

There are four ways in which chemicals can enter the body:

- absorption (through contact with the skin)
- contact with the eyes
- ingestion (swallowing), and
- inhalation (breathing in dusts, sprays, mists or vapours).

There are many different types of hazardous substances and dangerous goods used in the horticulture industry, including pesticides, herbicides and fuel for vehicles and equipment.

A Material Safety Data Sheet (MSDS) provides important information about the hazards of a specific chemical product. It also details emergency and first aid procedures in the event of someone being exposed to the chemical.

Your employer must make sure MSDS are available for every hazardous substance and dangerous good in the workplace. These must be easily accessible to all employees who may work with (or be exposed to) the chemicals involved.

Hazardous substances must be stored safely in a locked area with warning signs posted clearly outside. All chemical containers must be clearly labelled to prevent accidental misuse.

Handling chemicals safely

Employers must take steps to ensure that hazardous substances and dangerous goods do not place their employees – or members of the public – at risk. They must:

- keep a register of all hazardous substances and dangerous goods at the work site
- train employees in the safe use of chemicals, and ensuring that they are suitably qualified (e.g. by obtaining Chemical User's Certificates)
- provide personal protective clothing and equipment to protect employees when using chemicals
- provide well ventilated areas for pouring and mixing chemicals
- provide first aid facilities where chemicals are used (including eye wash bottles)
- provide adequate facilities for washing (including water, soap and towels)

Chemicals and the environment

Many of the chemicals used in horticulture can harm the environment if not used carefully. Employers must make sure:

- hazardous substances and dangerous goods do not get into waterways (for example, through drains
- spraying does not take place where wind can carry the spray drift to areas where people are working or livestock are grazing
- chemicals are not applied in excessive quantities
- chemical containers and unused chemicals are disposed of in the correct manner, where they will not have an adverse impact on the environment

Employers must provide information about hazard substances to their employees. This includes potential harmful effects, and action required in the event of a spill or of a person being exposed to a chemical.

UV radiation, heat and cold

In the horticulture industry, you may often have to work in the open, in hot or cold weather. Employees working outdoors are exposed to damaging ultra-violet (UV) radiation from the sun. Work in cold conditions also presents health risks.

Short-term risks of exposure to UV radiation include sunburn and sore, swollen eyes sensitive to bright light. Long-term risks include skin cancers, wrinkling, wasting skin tissues, excessive pigmentation, and clusters of tiny blood vessels and cataracts of the eye.

Your employer should assess whether the day's tasks could cause heat stress or heat stroke, and consider ways of eliminating or reducing the risks by considering factors like:

- the weather forecast: temperature, humidity and UV index
- personal protection that will be required – broad brimmed hats, sunscreen, fluids
- availability of shade near the work area
- how strenuous the work is likely to be, and how often employees will need to take breaks

Where possible, your employer should re-schedule heavier work for cooler times of the day (or wait for cooler weather), and arrange breaks where employees can rest in a shaded environment. Rotating jobs between workers is one way of reducing the time individuals have to spend in the sun.

Your employer should brief you in safe work procedures for working in the sun, including how often (and for how long) you should take rest breaks.

Heat stress

The effects of heat stress range from simple discomfort to life-threatening illnesses such as heat stroke. Signs of heat stress include tiredness, irritability, inattention and muscular cramps.

Heat stroke

Heat stroke is not common. A person suffering from heat stroke will stop sweating and body temperature will be high. Skin will be hot and dry. Confusion and loss of consciousness may occur.

Ways to reduce the risk

Your employer should make sure you are trained in ways to reduce the risk of sunburn, heat stress and heat stroke. Some of these are:

- drinking plenty of water
- taking rest breaks in a shaded place
- wearing cool, protective clothing such as a shirt with collar and long sleeves, and long trousers
- wearing a broad brimmed hat that shades your head, neck, face and ears
- applying SPF30+ sunscreen before exposure to sunlight as well as on overcast days – your nose, lips, ears, neck and backs of hands need extra protection

Protective clothing provided by your employer MUST be worn when protection from UV radiation is needed. Sunscreen must be re-applied regularly while you are in the sun.

Cold and wet-weather conditions

In the horticulture industry, you may have to work where there is little or no protection from cold or wet-weather conditions. For employees working outdoors, there is a risk of hypothermia from prolonged exposure to cold and wet weather conditions.

Appropriate protective clothing and footwear must be worn to protect you from extreme cold and wet-weather conditions.

As with work in hot conditions, it may be necessary to re-schedule the work if cold, wind and rain are likely to place individuals at risk of illness.

Confined spaces

A 'confined space' is an area that presents dangers to anyone entering, because of:

- low oxygen levels
- presence of dangerous contaminants (such as carbon monoxide)
- intense heat or cold
- difficulty in exiting the space (or in entering the space for another person attempting first aid or rescue)

Confined spaces can present risk of collapse if someone is overcome by gases, fumes or vapours within, or if there is insufficient oxygen. This also creates serious risk for any person attempting to come to the assistance of someone in a confined space. For this reason, many confined space fatalities are double fatalities.

If a confined space contains flammable gases or vapours, there is also the risk of fire or explosion. Welding in a confined space can generate a dangerous atmosphere.

Horticultural properties contain a number of areas that may be considered confined spaces. These include:

- water tanks
- chemical spray vats
- mixing tanks
- irrigation header boxes
- pipes, culverts and deep trenches
- disused refrigerators

It is an employer's responsibility to know where in their workplace confined spaces may be found, and to ensure that all employees have been informed of their location and the potential risks of entry. Where possible, entry to confined spaces should be prevented by locks and warning signs.

Your employer should point out any prohibited areas to you. Potential confined spaces should be identified by warning signs to alert people to the hazard.

Biological hazards

Handling potting and seed-raising mixes may cause irritations or respiratory problems, especially if you have allergies or are susceptible. Employees should wear gloves and an industrial dust mask when handling soil and potting mix.

Legionella longbeachae occurs naturally in soil and compost, and has been detected in commercial potting mixes. Their have also been reported cases of the disease being contracted after high pressure hoses were used on recently laid potting mix.

However, it's a sound practice to moisten potting mix before using it, to suppress dust. Users should avoid inhaling the dust, particularly when the bag is being opened or when shaking the mix to loosen it up. You should always wash your hands after using potting mix, soils or compost.

If you are working with potting mixes, fertilisers and soils, you should be provided with gloves and (if there is a possibility of inhaling dusts) a disposable mask.

Self-Check –4	**Written test**

Name…… ID…… Date…….

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

Test I: Short answer questions (10 points)

1. What are the OHS hazards in post harvest operations? (5pts)
2. How these hazards can be controlled? (5pts)

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

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 5- Selecting, using and maintaining suitable *safety* and *PPE*

Introduction

Personal protective equipment (PPE) refers to any specialized equipment or clothing worn by farmers and ranchers for protection against health and safety hazards. PPE is designed to protect many parts of the body; eyes, head, face, hands, feet, ears, or torso. PPE does not prevent accidents, but it does prevent or reduce injury and even fatalities when used. PPE not only helps protect people but also improves productivity. Farmers and ranchers can benefit from using the appropriate protective equipment for themselves, family members, and workers when the job and its potential hazards call for it. Protective equipment must be carefully selected. Test fit the protective equipment to be sure of a proper and comfortable fit. If it isn't comfortable - it won't be worn; if it isn't worn - it won't protect.

Definitions of equipment protection

Eye and face protection - to provide protection during exposure to hazards like flying particles, metal or sparks, liquid chemicals, caustic liquids, light radiation,

Figure 5.1. Eye glasses

Figure 5.2. Face shield

Hearing protection - to provide protection during exposure to high pitch and loud noise levels.

Figure 5.3. Formable earplugs

Figure 5.4 Pre-molded earplugs

Respiratory protection - to provide protection from inhalation hazards such as vapors, mists, particulates, pesticides, and gases.

Figure 5.5. Air purifying disposable particulate masks with exhalation valve

Figure 5.6.Chemical cartridge respirators

Hand protection - to provide protection during exposure to potential hazards such as sharp objects, abrasive surfaces, temperature extremes, and chemical contact.

Figure 5.7 Padded cloth gloves

Figure 5.8 Metal mesh gloves

Head protection -to provide protection to potential hazards such as falling objects, striking against low-hanging objects, electrical hazards, or chemical application.

Figure 5.9 Head hat

Foot protection - to provide protection for situations with the potential of injuries such as falling or rolling objects, chemical or liquid exposures, piercing objects, and where feet are exposed to electrical hazards

Figure 5.10 Steel toe footwear

Figure 5.11 Latex/rubber footwear

Clothing protection - to provide protection from potential hazards such as entanglement, skin cancer, bodily injury, and pesticide contamination

Figure 5.12 Apron

Figure 5.13 Sun protective clothing

PPEs must be cleaned after every working day and allowed to dry before use. The management shall provide the required cleaning detergents. The spray supervisor shall inspect all PPEs after they are washed and certify they are clean. There must be water/ showers on every farm to deal with operator contamination.

PPE storage

PPE must be kept in a secure locker or room with good ventilation, separated from other materials and equipment. There shall also be available during all applications a secure locker or room for the storage of the operator's personal clothes and new protective clothing separate from other materials and equipment. PPE must be stored separately from crop protection products.

Self-Check –5	**Written test**

Name…… ID…… Date…….

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

Test I: Short answer questions (10 points)

1. What are the PPE used in post harvest operations? (5pts)
2. What is the importance of wearing suitable PPE? (5pts)

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

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Operation Sheet 1-perform pre-operational safety checks

Purpose: - to practice proper functionality of post harvest machineries

- to maintain the quality of harvested produce

Materials: post harvest equipment/machinery found in your college or locality

Procedure: Select one post harvest machinery and perform pre-operational safety checks

LAP TEST	**Performance Test**

Name_____ ID…….Date……

Time started: _____ **Time finished:** _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 3 days. The project is expected from each student to do it.

Task-1 perform preoperational checks

LG # 87	LO #2- Co-ordinate post-harvest work

Instruction sheet-2

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

- Identifying and co-ordinating work team and tasks
- Undertaking post-harvest operations
- Maintaining a clean, safe and hygienic work area

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, **you will be able to**:

- Identify and co-ordinate work team and tasks
- Undertake post-harvest operations
- Maintain a clean, safe and hygienic work area

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”

Information Sheet 1- Identify and co-ordinate work team and tasks

Prior to the harvest it is important that farmers should prepare for their postharvest activities. They must ensure that:

The equipment needed for their harvest and postharvest activities is available and in good repair

They have decided where important activities will take place (allocating drying and threshing areas)

There will be sufficient storage space for the crop

Grain stores and sacks have been thoroughly cleaned before the new harvest arrives so that the residues of the old harvest (last season's crop) are removed from all cracks and crevices and either burnt or fed to animals (alternatively, they can be stored in a separate place and consumed quickly.

Good hygiene is a very important activity to prevent postharvest losses, the new harvest should never be placed on, or with, grain from the previous season as this will encourage the movement of pests from the old to the new.

Sacks and stores need cleaning, good hygiene is an essential part of grain quality management

Figure 1.1 Sacks and stores cleaning(good hygiene is an essential part of grain quality management)

Self-Check –1	**Written test**

Name…… ID…… Date…….

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

Test I: Short answer question (6 points)

1. Briefly explain the tasks that should be identified in post harvest operations

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

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

Information Sheet 2- undertaking post harvest operations

Objective of post harvest operations

The primary objective of post-harvest operations is to maintain product quality as high as possible and for as long as necessary. Cooling and low temperature storage and handling is probably the single most important post-harvest process affecting quality maintenance of perishable produce. With respect to durable produce, crop drying and dry storage can be considered the most important process. These operations are primarily directed at minimizing the rate of metabolism of harvested produce. Measures taken to control post-harvest pests and diseases are also of profound importance. Postharvest operations generally cannot improve quality.

However, some operations, such as waxing of apples to enhance surface gloss, might be considered exceptions to this rule.

Figure 2.1.some post harvest operations of crops

2.1. Post harvest operations of durable/field crops

- **Threshing or shelling**

Grains are separated from the husk and plant to which they are attached. The process may be performed manually or mechanically using threshers, shellers or combine harvesters. When done mechanically, additional losses may occur due to grain damage during processing. However, this does not necessarily imply that losses are always lower when threshing or shelling is done manually, as mechanical threshers may reduce losses due to spillage.

