

# **CROP PRODUCTION**

## **Level-III**



**Based on April 2022, Version 1 Occupational  
Standard**

**Module Title: - Performing post-Harvest management  
for Horticultural Crop**

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## Introduction to the Module

This module covers the knowledge, skills and attitude for implementation of horticultural crop harvest, post-harvest operations, co-ordinate post-harvest activities, implement post-harvest treatments, implement hazardous waste disposal guidelines, implement packing and appearance requirements of produce and Implement storage requirements of produce.

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## LG #1

## LO #1 Plan and implement horticultural crop harvest

### Instruction Sheet 1

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

- Introduction to the module
- Estimating of the commencement date and the time span
- Calculating the equipment and labour resources required
- Planning harvest on the maturity indexes for horticultural crops
- Determining, planning, and describing method and order of harvesting

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:

- Estimate of the commencement date and the time span
- Calculate the equipment and labour resources required
- Plan harvest on the maturity indexes for horticultural crops
- Determine, plan, and describe method and order of harvesting

### 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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

## Information Sheet 1

### Introduction

Appropriate production practices, careful harvesting, and proper packaging, storage, and transport all contribute to good produce quality. Quality cannot be improved after harvest, only maintained; therefore it is important to harvest fruits, vegetables, and flowers at the proper stage and size and at peak quality. Immature or over mature produce may not last as long in storage as that picked at proper maturity.

#### 1.1 What is Post-harvest?

A pragmatic (practical) science primarily deals with perishable commodities however, also concerned the harvest of the crop (e.g when and how to harvest ; maturity standard, etc) Pre-harvest factors (seed sources, root stock etc) because they strongly influence post-harvest quality, ultimately, maximum product quality is determined at harvest.

Post-Harvest Technology:-is a science and art dealing those activities under taken from harvesting until the product reaches the hand of consumers or refers to the time period from harvesting/removing of usable part from the mother plant or its growing environment to the time of utilization, deterioration or death or losses of quality.

#### Post-Harvest Goals

1. Harvest product at its optimum maturity
2. Maintain the product's internal and external quality throughout packing, storage and distribution. It is alive during this process.

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3. Deliver the fruit to consumer at the time and in a form (e.g ripe, cut up, etc ) that they will purchase it .

## **1.1 Estimation of the commencement date and the time span**

### **1.1.1 Post harvest Shelf Life**

- Once harvested, vegetable and fruit are subject to the active process of senescence.
- Numerous biochemical processes continuously change the original composition of the crop until it becomes unmarketable.
- The period during which consumption is considered acceptable is defined as the time of "post harvest shelf life".
- Post harvest shelf life is typically determined by objective methods that determine the overall appearance, taste, flavor, and texture of the commodity. These methods usually include a combination of sensorial, biochemical, mechanical, and colorimetric (optical) measurements.

### **1.1.2 Post harvest Physiology**

- Post harvest physiology is the scientific study of the physiology of living plant tissues after they have denied further nutrition by picking.
- It has direct applications to post harvest handling in establishing the storage and transport conditions that best prolong shelf life.
- An example of the importance of the field to post-harvest handling is the discovery that ripening of fruit can be delayed, and thus their storage prolonged, by preventing fruit tissue respiration. This insight allowed scientists to bring to bear their knowledge of the fundamental principles and mechanisms of respiration, leading to post-harvest storage techniques such as cold storage, gaseous storage, and waxy skin coatings.

## **1.2 Calculating the equipment and labour resources required**

### **1.2.1 Confirming and arranging labour and equipment**

In horticultural crop, during post-harvest is important to confirm and arrange labour and equipment required before implementing post harvest operations considering the size of the field, weather condition and post harvesting material availability.