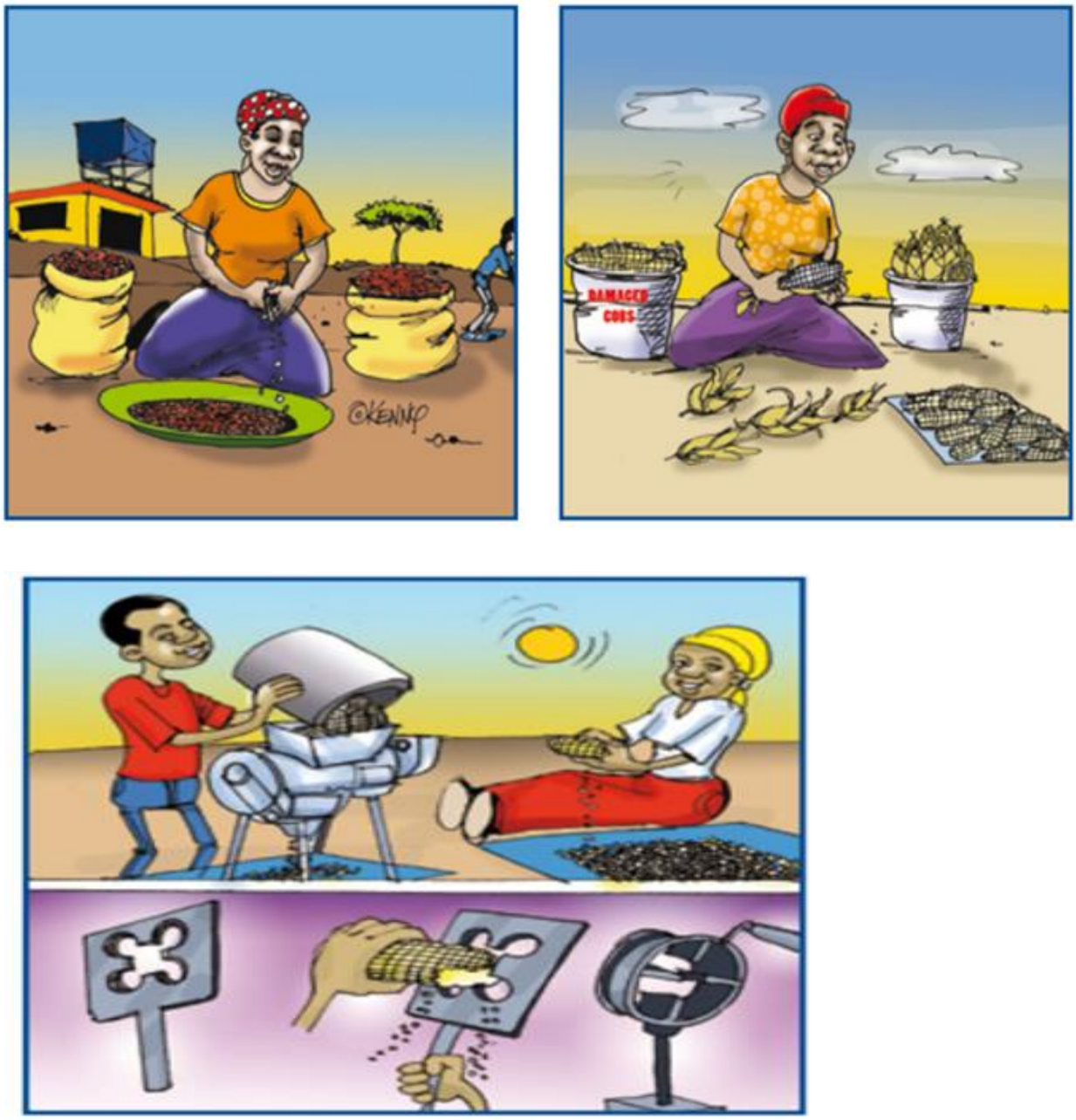


Figure 2.2.Treshing of maize

- **Cleaning or winnowing**

The process consists of cleaning the grain by blowing the chaff away from it. In doing so, losses occur because a certain amount of the edible grain passes into chaff. The cleaning operation may be done manually or mechanically (the winnower may be hand- or machine-operated). Contrary to the case of manual processes, the use of combine

harvesters allows harvesting, threshing and winnowing to be performed in one single operation: in this situation, losses cannot be attributed to each activity.

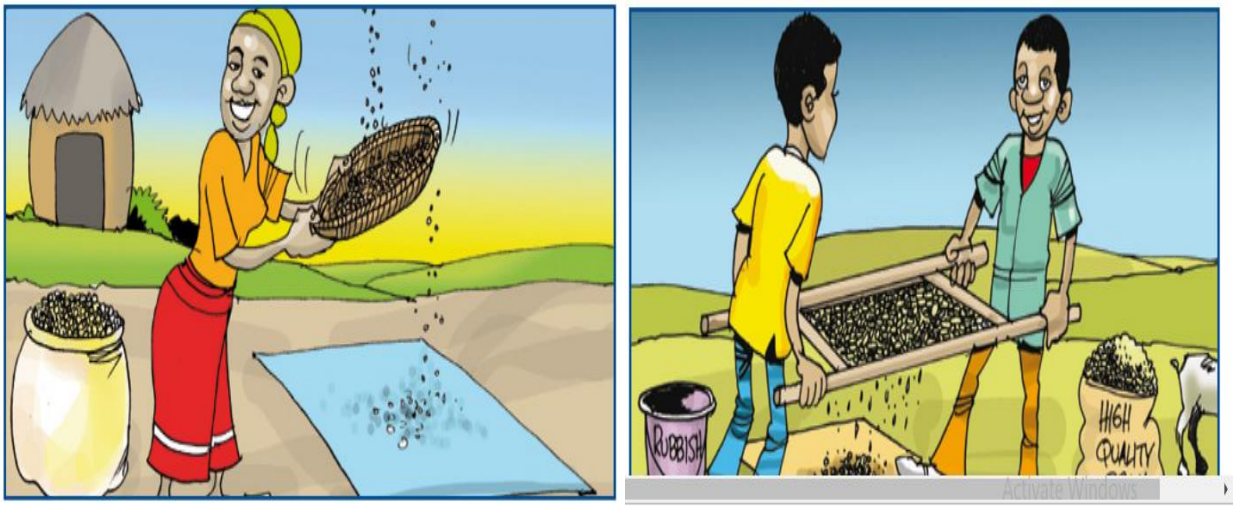


Figure 2.3 Winnowing of grains

- **Drying**

Drying is often necessary to bring the moisture content of the grain to the recommended level for storage, selling or consumption. The causes of losses at the drying stage are similar to those arising during storage: damages and losses caused by pest infestation, rodents, birds, etc., especially if the grain is dried in the open air (yard, road, etc.), a common practice in developing countries for crops such as paddy, pearl millet or sorghum. Insufficient drying may also lead to fungal damage to grain during storage.

Figure 2.4.Drying of grain

- **Storage**

Grain can be stored by different actors, from the farmer to the wholesaler, using a variety of facilities and equipment, ranging from traditional granaries to metallic silos and sophisticated storage facilities with controlled temperature and humidity levels. The deterioration of stored produce, leading to weight or quality reduction, is principally caused by pest infestation, rodents, birds, etc., as well as by attacks by microorganisms (fungi, bacteria, and yeasts) and metabolic activity. Storage losses generally increase with storage time.

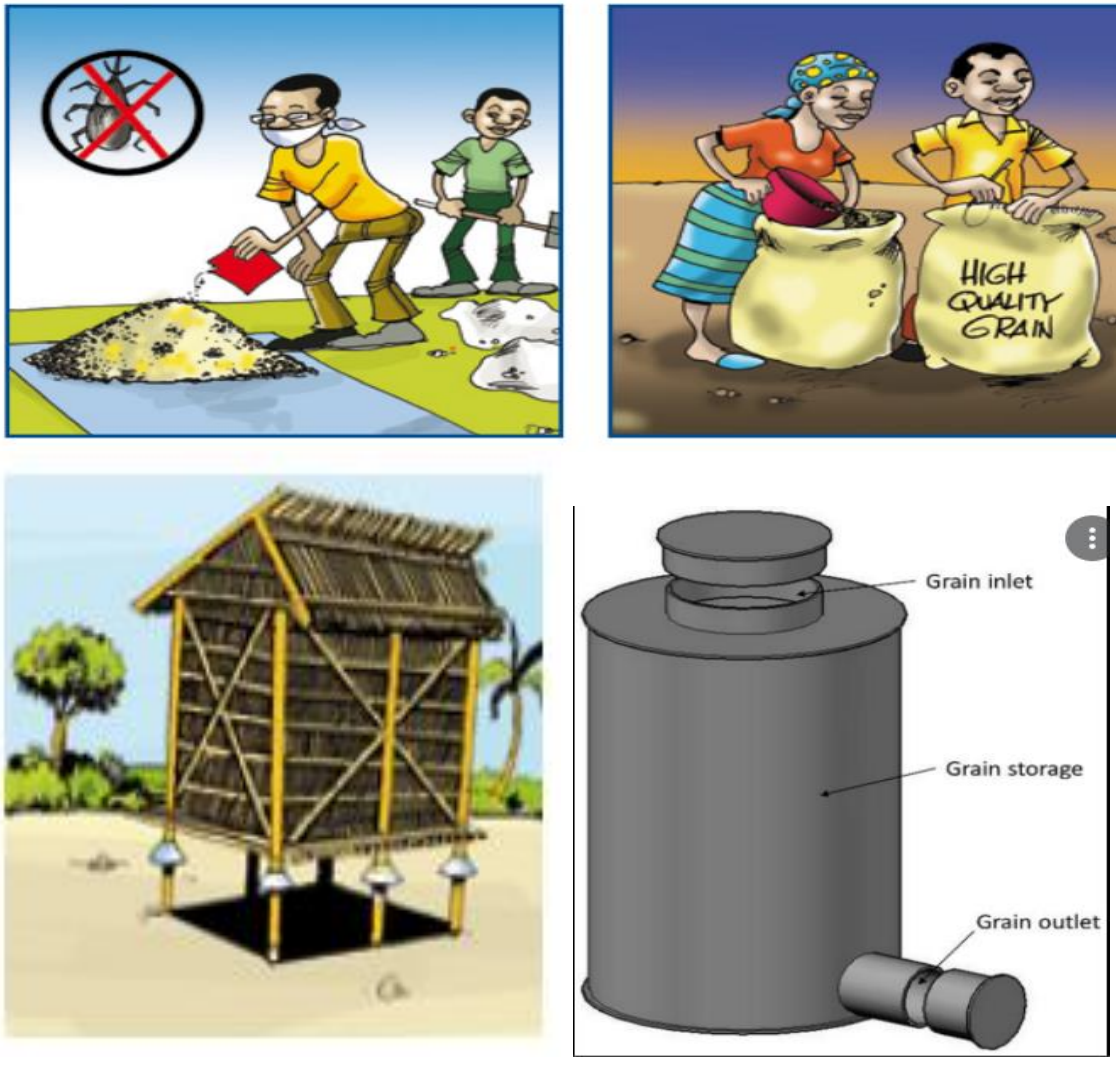


Figure 2.5.Treating the grain before storage and putting in the sack store

- ✓ **Chilli storage**

Chillies stored in amber coloured polythene bags were found to retain colour for longer period of storage. Mechanically dried chillies showed higher colour value in chillies during storage than that open yard sun dried produce.

- ✓ **Safe storages of pulses**

Pulses can be safely stored in nylon bags, polythene lined gunny bags for up to 6 months provided the grain is properly dried before storage. Mixing of 250g of edible oil per quintal of pulses is beneficial in safe storage.

- **Processing**

Food grains are subjected to different types of processing before reaching the market and being finally consumed. For instance, paddy rice is generally de-husked or dehulled to obtain brown rice, manually by hand pounding or, more commonly, by machines such as rice hullers. When processing paddy, additional operations such as pre-cleaning, de-stoning, parboiling (pre-milling treatment), polishing and glazing may also be required. During these operations, losses are essentially due to damage to the grain, certain grain kernels resulting broken, and to spillage.

- **Packaging, handling and distribution**

Improper packaging of produce may facilitate pest infestation or the appearance of moulds and fungi leading to grain damage, weight loss, or rejection because of spoilage, especially if the produce is stored or transported for long periods. Improper handling may lead to grain damage and spillage, resulting in weight as well as quality losses. These losses may arise at different phases, for example during transport from farm to storage and from storage to market, at different points of marketing channels, and at the wholesale and retail levels.

- **Transport**

During post-harvest operations, transport is involved on several occasions: harvested crop may need to be moved from the field to the threshing floor, and from there to the farm storage area, and finally from the storage area to the processing facilities and collecting markets. From those markets, crops may be transported by retailers to their shops or transported by wholesalers over long distances to distant or foreign markets by train, trucks, ships, etc. During these operations, which require multiple loading and unloading, spillage or pilferage entrain losses. In addition, transit losses may also occur because of damage to grain in trains, trucks, or ships caused by time-bound deterioration. In long-distance transport, grain may also be attacked by insects, fungi and other pests, similarly to what usually happens during normal storage

Figure 2.6. Ways to move the newly harvested crop from the field to the homestead

2.2. Post harvest handling operations of horticultural crops

- **Dumping**: The first step of handling is known as dumping. It should be done gently either using water or dry dumping. Wet dumping can be done by immersing the produce in water. It reduces mechanical injury, bruising, abrasions on the fruits, since water is gentle on produce. The dry dumping is done by soft brushes fitted on the sloped ramp or moving conveyor belts. It will help in removing dust and dirt on the fruits.

- **Pre-sorting**: It is done to remove injured, decayed, mis-shapen fruits. It will save energy and money because culls will not be handled, cooled, packed or transported. Removing decaying fruits are especially important, because these will limit the spread of infection to other healthy fruits during handling.

- **Washing and cleaning**: Washing with chlorine solution (100-150 ppm) can also be used to control innoculum build up during pack house operations. For best results, the pH of wash solution should be 6.5-7.5. Mangoes, bananas should be washed to remove latex.

- **Waxing**: the application of wax or similar coating to enhance appearance and limit water losses from produce such as citrus requires specialized equipment and has little relevance to small-scale packing. Waxing is normally preceded by fungicide treatment.

- **Curing**: the only post-harvest treatment required for the long storage of bulb onions is a thorough curing of the bulbs. Curing is a drying process intended to dry off the

necks and outer scale leaves of the bulbs to prevent the loss of moisture and the attack by decay during storage. It can be carried out in the field under dry conditions by windrowing the bulbs. The essentials for curing are heat and good ventilation, preferably with low humidity. This dries out the neck and the two or three outer layers of the bulb

- Fungicide treatment

Decay caused by molds or bacteria is one of the major causes of loss of fresh produce during storage and marketing. Infection may occur before or after harvest, either through injuries or direct penetration of the intact skin of the produce. Post harvest application of fungicide is usual in crops such as apples, bananas and citrus fruits which have to be stored for a long period or those which undergo long periods of transport. Fungicide is normally applied only after the produce has been washed and drained. In small-scale packinghouse operations, fungicide can be applied by:

- ✓ Dipping: treatment is normally carried out by hand operation using a suspension of fungicide agitated using stick .Wire-mesh baskets are used to dip the fruits. After dipping produce should be drained and dried.
- ✓ Spraying. This can be done using a hand-operated sprayer while the produce is still in trays or racks after washing and drying. It is often done on bananas following the de-handing of bunches.

- **Grading**: Grading can be done manually or by automatic grading lines. Size grading can be done subjectively with the use of standard size gauges. Round produce units can be easily graded by using sizing rings. The grading of fruits plays an important role in domestic and export marketing of fruits. Different fruits have different grades on the basis of their size and weight. The grades of some fruits and vegetables suggested by Directorate of Marketing and Inspection (DMI) are as under.

Table 2.1 Grading of fruits and vegetables

Grapes

Grade	Large berries bunch weight (g)	Small berries bunch weight (g)
Extra class	200	150
Class I	150	100
Class II	100	75

Guava

Size code	Weight (gm)	Diameter (mm)
A	>350	>95
B	251-350	86-95
C	201-250	76-85
D	151-200	66-75
E	101-150	54-65
F	61-100	43-53

Pomegranate

Grade	Fruit weight (g)	Diameter (mm)
A	400	90
B	350	80
C	300	70
D	250	60
E	200	50

Tomato

Size Code	Diameter (in mm)	
	Minimum	Maximum
1	30	34
2	35	39
3	40	46
4	47	56
5	57	66
6	67	81
7	82	101
8	102	above

- Pre-cooling of horticulture produce

Pre-cooling of the produce soon after their harvest is one of the important components of the cool chain, which ultimately affect the shelf life of the produce. The main purpose of precooling is to immediately remove the field heat from the produce.

- ✓ Room cooling: It is low cost and slow method of cooling. In this method, produce is simply loaded into a cool room and cool air is allowed to circulate among the cartons, sacks, bins or bulk load.
- ✓ Forced-air cooling: Forced air-cooling is mostly used for wide range of horticultural produce. This is the fastest method of pre-cooling. Forced air-cooling pulls or pushes air through the vents/holes in storage containers. In this method uniform cooling of the produce can be achieved if the stacks of pallet bins are properly aligned.
  - ❖ Cooling time depends on
  - (i) the airflow
  - (ii) the temperature difference between the produce and the cold air and
  - (iii) produce diameter.
- ✓ Hydrocooling: The use of cold water is an old and effective cooling method used for quickly cooling a wide range of fruits and vegetables before packaging. For

the packed commodities it is less used because of difficulty in the movement of water through the containers and because of high cost involved in water tolerant containers. This method of cooling not only avoids water loss but may even add water to the commodity.

The hydrocooler normally used are of two types i.e., shower type and immersion type.

- ✓ Vacuum cooling: Vacuum cooling take place by water evaporation from the product at very low air pressure. In this method, air is pumped out from a larger steel chamber in which the produce is loaded for pre-cooling. Removal of air results in the reduction of pressure of the atmosphere around the produce, which further lowers, the boiling temperature of its water. As the pressure falls, the water boils quickly removing the heat from the produce. Vacuum cooling causes about 1 per cent produce weight loss (mostly water) for each 6oC of cooling.

- ✓ Package-icing: In some commodities, crushed or flaked ice is packed along with produce for fast cooling. However, as the ice comes in contact with the produce, it melts, and the cooling rate slows considerably. The ice keeps a high relative humidity around the product. Package ice may be finely crushed ice, flake ice or slurry of ice. Liquid icing distributes the ice throughout the container, achieving better contact with the product. Packaged icing can be used only with water tolerant, non-chilling sensitive products and with water tolerant packages (waxed fiberboard, plastic or wood).

- **Packaging of horticulture produce**

  Packing is a coordinated system of preparing goods for transport, distribution, storage, retailing and end use and a means of ensuring safe delivery to the ultimate consumer in sound conditions at minimum cost.

Packaging helps in:

- ✓ Safe transportation
- ✓ Storages
- ✓ Marketing and
- ✓ Distribution of produce.

It protects the produce from pilferage, microorganisms and adverse weather condition and it is also used to advertise the product.

Requirements of a good package

- ❖ Should be environment friendly.
- ❖ Should have sufficient strength in compression and against impact and vibrations
- ❖ Should be stable during the entire distribution chain.
- ❖ Should be compatible with the automatic packing/filling, handling machines (mechanical filling systems)
- ❖ Should facilitate special treatments like pre-cooling.
- ❖ Should have consumer appeal.
- ❖ Should be easily printable.
- ❖ Should be cost effective.

Materials for packaging

- ✓ Wood - boxes, bins, trays, barrels, pallets
- ✓ Jute/canvas - sacks
- ✓ Paper and card board - liners, boxes, trays
- ✓ Plastic- Rigid - crates, pallets, trays
  - ❖ Flexible - films (single & multi layered)
  - ❖ Polystyrene boxes / trays and plastic

- **Storage of fruits and vegetables `**

The management of temperature and relative humidity are the most important factors determining storage life of horticultural produce. The natural means like ice, cold water, night temperature have been used for long time for protecting food materials from spoilage and these are still common. However, with the development of innovative technologies, it is possible to achieve optimal environments in the insulated stores.

Objective of storage

- ✓ Regulate the market in an orderly manner.
- ✓ Avoid glut and distress sale in the market, thus prolonging the market period.
- ✓ In long-term storage, making the food available in off-season.

Cold storage: Lowering the temperature to the lowest safe handling temperature is of paramount importance for enhancing the shelf life, reducing the losses and maintaining higher quality during marketing. Always, handle produce gently and never store produce unless, it is of the best quality. Damaged produce will lose water faster and have higher decay rates in storage when compared to undamaged produce.

- ✓ **Processing of horticultural crops**

When conditions are not suitable for storage or immediate marketing of fresh produce, many horticultural crops can be processed using simple technologies. There are many processing methods that can be used by small-scale handlers, including drying, fermenting, canning, freezing, preserving and juicing. Fruits, vegetables and flowers can all be dried and stored for use or sale in the future. Fermentation is popular throughout the world as a food preservation method .Fruits and vegetables can be canned or frozen, and fruits are often preserved in sugar or juiced.

Processed products must be packaged and stored properly in order to achieve their potential shelf life of up to one year. Dried products must be packaged in air-tight containers (glass or plastic bottles or sealed plastic bags). Canned and bottled products

must be adequately heat processed using high quality containers that provide good seals. Dried and canned or bottled products are best stored in a cool, dark place.

Postharvest handling, transport and marketing of processed products can be much simpler and less costly than for fresh products, since refrigeration is unnecessary. Dried products take up much less space than their fresh equivalents, further reducing transport and storage costs.

Table 2.1.Drying weight advantage of fruits and vegetables

25 pounds of:	Yields this much dried product:
Fruits	4 lb
Carrots or beets	3 lb
Celery, cabbage or tomatoes	1.5 lb
Onions or zucchini	2.5 lb

Preparation for processing

Some produce requires blanching before freezing or drying. blanching by boiling water bath or in steam ends certain enzymatic reactions in the product and helps retain color and flavor after processing. Always rinse blanched produce under very cold water or dip blanched produce into an ice water bath to stop the cooking process and quickly bring the temperature down.

Blanching times for selected commodities {use one gallon of water per pound (8 liters per kg) of produce}. Add one minute for each 2000 ft altitude if you live at elevations over 4000 ft.

Table 2.2. Blanching time of vegetables

Commodity	Blanching time in boiling water (minutes)
Broccoli	3
Green Beans	3
Cabbage (wedges)	5
Carrots	5
Cauliflower	3 (add 4 teaspoons of salt)
Collard greens	3
Corn (sweet)	7
Eggplant -	4 (add 1/2 cup lemon juice)
Leafy greens	2
Mushrooms	3 to 5
Peas	2
Potatoes (new)	4 to 10
Pumpkin	2 to 3 or until soft
Sweet potatoes	15 to 20 or until soft
Zucchini/summer squash	3

Fruits such as apples, pears, peaches and apricots are sometimes treated with sulfur being dried. Sulfuring {burn one tablespoon of sulfur powder per pound (12g per kg) of fruit} or sulphiting (dip fruit in a 1% potassium metabisulfite solution for one minute) helps prevent darkening, loss of flavor and loss of vitamin C.

Sulfur has been a source of allergic reactions in some people, so packages of sulfured product should always be clearly labeled. Vitamin C can be used as an alternative pre-treatment to prevent browning during the drying process. Use 30 ml ascorbic acid powder in one liter (or 2 tablespoons in one quart) of lukewarm water. Slice the fruits directly into the solution, remove with slotted spoon, drain well and pat dry.

For best results when drying fresh produce, fruits should be sliced or quartered, and vegetables should be thinly sliced, chopped or diced. Solar drying of fruits will take 2 to 3 days or longer, while most chopped or diced vegetables will dry in 1 to 2 days.

Table 2.3. Sulfuring times for selected fruits

Commodity	Sulfuring Time for Quartered Fruits
Apples	45 minutes
Apricots	2 hours
Cherries	20 minutes
Nectarines	2 hours
Peaches	2 hours
Pears	2 hours

A low cost sulfuring box can be constructed from a large cardboard box that is slashed in several places to allow adequate ventilation. Trays for drying be stacked using bricks and wooden spools as spacers. The trays must be made completely of wood, since sulfur fumes will corrode metal The entire assembly must be located out of doors, preferably on bare soil. Use one tablespoon of sulfur powder per pound (35 mls per kg) of fruit. Place the sulfur in a container well away from the side of the box since it will become quite hot. Seal the bottom edges of the box with soil.

Drying flowers

Cut flowers can be air dried by hanging upside down or while supported by chicken wire. Certain flowers will look more natural if left standing in a vase while they dry. Anthurium dries best if left to dry very slowly. Cut the stems at a sharp angle, and place the flowers into a vase containing two inches of water. In all cases, flowers should be left to air dry in a dark, well area.

Flowers that dry best if left standing: strawflower, delphinium, larkspur, okra pods

Flowers that dry best while hanging upside down: chysanthemum, amaranthus, African daisy, statice, marigold

Cut flowers can be dried quickly and easily in sand or silica gel. Sand used for drying flowers should be clean, smooth and the finer the better. Starting with one inch of sand in a container, place the flower to be dried on the sand and gently cover the entire flower with more sand. The container should be left uncovered and flowers should be dried in about three weeks. Flowers that dry well in sand are shasta daisy, lily-of-the-valley, cosmos, dahlia, sweet william carnation, stock, freesia and narcissus.

Silica gel is relatively expensive but reusable if heated to dry out the gel between uses. To use, cover the flower as with sand, then tightly seal the container. Check for drying in two to three days. Silica gel is especially useful for drying fragile plants and flowers with delicate colors.

Flowers that dry best in silica gel are allium, anemone, cornflower, roses, tulip and zinnia.

- ✓ **Post-harvest handling practice of banana fruit**

Good post-harvest handling practice is important in maintaining the quality and assuring the safety of the banana fruit as it moves through the supply chain from producer to consumer. Over-ripening, and mechanical damage caused by bruising and compression are the main causes of losses in banana supply chains

Figure 2.7.Quality loss in bananas due to poor post-harvest handling practice

Figure 2.8 Bananas of good quality desired by consumers

Characteristics of bananas that affect their post-harvest life

- The banana is a living entity. Even after harvest, it is still alive hence it is subject to continued change until it completely deteriorates. A number of changes take place inside the fruit that influence its appearance, flavor, texture and nutritive value, and that cause it to age (Figure 2.9) and subsequently to rot and decay. While some changes are desirable (e.g. changes associated with ripening such as sweetness), many bring about quality deterioration. These post-harvest changes cannot be stopped but can be slowed down within certain limits through the application of good post-harvest management practice.

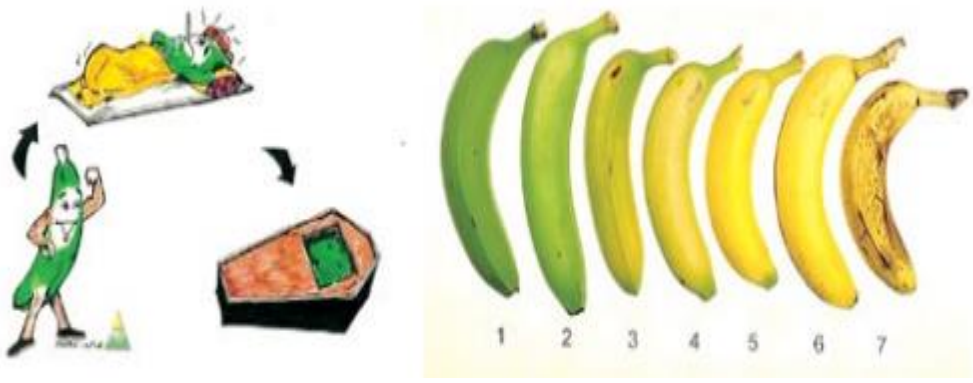


Figure 2.9 Bananas progress through various changes after harvest

- Bananas lose water

Bananas are of a high water content. When harvested, bananas can no longer replace the water that is lost from the peel. They are, therefore, subject to shriveling and weight loss resulting in a loss in their marketable weight and their visual quality, if stored under conditions of low humidity. The moisture content of the banana must be maintained in order to retain the quality of the fruit.

Figure 2.10 Causes of lose and damage of banana(Contact of bananas with the soil will promote decay and cross-contamination) .

- **Bananas are prone to decay**

Bananas are susceptible to attack by insects and decay-causing organisms. Attack by insects and decay-causing organisms can promote the rapid deterioration of bananas. Rough handling of bananas can create wounds that could serve as entry points for microorganisms. Bananas that come into direct contact with the soil are susceptible to microbial contamination (Figure 2.11) which could pose a food safety risk and lead to illness in humans when consumed.