**Labour:** With small-scale family production for local markets, the labour supply will probably not be a problem. As the scale of commercial production and the distances between the rural producer and urban consumer increase, more exacting requirements will have to be met in regard to training and supervising labour. It is economically sound in terms of return to invest more in proper packing and handling of the produce before it leaves the farm. Growers will have to train their own field labour, accepting whatever support local extension workers are able to provide

#### **Assessing resource requirements**

Resource requirements for post- harvest handling are assessed giving consideration to the size of the commodity which mean the quantity of commodity in quintal and estimated timing of operation to complete a given commodity. These resources required will be stated in terms of personnel (these might be temporary, permanent, or contracted workers), machinery and equipment, consumables, and leasing arrangements.

#### **For example**

A certain Enterprise has grown tomato on the farm land area of 30ha and post harvest handling operation of the crop has become a big issue for the enterprise. Considering this situation the candidate is expected to perform the following activities.

- A. Prepare plan for post-harvesting machinery, man power and resource
- B. Prepare post-harvesting scheme

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Assumption:-

- total post-harvest handling days =3 days
- factory starts to on December 1<sup>st</sup>
- average crop yield per ha =200 qt/ha
- labour productivity =7 quintal /day/man
- average post harvest operating of one machine capacity /day = 150 qts
- A. calculate number of machine required
- B. calculate number of labour required

### 1.3 Planning harvest on the maturity indexes for horticultural crops

#### 1.3.1 Assessing crop maturity and quality

##### Maturity

When a fruit acquires the characteristic size and shape and is ready for harvest, it is said to be mature.

The stage of maturity at harvest decides the quality of products.

The harvesting of immature and over-mature fruits and vegetables lowers the quality of products.

Optimum maturity at harvest is a very important determinant to the final quality of the product. It is advantageous to harvest the crop at physiological maturity. However, it is always not possible to take up harvesting at this stage due to scarcity of labour and hence harvesting may be taken up calculating the crop duration. There are some definitions of maturity

##### A. physiological maturity

- **Physiological maturity** (natural maturity) means fruit has been ripened and seed have independent viability and ability to breed.

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- It is usually associated with full ripening in the fruits
- If harvesting for the purpose of picking ripe seeds or old grains, it's time to harvest.
- Is the final stage of fruit development while still attached to the mother plant .

#### **B . commercial maturity**

- A vegetable and fruits are said to be commercially mature when the plant parts have developed the characteristics preferred by consumers.
- **Commercial maturity** (edible organ maturity) means the edible organ of vegetable and fruits have grown to the desired shape, colour, flavor and fragrance, and have higher nutrition value.
- It is also the best period of hardness and has the highest merchandise value.
- Most of vegetables and fruits are harvested at the time, but at this time, some vegetable crops have not ripened completely.

**C. Harvest Maturity** It may be defined in terms of Physiological maturity and horticultural maturity, it is a stage, which will allow fruits / vegetables at its peak condition when it reaches to the consumers and develop acceptable flavour or appearance and having adequate shelf life.

**Ripening** Is the qualitative change that takes place ;-

- Softening of fleshy fruits (change in texture from firm to soft)
- Change in colour (loss of chlorophyll and synthesis of yellow or red pigments)
- Change in aroma in flavor
- Decrease in acidity
- Change of starch to simple sugar

## **Maturity determination**

• Harvesting at the right time is important because if you harvest too early ( may shrivel due to loss of water. If you harvest too late, the fruit loses firmness. Various factors are considered in determining the maturity of fruits such as :The following indicators show us the maturity of the crop in readiness for harvesting

### **A. Days from full bloom**

- Not always constant from year to year and from location to location
- May be used to indicate the earliest date of harvest

### **B. Colour**

- It is the most obvious change that occurs in many fruits
- Useful harvest indicator especially for varieties that requires multiple picking
- Major criteria used by consumers to determine whether the fruit is ripe or not.
- The most common change is the loss of green colour (degreening), but with few exception.E.g (Avocado)
- Decrease in chlorophylls and increase in anthocyanins (red and blue colors)

### **C. Shape**

- Used to decide fruit maturity because some fruits change their shape up on maturity.
- E.g: Immature banana fruits are angular in shape while mature ones are more rounds.