Figure 2.11 Poor transport practices lead to mechanical damage and cause the fruit to ripen more rapidly than normal

Figure 2.12 Use of layers of banana leaves as underlay prevents contamination of bananas with soil

Figure 2.13 Wrapping the crown until the mid portion of the banana hand, to prevent abrasion and latex staining

Figure 2.14 Motorcycle equipped with cushion to carry bananas from the farm to the packing shed

Figure 2.15 Field-de-handed bananas are easier to transport (a); bananas transported in bunches are prone to damage (b)

- ✓ De-handing of bananas : is the separation of hands and removal of the stalk of the banana De-handing is best done with a de-handing knife that is curved to fit the crown of the banana.

Figure 2.16. De-handing of bananas (a); a de-handing knife (b); common method of de-handing bananas (c); use of clean gloves during de-handing (d)

- ✓ **Washing**

Washing removes dirt from the surface of the banana and coagulates exuded latex from the cut surface of the crown, thereby reducing staining. Bananas destined for sale to institutional buyers like hotels, supermarkets and food service establishments may need to be washed if they are not bagged.

Bananas must be washed in clean water in a wash tank (Figure 2.17). Extended periods of washing should also be avoided because this can result in the absorption of water by the bananas. If removal of latex poses a problem, it may be necessary to wash bananas in two tanks – washing in the first tank to remove dirt, followed by delatexing in a solution containing 1 percent alum.

Figure 2.17. Washing of bananas in clean water prevents contamination

- ✓ Grading/sorting

Grading is the process of classifying the produce into groups according to specific criteria accepted by the industry such as quality and size.

Sorting on the other hand, is the grouping of bananas based on the criteria of the one classifying the bananas. No definite set of standards is followed during sorting.

Bananas are generally sorted prior to sale, based on the following parameters:

- ❖ Freedom from mechanical damage,
- ❖ Foreign matter
- ❖ Decay
- ❖ Freshness
- ❖ Maturity and size are some of the quality criteria considered during sorting. No established quality standards are followed in local markets. Price is merely based on agreement of both parties (supplier and buyer). Bananas are commonly sorted according to size (length of fingers). Bananas are classified as A, B or C based on size and external appearance-smoothness, freedom from defects or blemishes and decay (Figure 2.18). Although specific quality standards are not normally required, local markets and institutional buyers, particularly hotels and supermarkets demand fruit of better quality (Figure 2.19)

Figure 2.18.Grading of banana

Figure 2.19.Good quality fruits demanded by institutional buyers and supermarkets

- ✓ Bulk packaging

Good bulk packaging is essential in maintaining the quality of bananas during transport and subsequent handling. The basic functions of bulk packaging are to provide adequate protection to the bananas, to contain convenient quantities of bananas, to facilitate the transportation, handling and distribution of bananas.

❖ Bulk packaging containers for bananas

Rigid containers such as plastic crates are highly recommended for the bulk packaging of bananas since they provide adequate protection against compression damage (Figure-). Plastic crates have a smooth inside finish and can be easily cleaned. They are also stackable and reusable/returnable. Although more expensive than traditional packaging containers, such as woven baskets, plastic crates are re-useable and economical in use over the long term.

Wooden crates are also rigid bulk packaging containers that provide protection during transport. Lining materials (such as newspaper) are placed between hands of bananas (Figure 2.20) and the crate is lined with fresh banana leaf sheaths (trunk) to prevent damage to fruits caused by the rough inside finishing of the crates . Over-packing should be avoided since it leads to bruising and compression damage of the bananas.

Figure 2.20. Bananas packed in stackable plastic crates with newspaper liners on all sides to prevent latex staining of the crate

Figure 2.20. Wooden crate with newspaper liner between hands of bananas (a); banana leaf sheaths used as liners on all sides of the crate of bananas (b); compression damage due to over-packing (c); newspaper liner between fingers of banana(d)

Good practice for the use of plastic crates

- ✓ Plastic crates must be thoroughly cleaned with soap/detergent after use (Figure 2.21).
- ✓ Plastic crates must be stored in a clean area that will not attract the breeding of insects and rodents. The crates must be stored separately from chemicals and farm machinery to prevent contamination. Crates should not be left exposed to the external environment since they will readily wear out (Figure 2.22).
- ✓ Plastic crates used for the bulk packaging of bananas must not be used as a container for chemicals (fertilizers and pesticides).

Figure 2.21 Dirty` plastic crates (a) as source of contamination; cleaned plastic crates after use (b)

Figure 2. 22. Plastic crates exposed to the environment will readily wear out

- ✓ **Transportation**

Transportation is one of the critical stages in the banana supply chain. Poor transport conditions, rough handling, and delays in transportation contribute to losses in banana supply chains.

- Bananas are transported:
  - ✓ From the field to the collection site.
  - ✓ From the collection site to the retail market.

- Good transport practice for Bananas:
  - ✓ Bananas must be carefully handled. They must not be dropped or thrown on to each other; the transport vehicle must not be overloaded as overloading increases the risk of damage to the fruits.
  - ✓ Bananas at the bottom of the transport vehicle should not be used as steps to allow stacking to a greater height (Figure 2.23).
  - ✓ Air circulation in the stacks or piles of produce is of critical importance in preventing heat build-up. This is facilitated by providing space in between stacks.

.

Figure 2.23. Bad practices during the transportation and handling of bananas

For bananas transported in bulk or in bunches , heat build-up will occur leading to premature ripening during transit.

- ✓ The use of stackable plastic crates as transport containers is highly recommended since they provide adequate protection to bananas during transport.
- ✓ If canvass is used as a cover over the bananas; provisions must be made for air circulation through the stack. Light colored material is preferred as a cover as it will reflect heat.

Figure 2.24. Stackable plastic crates

Handling at retail markets

Retail markets serve as outlets for banana producers, and collectors. The basic rules that should be observed in retail markets are as follows:

1. Containers from the transport vehicle must be unloaded under cover/shade with careful handling to minimize mechanical damage.

2. Bananas must be re-sorted using a sorting table; culls must be properly discarded.

3. Bananas must be re-graded according to size, appearance and stage of ripeness as the case may be depending on the requirement of the target market.

4. When distribution cannot be completed in one day, unsold bananas must be kept under clean storage conditions with proper ventilation. Keeping bananas under unsanitary conditions will lead to contamination and could compromise their safety.

5. At the retail market, bananas should be displayed in an elevated tray or rack and not on the ground since the possibility of contamination on the ground is high.

Self-Check – 2	**Written test**

Name…… ID…… Date…….

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

Test I: Short answer questions (10 points)

1. What is the primary objective of performing post harvest operation for horticultural and field crops?
2. Explain each of the post harvest operations for horticultural and field crops?

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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

Equipment and accident procedures

First Aid boxes must be present in the vicinity of the workplace and secured against the risk of theft; all separate buildings and permanent installations on the farm shall be equipped with a complete First Aid kit, which would be available and accessible in case of emergency. The farm manager must ensure that the First Aid box is always sufficiently equipped (Paracetamol, piritons, magnesium sulphate, methylated spirit, eusol, plaster, cotton, alcohol scissors, surgical gloves). This should be controlled by the health officer on each farm.

Accident procedure and a fire procedure form must be displayed on all farm notice boards and at the chemical and fertilizer stores. These procedures must be within 10 m of the plant protection product store and in all mixing areas, including those in the field. The accident and fire procedures indicating updated telephone numbers of persons to contact in an emergency. There must be at least one fire extinguisher available on the farm with a current service date. Potential hazards in the farm, e.g. waste pits and fuel tanks, workshops as well as treated crops, must be clearly identified by warning signs.

Recommended precautions for handling drinking water in the fields

• Water supply systems should be in good condition and operating properly and monitored.

• Water should be stored in clean, previously sanitized containers and tanks.

• Water containers should be washed and sanitized on a daily basis.

• Water storage containers should be closed at all times.

• Containers should be kept away from the sun and excessive heat.

• Disposable cups should be provided and each person should use a different cup.

• Frequent microbiological and physical evaluation should be performed on drinking water when the water is being stored or treated on-site.

• Simple organoleptic evaluations (colour, odour and taste) of water should be part of the daily monitoring procedures.

• If any of the water quality tests indicate the quality is not adequate, the water should be replaced to reduce the chances of infection and the proper authorities should be notified of the problem.

Living quarters

Living quarters, if provided, should be located at a proper distance from the fields so as not to pose a health risk to persons; the quarters must be habitable with the basic services and facilities, such as running water and toilets.

Long working hours

Agricultural workers must not be subjected to longer working hours than those stipulated by the national labour law; the management must adequately remunerate overtime and also consider unattended children at home because of overtime work.

Gender

The labour law requires that both men and women workers be treated equally, that they be provided with the same opportunity for promotion and sexual harassment is prohibited.

Sitting facilities

Suitable sitting facilities must be provided to enable workers to take advantage of resting periods.

Child labour

Child labour is prohibited on the farms; children's welfare must be considered and facilitated to attend schools.

The packing area must provide adequate protection from sun and rain, and must be kept clean at all times. Pet animals must be kept away from the packing area. All workers must apply good practice and observe good hygiene.

Safety signs

There must be permanent and legible signs indicating potential hazards such as waste pits, fuel tanks and workshops. After spraying session(s), the spray supervisor must install a sign in the field reading “Treated area, do not enter”, which will be removed after 24 hours. The area will also be roped off with red tape/string as a deterrent. Pregnant and lactating mothers must be kept off an extra 24 hours. Welfare On-site medical facilities .The law requires on-site medical facilities, including a First Aid kit and trained first aiders to be available on every farm. Each employee is obliged to undergo a medical checkup before appointment as a farm employee and undergo regular medical checkups during the full period of employment as an agricultural worker.

Toilets and sanitary facilities

Adequate toilets with hand wash facilities must be provided near grading areas, living quarters and production areas. The toilets shall be in a good state of hygiene, accessible to employees and no more than 500 m from the area of working activity. Pit latrines are acceptable provided they are fully enclosed with a concrete base and are gender specified (marked women or men). Toilet paper must be provided. Hand washing facilities should be serviced with running water and non-perfumed soap. If running water is not possible, potable water may be provided in drums with a tap. Ensure that microbial analysis of hand washing water is done at least annually and the results filed in the farm office. Toilets must be regularly cleaned and the cleaning schedule must be recorded and be available for inspection.

Self-Check – 3	**Written test**

Name…… ID…… Date…….

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

Test I: Short answer questions (6 points)

1. What are the parameters that should consider in work place cleanness, safety and hygiene?

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

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet 1-perform post harvest operations

Purpose: - to practice proper handling produce

- to maintain the quality of harvested produce

Materials: post harvest tools ,materials and equipment/machinery found in your college or locality, horticultural crops

Procedures for horticultural crops post harvest operations

1. Select one matured/ ripe horticultural crops
2. Collect all the required materials
3. Perform :
   - Dumping
   - Presorting
   - Washing and cleaning
   - Waxing
   - Curing
   - Treating
   - Grading
   - Packing and labeling
   - Storage
4. Keep records about all the operations
5. Present for your class

LAP TEST	Performance Test

Name_____ ID…….Date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within a week. The project is expected from each student to do it.

Task-1 perform post harvest operation of horticultural crops

LG # 88	LO #3- Implement post-harvest treatments

Instruction sheet-3

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

- Grading and labelling harvested produce
- Identifying and disposing of Produce
- Selecting Post-harvest treatments
- Conforming timing, rate and application method of handling techniques
- Minimising damage to produce
- Cleaning and maintaining tools, equipment and machinery

This guide will also assist you to attain the learning outcomes 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 of Produce
- Select Post-harvest treatments
- Conform timing, rate and application method of handling techniques
- Minimise damage to produce
- 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) Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4) Accomplish the “Self-checks” which are placed following all information sheets.
5) Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet 1 - Grading and labelling harvested produce

Grading

Grading of products is usually a voluntary programme used by the industry. Grading standards describe the quality requirements for each grade of product, giving the industry a common language for buying and selling. Grading is based on certain characteristics, generally related to external attributes of appearance such as product size, shape and colourization. Grading usually does not imply criteria for food safety. Grading standards are developed and adopted either by private industry or national bodies and might be mandatory for export.

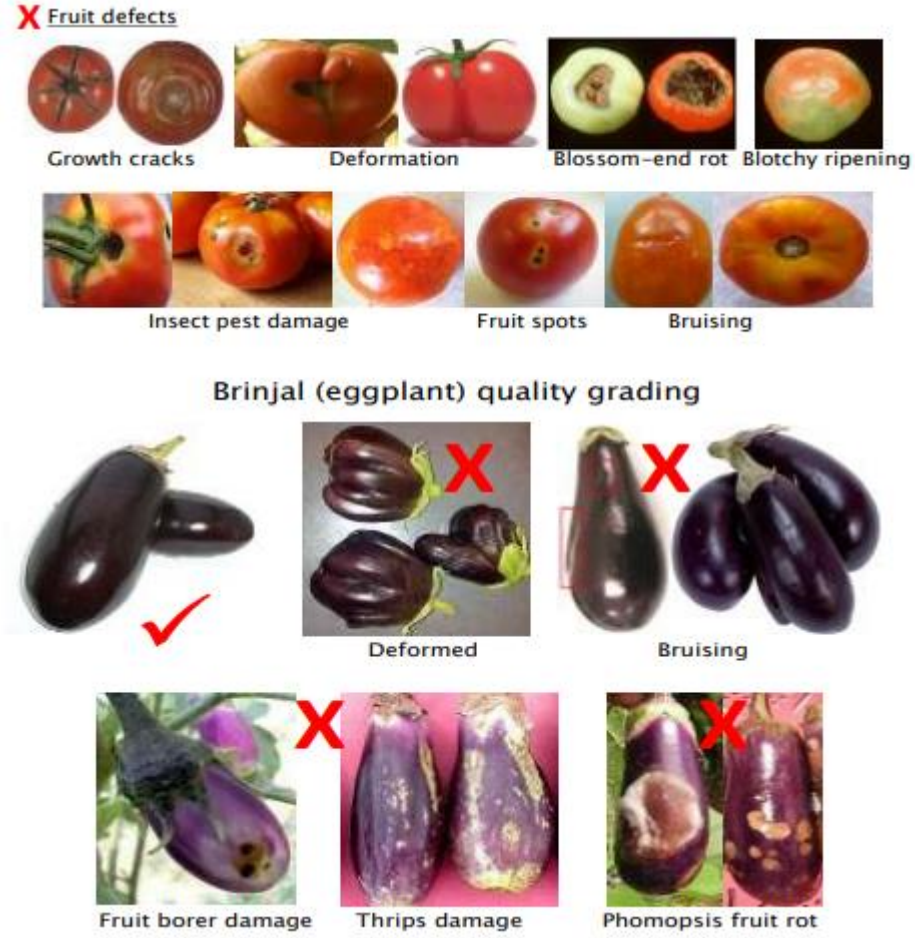


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Figure 3.1. Some instruments for quality measurement.