**D. Size** Measured by circumference, diameter, length, width, weight or volume. Normally immature fruits are known to be small compared to fruits of the same type (larger to maturity).

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**E. Flesh firmness** As fruits mature and ripen they soften Enzymes act on cell membrane, cell wall and intracellular materials breakdown which leads to soften the fruits

This softening can be estimated by subjective and objective methods.

- Subjective:- is by finger or thumb pressure,
- Objective: is by using a fruit pressure tester instrument called penetrometer.

The objective measurement is more important because it yields a numerical expression of flesh firmness.

E.g Mangoes are said to be mature when fruits have ability to withstand a pressure of 1.75 to 2kg/cm<sup>2</sup>

**F. Taste;-** Is subjective measure but with experience can be used to determine harvesting time.

**G. Iodine test ;-** Used to determine conversion of starch (complex carbohydrate) to simple sugar (for Apple). An Iodine solution will turn starch black but not affected by sugars As fruits mature and ripen, starch converted to sugars so the black staining disappears

E.g Iodine + Apple    black    immature apple (there is starch).

### **G. Measuring the total soluble solids in the juice (TSS)**

- Measuring the sugar content of the fruits
  - The percentage of sugar in juice is estimated from the soluble solids content
  - Commonly expressed as degree brix or grams of sucrose per 100 grams of juice
  - Procedures for determining soluble solids are found in different books
- ✧ The degree brix is most commonly measured with refractometer

- ✧ For grape and citrus high TSS shows maturity
- ✧ But growing condition can affect sugar content in the fruits so by it self this is not a good indicator.



**Figure 1.1;-mobile and digital refractometer**

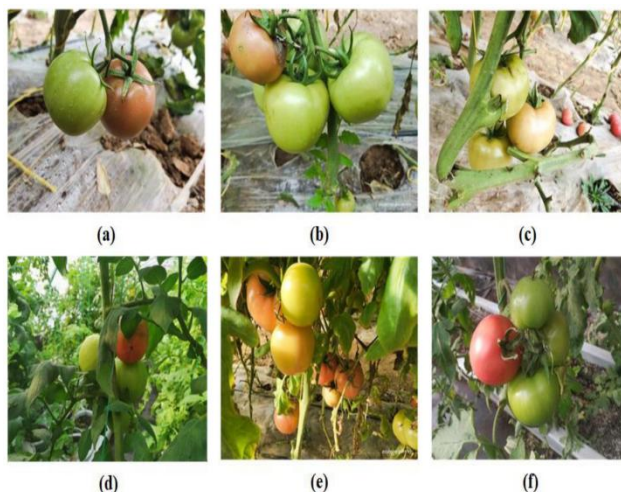
#### **H. Total acid (TA)**

- Measures the acid content of extracted juice
- Citric acid is the predominantly found acid in most fruits
- Malic acid (apple) and Tartaric acid (grape... Sugar to acid ratio
- For citrus fruits high sugar or to acid ratio shows maturity.
- Acidity decrease and pH increase due to – the breakdown of malic acid and citric acid – dilution of acid concentration as water content increase rapid.

#### **I. Oil content** For avocado high oil % shows maturity

- Mobile **refractometers** provide direct measurements **of maturity** in the field and can be carried out without harvesting the product.

- **Hand-held refractometers** are durable and very reliable (when used properly) field instruments for measuring sugars or soluble solids in fruits such as melons, citrus, pineapple and others.
- Some refractometers **measure per cent sugars directly**, while others measure soluble solids in Brix units that can be converted to show the percentage of sugar in the fruit.
- The '**Atago**' type refractometers are self-compensating for temperature differences but other units need to refer to temperature compensation tables. More precise analysis can be provided by laboratory equipment such as **photometers that measure the colour** of products and **spectrometers, which analyse the concentration of certain chemical components** in plant tissues.



**Figure 1.2;-** indicators of maturity of fruit

## 1.4 Determining, planning, and describing method and order of harvesting

### 1.4.1 method of harvesting

The goals of harvesting are to gather a commodity from the field at the proper level of maturity with a minimum of damage and loss, as rapidly as possible and at a minimum cost. This is

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achieved through hand-harvesting in most fruit, vegetable and flower crops. There are different method of harvest in. such as

### **A. Hand Harvesting**

Hand harvesting has a number of advantages over machine harvest. People can accurately determine product quality, allowing accurate selection of mature product. This is particularly important for crops that have a wide range of maturity and need to be harvested several times during the season. Properly trained workers can pick and handle the product with a minimum of damage.

Many fresh-market products have a short shelf life if they are bruised or damaged during harvest and handling. The rate of harvest can easily be increased by hiring more workers. Hand-harvesting also requires a minimum of capital investment. The main problem with hand harvesting is labour management. Labour supply is a problem for growers who cannot offer a long employment season. Labour strikes during the harvest period can be costly. In spite of these problems, quality is so important to marketing fresh- market commodities successfully that hand harvesting remains the dominant method of harvest of most fruits and vegetables and for all cut flowers. Effective use of hand labour requires careful management. New employees must be trained to harvest the product at the required quality and at an acceptable rate of productivity. Employees must know what level of performance and must be encouraged and trained to reach that level.

### **A. Mechanical Harvesting**

Mechanical harvest is currently used for fresh-market crops that are roots, tubers, or rhizomes and for nut crops. Vegetables that are grown below ground (radishes, potatoes, garlic, carrots, beets and others) are always harvested only once and the soil can be used to cushion the product from machine caused mechanical injury. Tree nuts and peanuts are protected by a shell and easily withstand mechanical handling. A number of products destined for processing such as

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tomatoes, wine grapes, beans, peas, prunes, peaches and some leafy green vegetables are machine harvested because harvest damage does not significantly affect the quality of processed product. This is often because the product is processed quickly after harvest. These crops have also been amenable to new production techniques and breeding that allow the crop to be better suited to mechanical harvest.

The main advantage of mechanical harvest equipment is that machines can often harvest at high rates. Tree nut harvesters, for eg. attaching a shaking mechanism to the tree and remove most of the nuts in few seconds. The nuts are either caught on a fabric- covered frame or picked up from the ground by other machines. This allows an orchard to be harvested very quickly compared to hand shaking with poles. Machine harvest also reduces management problems associated with workers. The commodity must be grown to accept mechanical harvest.

Demerits of Mechanical:- Harvesting Machines are rarely capable of selective harvest. Mechanical harvesting will not be feasible until the crop or production techniques can be modified to allow one time harvest. Harvesting machines often causes excessive product perennial crops eg. Bark damage from a tree shaker. The harvesting machines are quite expensive.

#### **1.4.2 factor that influence time of maturity and standard**

Time of maturity and standard can be influenced by several factors, such as genetics, environment (including weather, soil conditions, and fertilization), growing practices, and harvesting techniques.

#### **some factors that influence the time of maturity and standard of horticultural produce:**

- **Genetics:** The time of maturity and standard of horticultural produce varies based on the crop variety. Some varieties reach maturity faster than others, while others may take longer to mature.



- **Environmental conditions:** Environmental factors such as temperature, water availability, and sunlight can all influence the time it takes for a crop to reach maturity. For example, crops grown in warm temperatures may mature faster than those grown in cooler temperatures.
- **Growing practices:** The way crops are grown can also play a role in their time of maturity and standard. Factors such as fertilization, pruning, and pest control can all impact the rate at which a crop grows and matures.
- **Harvesting techniques:** The timing and method of harvesting can also influence the quality and standard of horticultural produce. For example, crops harvested too early may be underdeveloped and lacking in flavor, while crops harvested too late may be overripe and less desirable.
- **Post-harvest handling:** Finally, how horticultural produce is handled after harvesting can impact its quality and standard.