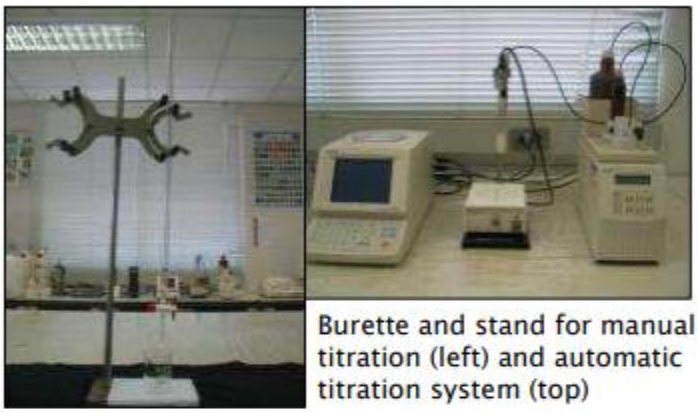
Colorimeter to quantify color

Gloss meter

Caliper (top) and weight scale (bottom) for size and weight

Penetrometer (top) and electronic texture analyzer (right)

Refractometer, analog (top) and digital (bottom)



Burette and stand for manual titration (left) and automatic titration system (top)

pH meter

Pesticide residue meter

ATP hygiene meter

DA meter for non-invasive quality evaluation

In a quality conscious market, cereal grains and grain pulses are bought and sold at specific grades, often based on national or international standards. The potential benefits of supplying better quality grain (more sales, more money) should be explained to farmers as well as the risks of market failure (loss of investment in their time, labour and in improved postharvest technologies).

The farmer needs to be encouraged to produce high quality grain, that is grain without the low quality factors listed in Table 2.1.

Table 2.1: Low quality factors that are often assessed when grain is graded

High quality grain	Low quality factor	
		**Foreign matter and filth** Grain may be contaminated with foreign matter that is either organic (e.g. maize cob cores, tassels etc) or inorganic (e.g. stones). Examples of filth are rodent dropping and dead insects. Careful sieving can reduce much of the foreign matter content.
		**Broken** Most broken grain comes from poor postharvest handling especially shelling or threshing.
		**Damaged by insect pests** Insects make holes in grains and hollow 

High quality grain	Low quality factor	
		Rodents chew into grain and remove the germ.  **Rodent damage**
		**Mould damaged** Mouldy grains have been dried too slowly or allowed to become wet. They have patches of mould growth on them and may also be discoloured. Some moulds also produce mycotoxins that are dangerous poisons, e.g. aflatoxin, but physical appearance is no guide to aflatoxin contamination.
		**Discoloured** Grain may be discolured due to grain heating, especially stack burn (see ***Sub-Section 5.8***) this may have no connection with mould growth.
		**Smells bad (off-odours)** Poor handling, especially slow drying or contamination or storage near fertiliser or other agrochemicals can give grain off odours that are unacceptable.

Producing and selling high quality grain is not the only concern. Farmers should also be encouraged to plan their crop storage and crop sales to obtain the best balance between household food security and opportunities to earn cash from sales. If the household sells too much grain at harvest and does not retain enough for their own consumption then they may find that they have to buy back grain later in the season when prices are much higher. But retaining grain in the house for periods of more than three months requires good storage practice and good stores

Grade standards are used for monitoring quality. They ensure that produce complies with buyer's requirements. Grade standards facilitate labelling, provide a basis for

reporting on market prices, and are the legal framework used for the settlement of commercial disputes. Quality standards take into account many factors, such as

- Definition of the produce
- Minimum requirements (cleanliness, appearance, flavor, odor, maturity)
- Definition of different classes or grades based on quality characteristics, acceptable product size, presentation of the produce in terms of their uniformity and packaging, information on the package such as origin of the produce, grade, size, storage conditions and methods of handling, and approved pesticides and maximum residue levels

Labeling of packages

The importance of labeling of packages

Part of the post-harvest losses of fresh produce in less developed regions are a result of mechanical injuries due to poor handling and inadequate packaging. In more developed marketing systems packages serves also other objectives, such as market penetration, competitiveness.

Proper packaging of a product can reduce not only bruising and crushing, but can also improve marketing of produce, reduce moisture loss, prevent (re-)contamination of the product with spoilage organisms, reduce pilferage, maintain a sanitary environment during marketing.

All aspects of packaging must be taken into account when considering the introduction of new packaging. These aspects involve, among others, cost of packaging material, labour, acceptance by trader and consumers and changes in product condition. The ultimate goal of packaging must lead to easier handling of the produce, a better quality and better marketable product.

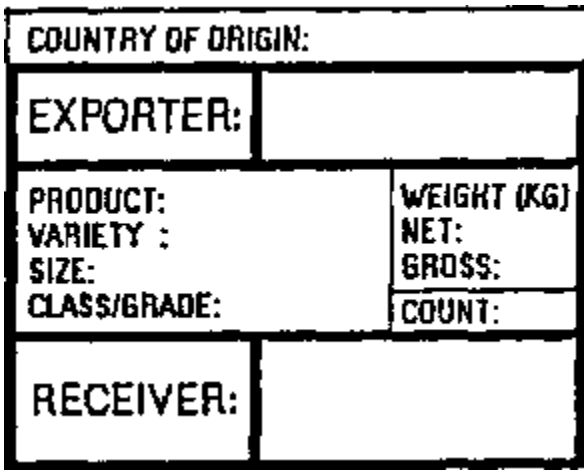
Each container should be marked with a label with the following information:

- Country of origin.
- Name and address of exporter or grower.

- Brand name.
- Description of content (product, variety, size, class, quality grade).
- Gross weight.
- Net weight or count.
- Overall dimensions in metric units.
- Full name and address of receiver.

The following rules should be maintained with regards to labels:

1. Each container should have at least two labels on both short sides of the container.
2. The label should be placed in such a way that it is least liable to be damaged or dirtied.
3. Each long side of the container should contain general information such as brand name, type of commodity and a logo.
4. Extra information such as FRAGILE, TOP or special storage or handling requirements should be placed on top and at least on one of the sides of the crate.
5. Only water-proof ink should be used.
6. Differences in colour for the different commodities and grades should be used, where these additional cost can be accounted for.
7. Obsolete labels should be removed or taped off.
8. Hand written information on the label should be in blockwriting.
9. Other remarks such as date of packaging, legal remarks and marking for electronic scanning could be included.


COUNTRY OF ORIGIN:
EXPORTER:
PRODUCT:
VARIETY :
SIZE:
CLASS/GRADE:
WEIGHT (KG)
NET:
GROSS:
COUNT:
RECEIVER:

Self-Check – 1	**Written test**

Name…… ID…… Date…….

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

Test I: Short answer questions (10%)

1. Define the following terms
   A. Grading
   B. Labeling
2. What is the importance of labeling?
3. What are the parameters used for grading and labeling?

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

Information sheet 2- Identifying and disposing of damaged Produce

Culling out produce that are unmarketable in the field to lower the cost of hauling and to minimize disease contamination. Field sorting should be done on farm to cull out unmarketable produce such as those that are diseased, insect-infested or rat-damaged. Performing this operation in the field will also minimize hauling cost.

Figure 2.1 Forms of rejects culled during field sorting: diseased (a), insect damaged (b), rat damaged (c)

Losses and quality defects that result from inappropriate use of bulk packaging materials include: bruising, wounding (cut, puncture, crack, split, breakage), distortion, compression damage and abrasion. The extent of this damage increases when the packages are: either under-filled, over-filled or if the packaging material has rough surfaces, and when the packages are dropped during handling. A farm should have an operational waste management plan and should be properly followed.

Self-Check – 2	**Written test**

Name…… ID…… Date…….

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

Test I: Short answer questions (10%)

6. Why the damaged produce should be disposed?
7. Where is the place or the operation for identification of damaged produce takes place?

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

Information sheet 3- Selecting Post-harvest treatments

Special treatments after packing. Special post-packing treatments are applied to certain crops, but this is more common in large-scale operations for urban and export markets. The principal treatments are:

Treatment with fungicidal and bactericidal chemicals

Treatment with fungicidal and bactericidal agents is sometimes required to limit the growth and spread of pathogens in harvested fruit, to inhibit spore formation and to reduce the rate of germination of spores.

• Properties of an ideal post harvest fungicide

- ❖ Water soluble
- ❖ Broad spectrum of activity
- ❖ Non phytotoxic
- ❖ Safe to use
- ❖ No effect on produce palatability
- ❖ Retains activity over long periods
- ❖ Leaves no visible residue
- ❖ Effective at low concentrations
- ❖ Low cost

- Fumigation

The treatment is to control insect pests, such as fruit fly. It is a compulsory requirement for the importation of produce into many countries and requires specialized equipment and skilled operators.

- **Initiation of fruit ripening**

This takes several days and requires treatment of the packed fruit with ethylene gas in insulated, temperature-controlled stores. The costs are high and thus limited to large operations.

- **De greening of citrus fruit**

Citrus fruits grown in the tropics will remain green when ripe unless subjected to low night temperatures. They will, however, develop their normal natural colour if artificially degreened by an ethylene treatment like that initiating ripening; it is not often done in small packing houses.

Self-Check – 3	**Written test**

Name…… ID…… Date…….

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

Test I: Short answer questions (10%)

1. Explain the post harvest treatments
2. Mention the ideal properties of post harvest fungicide

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

Information Sheet 4- Conforming timing, rate and application method of handling techniques

When using fungicides, instructions must be carefully read to ensure proper usage. Minimum residue levels for importing countries must also be known and observed.

Methods of applying fungicides and bactericides

- Spraying
- Dipping
- Use of fungicide impregnated wraps or pads
- As fumigants, dusts and wax formulations

Factors that govern the efficacy of fungicide use

- Fungicides can only be effective if other crop management and handling procedures are observed;
- The inoculum within the packing house must be low;
- Correct handling procedures and optimum storage conditions will reduce the incidence of infection allowing the fungicide to work more effectively

Table 4.1 Some chemical treatments for controlling the microbial spoilage of harvested fruits

Produce	Chemical
Breadfruit Avocado Citrus Mango Papaya Banana	Fruit coating Fungicides: *Thiabendazole (TBZ)* *Prochlorus* *Carbendazine*

Table 4.2 Ripening conditions for some tree fruits using ethylene

Fruit	Temperature (°C)	Ethylene concentration (µL/L)	Treatment time (hours)
Avocado	18-21	10	24-72
Banana	15-21	10	24
Mango	29-31	10	24
Papaya	21-27	10	24
Stone fruits	13-25	10	24-72

[1]*Relative humidity is normally maintained at 85 to 90 per cent.*

Source: Wills et al., 1989

Self-Check – 4	**Written test**

Name…… ID…… Date…….

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

Test I: Short answer questions (10%)

1. What are the methods used to apply fungicides and bactericides ?
2. Explain the factors that govern the efficacy of fungicide use

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

Information Sheet 5- Minimising damage to produce

Proper timing of the harvest period is essential. For vegetables that lose quality rapidly due to high temperatures, such as sweet corn and green beans, early morning harvest prior to the buildup of field heat may be in order. However, with some vegetables which are prone to breakage, such as asparagus, late afternoon harvest when wilting generally occurs may be more beneficial.

Most postharvest problems are management problems, and therefore, are people problems. With all vegetables, care should be taken to prevent injury due to harvesting and handling errors. A crucial time to be aware of this is during the harvesting operation. The hands of the harvest worker are the most important hands that ever touch the product. The truly skilled worker does not inflict injury to the product. Broken skin and bruises reduce eye appeal and provide a ready access to decay organisms and enhance physiological breakdown. Although speed is an important consideration, excessive, unsupervised speed may result in a greater incidence of injury and quality losses. Therefore, time should be spent to properly train and monitor the performance of all personnel to insure maximum efficiency without sacrificing quality. Equally important is the need for periodic inspection and repair of all harvest containers, bulk bins and grading equipment to insure that these items are not causing injury to the produce.

Bruise damage will cause respiration rates and ethylene production to increase dramatically. This shortens the shelf life. There are several management practices that can reduce or eliminate harvest injury.

- Remove protruding nails or staples and smooth the rough edges on field containers.
- Harvest workers should not have long, sharp fingernails.
- Use care in dumping products from one container to another. This is one of the most common trouble spots.
- Use padding on all impact areas when possible.
- Clean sand and all debris out of all containers.

- Don’t overfill containers! Severe damage can result when stacked.
- Consider the time of day of harvest. Many products are more turgid in the early morning and bruise more easily.

Transport from field to packinghouse can be a source of injury. Roads should be maintained in good condition. Drivers should exercise care and remember that they are transporting living material. The springs and shock absorbers on trucks and trailers must be properly maintained.

Dumping or unloading at the packing shed is also a trouble spot. Dry dumping is an option for certain produce items. If a wet dump is necessary, appropriate flow control out of the dumping area is needed to minimize bruising. The packing line itself should have as few drops and shears as possible. Shears that are essential should be designed properly.

Rapid cooling as soon as possible after harvest is essential to the maintenance of optimum quality. The first consideration at harvest is removal of the produce from direct sunlight, and secondly, to precool as quickly as possible.

Self-Check – 5	**Written test**

Name…… ID…… Date…….
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (10%)

8. Identify all the causes of damage to the harvested produce
9. What are the possible solutions to reduce the damages?

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

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

All post harvesting equipment must be cleaned and stored in a predetermined storage space. The equipment must be kept dry and should not be kept on a dirt floor. Harvesting equipment must not be stored nearby or in the vicinity of pesticides, pesticide application equipment or fertilisers as these equipment could become contaminated and thereby contaminate the harvested produce.

When cleaning the tools the following should be considered:

- the removal of dirt and plant material adhered to the tools
- the removal of microscopic particles including disease organisms
- Sterilization is the elimination of all transmissible agents (such as bacteria, fungi and viruses) from a piece of equipment

Tools are cleaned to ensure:

- that post-harvest decay organisms do not come into contact with harvested produce
- that the life-span of tools and equipment is prolonged

Reporting equipment faults

Every farming enterprise develops specific guidelines as how to report and record equipment problems which may occur during harvesting. It is important to record every aspect of a problem especially where it can lead to serious losses. It is important that one always follows the required occupational health and safety rules as set out in the OHS act as well as all company or industry specific guidelines and procedures.

Self-Check – 6	**Written test**

Name…… ID…… Date…….

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

Test I: Short Answer Questions (10%)

1. What is the importance of cleaning tools, materials and machineries?

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

LG #89	LO #4- Implement hazardous waste disposal guidelines

Instruction sheet-4

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

- Reviewing Waste disposal requirements
- Monitoring and addressing collection of waste and disposal
- Reporting conditions on business viability.

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

- Review waste disposal requirements
- Monitor and address collection of waste and disposal
- Report conditions on business viability.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information sheet 1. Reviewing waste disposal requirements

Introduction

Waste management

Trash and waste products from fruit and vegetable processing operations can be a source of microbiological contamination. Decomposing organic matter can serve to spread micro-organisms around the facility and generate offensive odours, thereby attracting insects or other pests bearing pathogenic organisms. The following GMPs should be observed for the daily management of waste and trash in a food processing facility.

- Good manufacturing practices

Proper trash and waste handling

• Designate a specific confined area well outside the processing facility for the temporary holding of all waste;

• Design this area for easy cleaning and to prevent accumulation of residues and bad odours:

• Place trash and waste containers conveniently inside all operations sectors of the facility. They should be properly labelled and suitable for tight closure;

• Remove all trash and waste products on a frequent basis and include waste collection procedures in daily cleaning activities;

• Train all staff to make sure that waste collection procedures are correctly followed and properly handled;

• Separation of organic and inorganic waste material with proper recycling is recommended.

Several options are available for hazardous-waste management. The most desirable is to reduce the quantity of waste at its source or to recycle the materials for some other productive use. Nevertheless, while reduction and recycling are desirable options, they are not regarded as the final remedy to the problem of hazardous-waste disposal. There

will always be a need for treatment and for storage or disposal of some amount of hazardous waste.

An adequate waste management plan

Much of the harvested produce is lost due to a number of conditions. The harvested produce tends to go into a process of decay almost immediately after it is harvested. Although post harvest treatments will preserve the produce to some extent, there is always some degree of post harvest wastage which should be minimised during the harvest and packing process. Fruit must thus be handled with care. Losses associated with handling wastage that extends beyond the physical loss of the produce itself will reduce the gross income and also contribute to environmental pollution. Most fresh produce farms will however have an area set aside where harvest wastage is either stored as animal feed, or is composted. Such areas must be at a distance from both the fields and the processing areas. Every farm system must have an adequate waste management plan in place, taking in account the separation, storage as well as the removal there of according to (EUREPGAP, HACCP etc) and the national laws dealing with occupational health and safety as well as national environmental policies. The following aspects are normally taken into account in a waste management plan :

• Provision must be made for the storage, removal and separation of waste

• Waste must not be allowed to accumulate in pack houses, storage facilities, other working areas or adjacent environment areas. Waste accumulation normally impedes the proper functioning of the activities in these areas.

• Waste storage areas must be kept clean according to pre-developed cleaning schedules. By means of daily inspections it can be determined whether these schedules are properly adhered to.

• Waste must be stored away from the packing area to prevent fruit contamination.

Waste containers, inside and outside the pack-houses, must be covered or closed with a lid. It is a good idea to separate different types of waste into identified bins.

• Waste containers used to hold dangerous substances should be lockable and well identified - only trained and authorised personnel must have access to these containers.

• Waste and refuse must be stored in a designated container in a designated area to ensure that these do not become a breeding place for pests and rodents.

• Procedures should be in place to minimize the accumulation of waste in production areas

• All refuse bins and harvest utensils used as refuse bins must be specifically identified and suitably constructed •

Table 1: Generic food supply chain and examples of food waste (Parfitt et al., 2010)

Stage	Examples of waste
1. Harvesting, handling at harvesting	*Edible crops left in field, ploughed into soil, eaten by pests; timing of harvest not optimal; crop damaged during harvesting*
2. Threshing	*Loss due to poor technique*
3. Drying, transport and distribution	*Quality and quantity loss of during drying, poor transport infrastructure; loss owning to spoiling/bruising*
4. Storage	*Pests and disease attacks, spillage, contamination; natural drying out of food*
5. Primary processing, cleaning, classification, hulling, pounding, grinding, packaging, soaking, winnowing, drying, sieving, milling	*Process losses; contamination in process causing loss of quality.*
6. Secondary processing, mixing, cooking, frying, molding, cutting, extrusion	*Process losses; contamination in process causing loss of quality*
7. Product evaluation and quality control	*Product disregarded /out-grades in supply chain*
8. Packaging	*Inappropriate packaging damages produces; grain spillage from sacks; attack by pests*
9. Marketing, selling, distribution	*Damage during transport; spoilage; poor handling; losses caused by poor storage*
10. Post-consumer	*Poor storage/stock management; discarded before serving; poor food preparation; expiration*
11. End of life disposal of food waste/loss at different stages in supply chain.	*Food waste discarded may be separately treated, fed to animals, mixed with other wastes/landfilled*

Self-Check – 1	**Written test**

Name…… ID…… Date…….
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (10%)

3. What are the possible waste production activities in post harvest operations?
4. How the produced wastes are managed/disposed?

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

Information sheet 2. Monitoring and addressing collection of waste and disposal

Waste disposal must meet with legislative requirements, meaning that specified waste must be removed by licensed contractors. Where licensed contractors are not available, suitable procedures must be in place to meet legislative requirements. Separate procedures must be written for waste removal according to each producer's requirements.

• A management plan to rectify an accidental waste pollution on the premises must be in place, but where these requirements are not applicable; a separate plan must be in place.

• External waste collection containers, compactors and sites must be managed in a manner as to minimise risks of contamination.

• Effluent disposal of pack-house chemicals must be done in accordance with the laws laid down by the appropriate authorities.

Waste auditing

A visual waste audit involves inspecting bins and truck loads in order to estimate the percentage of each waste type in the bin or load. A limitation of a visual assessment is that it does not allow for compaction of the waste, which impacts on the accuracy of results. However, it is less time consuming (and therefore less expensive) than a physical waste audit.

The most detailed and robust waste data can be obtained by auditing. A household by household audit, or aggregated sampling, will enable you to measure household generation of waste, recyclables and organics; determine the composition of each waste stream, and assist in monitoring the performance of the scheme.

It is recommended that an audit of the residual waste stream be conducted prior to the implementation of the scheme. This will provide you with baseline data for the total amount of waste produced, and the type and volume of organics currently in the residual waste stream. The residual waste stream should then be audited, using the same metrics, seasonally (at least summer and winter) to obtain the best data for comparison of results.

It would also be beneficial to audit the organics and recyclables schemes to determine whether the introduction of the scheme has had any other impacts, such as reduction in total waste produced, and material capture rates.

Good manufacturing practices related to trash and waste handling in a packing house

Trash and fruit waste can be a source of microbial contamination. Decomposing organic matter can serve to spread microorganisms around the facility, produce offensive odours and attract insects and other pests bearing pathogenic organisms.

- It is important to designate a specific secure, confined area outside the packing house facility for the temporary storage of trash and produce waste;
- The trash and waste collection centre should be constructed to facilitate cleaning and to avoid contamination of residues and bad odours. This area must be well away from the product-handling perimeter.
- Trash and waste must be stored in closed containers and consideration must be given to the direction of dominant winds to avoid bad odours in the production and packing facilities and the surrounding neighborhood;
- Trash containers and wastebaskets used inside the produce handling and packing areas must be conveniently located, properly identified, should be tightly closeable, and should not be easily overturned;
- Trash and waste material should be frequently removed. A trash collection schedule should be included as an important part of the daily cleaning activities of the packinghouse;
- Separation of organic and inorganic waste material with appropriate recycling is recommended.

Self-Check – 2	**Written test**

Name…… ID…… Date…….
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (10%)

1. Why wastes monitoring in collection and disposal required?
2. What is waste audit?

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

Information sheet 3- Reporting conditions to impact on business viability

Good business practices support financial viability and farm food safety. General organization, good recordkeeping and effective communication and labor management are all essential for any business to succeed. Organization and efficiency are also key to preventing and managing produce contamination. The concept of “lean” in production deals with minimizing waste while maintaining productivity.

The causes of food losses and waste in low-income countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems. Given that many smallholder farmers in developing countries live on the margins of food insecurity, a reduction in food losses could have an immediate and significant impact on their livelihoods

Impacts of PHL(post harvest loss) and food security and livelihoods Postharvest technologies can contribute to food security in multiple ways. They can reduce PHL, thereby increasing the amount of food available for consumption by farmers and poor rural and urban consumers. For example, the control of the Larger Grain Borer (LGB) or Prostephanus truncanus greatly reduced the loss of maize in on-farm storage among smallholders in a number of African countries, thus improving their food security. The benefits to consumers from reducing losses include lower prices and improved food security. In addition, postharvest activities such as processing and marketing can create employment (and thus income) and better food security in the agricultural sector. Therefore, reducing PHL clearly complements other efforts to enhance food security through improved farm-level productivity. Techniques to reduce food losses require cultural and economic adaption. This is so because all food losses occur at a particular socio-cultural environment. The issue of food losses is of high importance in the efforts to combat hunger, raise income and improve food security in the world"s poorest countries

Self-Check – 3	**Written test**

Name…… ID…… Date…….
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (10%)

1. How impacts of post harvest loss contribute to food security?
2. What is the importance of reporting?

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

LG #90	LO #5- Implement packing and preservation

Instruction sheet-5

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

- Reviewing packing and preservation requirements.
- Conforming packing and preservation of produce.
- Monitoring and taking remedial action
- Recording packing and preservation processes.

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

- Review packing and preservation requirements.
- Conform packing and preservation of produce.
- Monitor and taking remedial action
- Record packing and preservation processes.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet 1- Reviewing packing and preservation requirements

Packhouse operations and packaging nature and importance

A packhouse is a physical structure where harvested produce is consolidated and prepared for transport and distribution to markets. Packing is the main activity from which the name 'packhouse' is derived. But there are activities before and after packing - together they are called packhouse operations.

Packhouse operations include receiving and recording, cleaning, sorting/grading, pre-treatments, packing, cooling, storage and dispatch to market. A packhouse enables quality assurance activities that ensure product quality and quantity meet market requirements and losses are minimized during transport and distribution to markets. Developing countries incur serious postharvest losses of vegetables usually ranging from 20-40% of production.

A packhouse can serve as a hub for coordination and governance of a farm-packhouse-market organization in which market demand dictates production and packhouse activities.

The activities depend on the type of produce and market. Fruit vegetables may require certain operations not applied to leafy ones nearby markets may need only sorting and packing while for distant markets, additional operations are needed. When immediate transport is available, storage in the packhouse may not be necessary.

- Tomato, eggplant, chili, cucumber, bitter gourd and yardlong bean:

receiving – sorting – cleaning/sanitizing – airdrying – grading – packing – storage - dispatch

- Cauliflower:

receiving – sorting – trimming – packing – storage – dispatch –

- Leaf mustard: receiving – sorting/grading – trimming/cleaning – airdrying – packing – storage - dispatch
- Cabbages and Chinese kale: receiving – sorting – trimming - bacterial soft rot control – air drying – sizing – packing – storage - dispatch

Treatments before packing

- Sanitizers

✓ Washing in 100-200 ppm chlorine (mixing 4-8 tablespoons of commercial bleach, which has 5.25% sodium hypochlorite or NaOCl, per gallon of water) for 1-3 minutes can reduce microbial load and decay in tomatoes (Figure--). The produce should be air-dried before packing.

✓ Calcinated calcium from scallop powder applied as 0.01% solution (0.1 gram scallop powder per liter of water) as 3-5 minute dip enhanced food safety (Table -). It was developed as a non-chlorine sanitize because of health concern on chlorine which reacts with organic matter in the produce to form trihalomethanes, a highly carcinogenic compound.

Figure 1.1.Reduction of Phomopsis rot in eggplant by chlorine wash.

Packaging

Packaging is the main packhouse operation. It must provide protection of produce from damage but existing practices remain wanting. Several packaging materials are available (Figure 1.2). Package selection depends on the type of produce, distance and mode of transport, and market.

Figure1.2. Vegetable containers: bamboo and plastic baskets; plastic crates; wooden crates with inner cardboard sides and collapsible type; carton and foam boxes.

Rigid containers, such as wooden or plastic crates, are more advisable but for wooden crates and other containers with rough surfaces, liners such as used newsprint, should be used.

Preservation is the process of treating and handling food to stop or greatly slow down spoilage (loss of quality, edibility or nutritive value) caused or accelerated by micro-organisms. Some methods, however, use benign bacteria, yeasts or fungi to add specific qualities and to preserve food. Maintaining or creating nutritional value, texture and flavor is important in preserving its value as food. This is culturally dependent, as what qualifies as food fit for humans in one culture may not qualify in another culture.

Self-Check – 1	**Written test**

Name…… ID…… Date…….
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (10%)

1. Define a) pack house b)packhouse operation c)preservation of crops
2. Explain the treatments before packing
3. List out packaging materials

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

Information Sheet 2- Conforming packing and preservation of produce

Specialized packinghouse operations

- Hot water treatment: mangoes are highly susceptible to stem end rot. Dipping in hot water is, therefore, used to control decay of the fruit due to stem end rot. Control of the temperature and duration of the hot water treatment are critical to assuring destruction of the pathogen while maintaining the quality of the fruit. •

    - ✓ Methods of hot water treatment – dip in water containing 5 percent sodium bicarbonate at 52 °C, for 5 minutes; or – Dip in water containing 5 percent calcium chloride at room temperature, for 10 minutes.

- Surface Coating with waxes : waxing with synthetic food grade resins:
    - ✓ Reduces moisture loss;
    - ✓ Prevents wilting and shriveling;
    - ✓ Provides protection against decay organisms;
    - ✓ Improves appearance/gloss.

Types of waxes: – fruit wax e.g. Semperfresh

Method of application: – Wax can be applied either by foaming, spraying, dipping or brushing.

Packing house operations

Treatment with fungicidal and bactericidal chemicals: treatment with fungicidal and bactericidal agents is sometimes required to limit the growth and spread of pathogens in harvested fruit, to inhibit spore formation and to reduce the rate of germination of spores.

Safe use of fungicides: Proper management and use must be assured in order to protect the:

- ❖ Worker
- ❖ Consumer
- ❖ Environment
- ❖ When using fungicides, instructions must be carefully read to ensure proper usage. Minimum residue levels for importing countries must also be known and observed.

Packing house sanitation

• Proper sorting and culling of product.

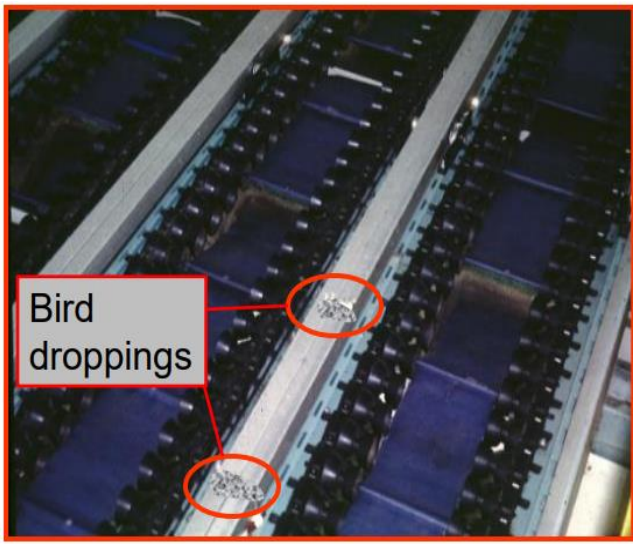
• Maintaining detectable free chlorine in wash waters.

• Enforcing good worker hygiene.

• Cleaning and sanitizing equipment.

Packing House Sanitation

- ✓ Excluding all animals from Packing House, especially insects, birds and rodents.



- Packing facility
- ✓ Should be arranged so that product moves to a cleaner area during each step of processing.

- ✓ Good sanitation & housekeeping should be practiced in the area – SOPs (Standard Operating Procedures).
- ✓ Cleaning supplies should be stored in a separate area.
- ✓ Rest rooms should not open directly into processing and packaging areas
- ✓ Should have adequate lighting and shielded to protect product if breakage occurs.
- ✓ Processing equipment food contact surfaces should be cleaned & sanitized and done as frequently as necessary.
- ✓ Use only food grade machinery lubricants
- ✓ Exposed overhead piping & ducts should be minimized and kept clean
- ✓ Work tables/product preparation surfaces – food contact surfaces:
- ❖ Smooth surfaces allow easy cleaning.

  -Rough surfaces harbor dirt and microorganisms.
- ❖ Important to clean and sanitize as needed.

  -Wash, Rinse, and Sanitize with approved food contact agents.
- ✓ Store packing containers away from contamination sources.
- ✓ Close doors at night.

- Test water frequently /First requirement for GAPs Certification.
- ✓ At least once a year:
- ❖ Municipal water – Well water
- ✓ Test surface water for quality assurance.
- ❖ 3 times during season in temperate climates.

- ✓ at planting (high flow) • at peak use (low flow) • at harvest
- ✓ Maintain good records of results.

- Worker Hygiene

✓ Workers should follow good hygienic practices to protect against contamination of the product.

✓ Workers should receive training in proper food handling techniques, food protection basics, personal hygiene and sanitary practices.

✓ Wear clean outer garments.

– Change clothing or don aprons if coming from the field.

✓ Maintain personal cleanliness

✓ Wash hands thoroughly

– Before starting work.

– After each absence from work station. – At any time when hands become soiled

Preservation usually involves preventing the growth of bacterial, fungi and other micro-organisms as well as retarding the oxidation of fats which causes rancidity. It also includes process to inhibit natural ageing and discolouration that can occur during food preparation such as the enzymatic browning reaction in apples which causes browning when apples are cut. Some preservation methods require the food to be sealed after treatment to prevent recontamination with microbes; others such as drying, allow food to be stored without any special containment for long periods.

Food preservation refers to any one of a number of techniques used to prevent food from spoiling. All food begin to spoil as soon as they are harvested or slaughtered, some spoiling is caused by such micro-organisms as bacterial and mold. Other spoilage results from chemical changes within the food itself due to natural process such as enzyme action or oxidation. For thousands of years humans have used methods of preserving food, so that they can store food to eat later. The simplest methods of preserving food, such as drying strips of fish or meat in the hot sun have been used for thousands of years and they are still used in the 2000s by indigenous people

The art of food preservation is based on the following reasons:

1. Destruction of micro-organisms
2. Prevention of their entry into the food
3. Arrest or prevention of purely chemical reactions
4. Arrest of the action of food enzymes

Foods are preserved for the following reasons:

- To prevent spoilage
- To avoid wastage, especially when they are in season
- To prolong its shelf life
- To allow for the use of foods during the off-season
- To eliminate the purchase of foods when they are most expensive
- To introduce variety in the family menu
- To be able to take care of emergency situations

Causes of food spoilage

Food spoilage is undesirable changes taking place in the food which eventually leads to its rejection. Food spoilage can be caused by the following factors.

- ✓ Action of insects
- ✓ Action of enzymes present in the food
- ✓ Purely chemical reaction in the food
- ✓ Action of micro-organisms e.g. bacteria, yeast and moulds
- ✓ Physical changes on the food

Various methods of preserving harvested produce

People have various methods by which they preserve their food. These include: drying, smoking, frying, salting, bagging, heating, fermentation, blanching etc.

Drying /dehydration: - drying is the process by which water is removed from farm products to a reasonable level to avoid spoilage. Drying is one of the oldest methods of food preservation

Smoking: - smoking is one of the ways of preserving farm produce. Smoking reduces water activity gradually to prevent bacteria and fungi growth. It works well for most food, like fish, tobacco leaves, etc., smoking works because it removes much of the foods water, it also reduces weight, making food more portable, dried foods are compact and easily stored or carried. The disadvantages of smoking food include loss of colour, loss of aroma and loss of quality, some of these losses can be avoid by not smoking the food too long. Smoked food can be kept for a long time without spoiling.

Salting: - Salting is another ancient method of preservation. Salt can be used as part of the drying process. The use of salt water brine is another common method of preservation and it has the benefit of stopping the growth of harmful organisms. Fish, meat and ground pepper can be preserved by either mixing or rubbing them with salt.

Fermentation: - fermentation is one of the oldest, traditional method of food preservation. Food fermentation involves the use of microorganisms and enzymes for the production of foods with distinct quality attributes that are quite different from the original agricultural raw material. When a food ferments, it produces acids that prevent the growth of organisms that cause spoilage.

Roasting: - Roasting is another method of preserving food, this impacts desirable sensory qualities, enhances palatability, reduce antinutritional factors. Peanuts are roasted by stirring in hot sand in a flat bottom frying pot over hot flame.

Blanching: It is a method of preservation of food. It inactivates plant enzymes and minimize oxidative changes leading to deterioration in sensory and nutritional qualities e.g. Enzymatic browning e.g. Slices of yam for elubo (yam flour) production are heated in hot water in a pot for various durations.

Canning or bottling: - This process requires canning equipment and the ability to use a heat source. Foods preserved by this method are sealed in a closed container, such as a can, glass or bottle, such foods can be stored for up to a year.

Preserved food

Refrigeration and freezing: - these methods are one of the most commonly used processes commercially and domestically for preserving a wide range of food including prepared food stuffs. Naturally, this requires access to electricity-generated refrigeration systems but if you have this it is one of the easiest methods to store food. There are many guidelines available on how long food can be stored in refrigeration or in a freezer.

Irradiation: - food irradiation is a physical method of preserving food. It has been thoroughly researched over the past decade and is recognized as a safe and wholesome method. It has the potential both of disinfecting dried food to storage losses and disinfecting fruits and vegetables to meet quarantine requirements for export trade. Low doses of irradiation inhibit spoilage losses due to sprouting of root and tuber crops. One of the most important advantages of food irradiation processing or preservation is that it is a cold process which does not significantly alter physic-chemical characters of the treated product it can be applied to food after its final packaging

Modern industrial preservation techniques

Pasteurization

Pasteurization is a process for preservation of liquid food. It was originally applied to combat the souring of young local wines. Today, the process is mainly applied to dairy products. In this method, milk is heated at about 70 °C (158 °F) for 15–30 seconds to kill the bacteria present in it and cooling it quickly to 10 °C (50 °F) to prevent the remaining bacteria from growing. The milk is then stored in sterilized bottles or pouches in cold places.

Vacuum packing

Vacuum-packing stores food in a vacuum environment, usually in an air-tight bag or bottle. The vacuum environment strips bacteria of oxygen needed for survival. Vacuum-packing is commonly used for storing nuts to reduce loss of flavor from oxidization. A major drawback to vacuum packaging, at the consumer level, is that vacuum sealing can deform contents and rob certain foods, such as cheese, of its flavor.

Freeze drying

Artificial food additives

Preservative food additives can be *antimicrobial* – which inhibit the growth of bacteria or fungi, including mold – or *antioxidant*, such as oxygen absorbers, which inhibit the oxidation of food constituents. Common antimicrobial preservatives include calcium propionate, sodium nitrate, sodium nitrite, sulfites (sulfur dioxide, sodium bisulfite, potassium hydrogen sulfite, etc.)

Modified atmosphere

Modifying atmosphere is a way to preserve food by operating on the atmosphere around it. Salad crops that are notoriously difficult to preserve are now being packaged in sealed bags with an atmosphere modified to reduce the oxygen (O_2) concentration and increase the carbon dioxide (CO_2) concentration. There is concern that, although salad vegetables retain their appearance and texture in such conditions, this method of preservation may not retain nutrients, especially vitamins. There are two methods for

preserving grains with carbon dioxide. One method is placing a block of dry ice in the bottom and filling the can with the grain. Another method is purging the container from the bottom by gaseous carbon dioxide from a cylinder or bulk supply vessel. Carbon dioxide prevents insects and, depending on concentration, mold and oxidation from damaging the grain. Grain stored in this way can remain edible for approximately five years.

Nitrogen gas (N_2) at concentrations of 98% or higher is also used effectively to kill insects in the grain through hypoxia. However, carbon dioxide has an advantage in this respect, as it kills organisms through hyper carbia and hypoxia (depending on concentration), but it requires concentrations of above 35%, or so. This makes carbon dioxide preferable for fumigation in situations where a hermetic seal cannot be maintained.

Self-Check – 2	**Written test**

Name…… ID…… Date…….

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

Test I: Short Answer Questions (15%)

1. What are the packhouse operations?
2. Mention the traditional and modern preservation techniques
3. Why foods/crops are preserved?

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

Note: **Satisfactory rating – 15 points** **Unsatisfactory - below 15 points**

Information sheet 3- Monitoring and taking remedial action

Monitoring:

A designated Production manager or supervisor will inspect employees when they report to work to be sure that each employee is following the Standard Operation Practices(SOP).

• The Production supervisor will monitor that all employees are adhering to the personal hygiene policy during all hours of operation.

Corrective action: Retrain any employee found not following the procedures in the SOP.

Verification and record keeping: The production manager will verify that employees are following the SOP by visually observing the employees during all hours of operation.

The production manager will verify that employees are following this SOP by visually observing the employees during all hours of operation.

Date implemented: _____By: _____

Date reviewed: _____ By: _____

Date revised: _____ By: _____

A monitoring checklist

Processing	Yes /No	Corrective action
• All produce stored or prepared in facility is from approved sources.	☐ ☐	_____
• Food equipment utensils, and food contact surfaces are properly washed, rinsed, and sanitized before every use.	☐ ☐	_____
• Procedures are in place to prevent cross-contamination.	☐ ☐	_____
• Produce is handled with suitable utensils,		

such as single use gloves. ☐ ☐ _____

• Clean reusable towels are used only for sanitizing equipment and surfaces and not for drying hands, utensils, or floor. ☐ ☐ _____

Finished product storage area	Yes/ No	Corrective Action
• Temperatures of storage area is between 15º-18 º	□ □	_____
• All cartons are stored 6 to 8 inches off the floor.	□ □	_____
• The FIFO (First In, First Out) method of inventory management is Used.	□ □	_____

Self-Check – 3	**Written test**

Name…… ID…… Date…….
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (15%)

1. What is the importance of monitoring post harvest operations?

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

Note: **Satisfactory rating – 15 points** **Unsatisfactory - below 15 points**

Information sheet 4- Recording packing and preservation processes

Records must be kept of all post harvest pesticide applications for preservation purpose including:

- ✓ Crop name
- ✓ Location of application
- ✓ Application date
- ✓ Type of treatment
- ✓ Pesticide trade name
- ✓ Product quantity applied
- ✓ Operator's name
- ✓ Justification for and type of application machinery can be recorded

Packing operations also recorded like:

- ✓ The type of package
- ✓ The type of packed produce
- ✓ Date of production and expiration
- ✓ Recipes
- ✓ Nutritional value
- ✓ Bar codes or any other relevant information on traceability are also included on packaging.

Table 4.1 Packaging sheet

Date	Fruit	Batch # or tag (from production book)	Weight (kg) of dried fruit before packaging	Size of packaging 100g, 50g, 2kg Bulk etc.	Total pieces (Packages)	Dried ends weight (kg)	Total kg# of packages plus dried ends weight.	Authorised signature

Self-Check – 4	**Written test**

Name…… ID…… Date…….

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

Test I: Short Answer Questions (10%)

1. What is the importance of record keeping?
2. What are the information that should be recorded in packing and preservation activities?

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

LG #91	LO #6- Implement storage

Instruction sheet-6

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

- Reviewing storage requirements
- Confirming storage and handling of produce.
- Monitoring storage processes and facilities and taking remedial action
- Recording storage processes and conditions

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

- Review storage requirements
- Confirm storage and handling of produce.
- Monitor storage processes and facilities and taking remedial action
- Record storage processes and conditions

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information sheet 1- Reviewing storage requirements

Introduction

Although in many parts of Africa certain crops can be produced throughout the year, the major food crops such as cereal grains and tubers, including potatoes, are normally seasonal crops. Consequently the food produced in one harvest period, which may last for only a few weeks, must be stored for gradual consumption until the next harvest, and seed must be held for the next season's crop. In addition, in a market that is not controlled, the value of any surplus crop tends to rise during the off-season period, provided that it is in a marketable condition. Therefore the principal aim of any storage system must be to maintain the crop in prime condition for as long as possible. The storage and handling methods should minimize losses, but must also be appropriate in relation to other factors, such as economies of scale, labour cost and availability, building costs and machinery cost.

Food storage is an important component of food preservation. Many reactions that may deteriorate the quality of a food product occur during storage. The nutrient content of foods may be adversely affected by improper storage. For example, a significant amount of vitamin C and thiamine may be lost from foods during storage. Other undesirable quality changes that may occur during storage include changes in colour, development of off-flavours, and loss of texture. A properly designed food storage system allows fresh or processed foods to be stored for extended duration while maintaining quality.

Requirements for safe storage

Crops left standing un-harvested start to show diminishing quantitative and qualitative returns through shatter losses and attacks by insects, mould, birds and rodents. It is therefore important to complete harvesting as soon as possible. In addition, it is necessary to remove dust and contaminants, which can include insects, and vegetable material, such as bits of straw and chaff and weed seeds. These will fill up pore spaces

Within the crop, inhibiting air movement and adding to any possible spoilage problems. The crop must therefore be clean.

One of the most critical physiological factors in successful grain storage is the moisture content of the crop. High moisture content leads to storage problems because it encourages fungal and insect problems, respiration and germination. However, moisture content in the growing crop is naturally high and only starts to decrease as the crop reaches maturity and the grains are drying. In their natural state, the seeds would have a period of dormancy and then germinate either when re-wetted by rain or as a result of a naturally adequate moisture content.

Another major factor influencing spoilage is temperature. Grains are biologically active and respire during storage. One of the products of respiration is heat, and reducing the temperature of the crop can help to diminish the rate of respiration, thereby lengthening the storage life by lessening the possibility of germination. Another major temperature effect is on the activity of insect and fungal problems. With lower temperatures, the metabolic rate of insects and fungi decreases and consequently so does the activity causing spoilage. A damp or warm spot in grain will increase the rate of respiration. In addition to heat, another product of respiration is moisture.

Careful control of atmospheric gases, such as oxygen, carbon dioxide, and ethylene, is important in extending the storage life of many products. High humidity conditions are required in order to prevent moisture loss and to preserve the freshness of fruit during low temperature storage. Given the fact that most fungi cease to grow under relative humidity conditions of less than about 90 per cent and only a few can grow at 85 per cent relative humidity, a relative humidity of 90 per cent is usually the best compromise condition for the storage of fruit.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

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

Test I: Short Answer Questions (10%)

2. What is the principal aim of storage?
3. What are the requirements of safe storage?

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

Information sheet 2- Confirming storage and handling of produce

Facts about fresh fruit storage

Fresh fruit:

• keep better under refrigerated conditions;

• shrivel or wilt under dry air conditions due to moisture loss;

• are damaged by freezing.

Cold storage

Temperature control is one of the main tools for extending the post harvest life of fresh fruit. Low temperatures slow the rate of produce metabolism and the growth of microorganisms responsible for quality deterioration. Low temperature, in addition, minimizes the vapour pressure between the produce and the external environment, reduces water loss and thereby contributes toward maintaining freshness.

Tropical fruits, when stored at temperatures below 15 °C but above 0 °C are easily damaged by 'chilling injury,' a disorder that results from the exposure of susceptible tissues to temperatures below 15 °C (Figure 2.1). It is, therefore, important to store fruits that are susceptible to "chilling injury" at temperatures above 10 °C. The susceptibility of a fruit to chilling injury is influenced by the species, variety and conditions under which it is grown. High humidity conditions are required in order to prevent moisture loss and to preserve the freshness of fruit during low temperature storage. Given the fact that most fungi cease to grow under relative humidity conditions of less than about 90 per cent and only a few can grow at 85 per cent relative humidity, a relative humidity of 90 per cent is usually the best compromise condition for the storage of fruit

Figure 2.1 Chilling injury of banana

Good practice for the cold storage of fresh fruits

– Never expose harvested produce to direct sunlight; keep in cool, shady places with adequate ventilation;

– Store only good quality fruit: i.e. produce that is clean, mature and free from disease and injury;

– Store tropical fruits that are susceptible to “chilling injury” at temperatures above 10 °C (for non chill sensitive produce: 0–5 °C);

– Store ripe fruits separately from unripe ones;

– Do not mix fruits of different kinds in one cold store (This could lead to the absorption of off flavors, as well as to rapid deterioration of ethylene sensitive fruits);

– Store fruit in containers that can withstand stacking without getting deformed or without injuring the commodity

Fruits must be stored in clean containers (i.e. they do not harbor contamination that could serve as a source of inoculum);

– Place containers of produce on pallets to avoid direct contact with the floor;

– Allow adequate clearance between the walls and floor of the storage container so as to allow for ventilation, air circulation and cleaning – 45 cm (17.5 inches) between pallets and walls and 10 cm (4 inches) between pallets and floors;

– Use an organized system for managing inventory within the cold store. Codes and inventory rotation are important in minimizing the time that the commodity is stored and to facilitate recall, should problems arise later in the food chain;

– Do not store chemicals, trash, waste or odorous materials in the vicinity of produce. – Maintain the cold store in a hygienic condition by systematically and periodically cleaning the walls, floors and ceilings to avoid contamination with filth;

– Monitor and maintain records of the temperature and relative humidity of the cold store in order to prevent or delay microbial growth;

– Remove produce from cold storage during the cool part of the day in order to prevent "sweating," i.e. moisture condensation on the commodity, which provides a good environment for microbial growth.

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 (Table 2.1). 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

Table 2.1 : Classification of horticultural crops according to their controlled atmosphere storage potential at optimum temperatures and relative humidities.

Range of storage duration (months)	Commodity
More than 12	Almond, Brazil nut, cashew, filbert, macadamia, pecan, pistachio, walnut, dried fruits and vegetables
6-12	Some cultivars of apples and European pears
3-6	Cabbage, Chinese cabbage, kiwifruit, persimmon, pomegranate, some cultivars of Asian pears
1-3	Avocado, banana, cherry, grape (no SO_2), mango, olive, onion (sweet cultivars), some cultivars of nectarine, peach and plum, tomato (mature-green)
<1	Asparagus, broccoli, cane berries, fig, lettuce, muskmelons, papaya, pineapple, strawberry, sweet corn; fresh-cut fruits and vegetables; some cut flowers.

Grain storage

Where can we store grain and beans?

Grain and beans are stored in tall grain elevators, almost always at a rail head near the point of production. The grain is shipped to a final user in hopper cars. Grains can be irradiated at the point of production to suppress mold and insects

Building for grain storage

Things to consider when deciding whether a given building would be a good choice for storing grain: Sanitation. Can you get the building clean enough for grain storage? If the building previously contained manure, ag chemicals, or petroleum products, can you completely remove these materials and their odors so that grain will not be physically contaminated or pick up odors that would result in down grading? Also, take a look at

the way the building is constructed and try to determine whether you can keep birds and rodents away from the grain.

Method of storage

The following are the different method of storage:

a) Improved grain storage (for small scale and large scale storage)

b) Underground storage structure

c) Surface storage structure (bag and bulk storage)

d) Commercial storage (silos, steel, tower silos, bag silos etc)

e) Warehousing

f) Rhombus, cribs, barns and raffles

g) Canning Surface Storage Structures Food grains in a ground surface structure can be stored two (2) ways –bag or bulk storage

Bag storage

a) Each bag contains a definite quantity, which can be bought, sold or dispatched without difficulty;

b) Bags are easier to load or unload.

c) It is easier to keep separate lots with identification marks on the bags.

d) The bags which are identified as infested on inspection can be removed and treated easily; and

e) The problem of sweating of grains does not arise because the surface of the bag is exposed to the atmosphere

Bulk or loose storage

The exposed peripheral surface area per unit weight of grain is less. Consequently, the danger of damage from external sources is reduced; and Pest infestation is less because of almost airtight condition in the deeper layers.

Improved grain storage structures

- The underground storage structures

  In underground storage, a portion of a ground may be dugout and line with water proofing materials. Then used for storing agricultural produce. Here, structures similar to a well with sides plastered with cow dung is constructed. They may also be lined with stones or sand and cement. They may be circular or rectangular in shape. The capacity varies with the size of the structure in mind. Underground storage may also make use of underground tanks.

  Advantages underground storage structures

- They are safer from threats from various external sources of damage, such as theft, rain or wind.
- They space can temporarily be utilized for some other purposes with minor adjustment and;
- They are easier to fill up owing to the factor of gravity.

Silo storage

Silo is a structure for storing bulk materials. Silos are used in agriculture to store grain (like in grain elevators) or fermented feed known as silage. Silos are more commonly used for bulk storage of grain, coal, cement, carbon black, woodchips, food products and sawdust.

Chemical storage

This is the use of some less toxic chemical like preservatives to keep the food product in a good state so it can be kept for some period of time. The product is protected

against quantitative and qualitative loses by the use of such method of preservation as are necessary.

Use of Warehousing

Warehouses are large house or hall that has a storage structures. It is especially constructed for the protection of the quantity and quality of processed agricultural products.

Self-Check – 2	**Written test**

Name…… ID…… Date…….
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (10%)

1. Explain **g**ood practice for the cold storage of fresh fruits

2. List out the facts about the fresh fruit storage

3. Explain the different methods of storage of crops

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

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

Information sheet 3- Monitor storage processes and facilities and taking remedial action

Grain storage management

The storability of grain depends on the grain quality, moisture content, and temperature. Grain moisture content must decrease as grain temperature increases to safely store grain. For example, the allowable storage time of 22 percent moisture corn is about 190 days at 30 degrees, 60 days at 40 degrees, and only 30 days at 50 degrees. Therefore, as stored grain temperature increases the grain moisture content must decrease for safe storage. Stored grain temperature increases in the spring due to outdoor temperatures increasing and solar heat gain on the bin. There is more than twice as much heat gain from solar energy on the south wall of a bin in early spring (raining season) as there will be during the summer (dry season). Immature grain and grain with damage to the seed coat is more prone to storage problems, so the grain should be stored at a lower moisture content than normal. Also, stored grain should be monitored more closely to detect any storage problems early.

Grain temperature and moisture content should be checked every two weeks during the spring and summer. Grain should also be examined for insect infestations. Corn needs to be dried to 13% moisture for summer storage to prevent spoilage. Soybeans should be dried to 11%, wheat to 13%, barley to 12% and oil sunflower to 8% for summer storage. Check the moisture content of stored grain to determine if it needs to be dried. Remember to verify that the moisture content measured by the meter has been adjusted for grain temperature. In addition, remember that moisture measurements of grain at temperatures below about 40 degrees are not accurate. Verify the accuracy of the measurement, by warming the grain sample to room temperature in a sealed plastic bag before measuring the moisture content. Grain temperature should be kept cool during spring and summer. Periodically run aeration fans to keep the grain temperature below 40 degrees during the spring. Grain storage molds will grow and grain spoilage will occur in grain bags unless the grain is dry. Grain in the bags will be at average

outdoor temperatures, so grain will deteriorate rapidly as outdoor temperatures increase, unless it is at recommended summer storage moisture contents.

Self-Check – 3	**Written test**

Name…… ID…… Date…….
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (15%)

1.What are the factors for storability of grains?

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

Note: **Satisfactory rating – 15 points Unsatisfactory - below 15 points**

Information sheet 4- Recording storage processes and conditions

Products should be stored off the floor in the storage room

• Staff entering storage room should wear protective clothing: (boots/rubber sandals & headgear)

• Check storage room daily and ensure protection against insects and rodents maintained.

• Keep storage room door and windows shut when not in use.

• Ensure correct ventilation is maintained

• Closely monitor duration of product in storage and record any anomalies.

• Always ensure that First In/First out (FIFO) system of stock control is used.

• Every product in/out of the storeroom should be correctly documented (use stock control sheets)

Self-Check – 4	**Written test**

Name…… ID…… Date…….
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (5%)

1. Point out the information that should be recorded in storage of produce

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

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

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