<b>Self-check 1</b>	Written test
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Name..... ID..... Date.....

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

**Test I: Write True or False**

1. The main advantage of mechanical harvest equipment is that machines can often harvest at high rates.
2. The timing and method of harvesting can not also influence the quality and standard of horticultural produce.
3. The goals of harvesting are to gather a commodity from the field at the proper level of maturity with a minimum of damage and loss, as rapidly as possible and at a minimum cost.

**Test II: Fill the correct answer in the black space**

1. \_\_\_\_\_ is types of maturity may be defined in terms of Physiological maturity and horticultural maturity, it is a stage, which will allow fruits / vegetables at its peak condition.
2. \_\_\_\_\_ is a fruit acquires the characteristic size and shape and is ready for harvest

**Test III: Short Answer Questions**

1. What are types of maturity
2. Write the basic techniques of maturity determination.
3. What are the difference between machine and hand harvesting?

## Operation Sheet 1

### 1.1 identify maturity index

#### A. Tools and equipment' .

- Refractometer
- Brit scale
- Colour chart
- Firmness tester:
- pH meter
- penetrometer
- Personal Protective Equipment (PPE) such as overall, Boots, Gown, helmets and Hand glove.

#### B. Procedures of determine maturity index

1. Select representative samples of the produce. The samples should be homogeneous, meaning that they should be alike in terms of size, shape and color.
2. Determine the harvest date of the samples. .
3. Measure the physical characteristics of the produce. These could include measurements such as size, shape, colour, surface texture, firmness and weight.
4. Conduct a chemical analysis of the produce. This could include measuring sugar content (Brix) or acidity levels.
5. Compare the results to previously established maturity indices for that particular crop.
6. Determine whether the produce is fully mature or not based on the results of the physical and chemical analyses.

## Operation Sheet 1.2

### 1.2 Determine order of harvesting

#### Tools and equipment

- sharp knives
- pruning shears
- Harvesting machine
- baskets

The general procedures for the order of harvesting horticultural produce:

1. Determine the optimal maturity stage for your specific crop by examining its size, colour, and texture.
2. Ensure that you have the right equipment and tools
3. Harvest the produce during the coolest part of the day
4. Handle with care to avoid bruising or damage,
5. Sort the harvested produce according to their maturity levels; separate diseased or damaged produce from healthy ones.
6. Store or transport to appropriate storage facilities in a clean, dry, and cool environment.

<b>LAP TEST-1</b>	Performance Test
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Name..... ID.....

Date.....

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1 hour. The project is expected from each student to do it.

Task-4.1 Perform techniques harvesting operation

## LG #2

## LO #2 Prepare for implementation of post-harvest operations

### Instruction Sheet 2

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

- Performing post-harvest operations
- Selecting materials, tools, equipment and machinery
- Performing pre-operational and safety checks
- Identifying, risks assessing, controls implementing and reporting OHS hazards
- 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:

- Perform post-harvest operations
- Select materials, tools, equipment and machinery
- Perform pre-operational and safety checks
- Identify, risks assess, controls implement and report OHS hazards
- 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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

## Information Sheet 2

### 2.1 Preparing for implementation of post-harvest operations

#### 2.1 perform post-harvest operations

In agriculture, post harvest handling operation is the stage of crop production immediately following harvest, including cooling, cleaning, sorting and packing.

#### Identifying post harvest operations

- post-harvest operations include:-
  - Transporting harvested produce from the field to post-harvest processing or storage facilities, grading, applying treatments, waxing, packing, labeling and, Storing harvested produce

There are several techniques that can be used to handle harvested produce effectively. Here are some of the most common ones:

1. **Sorting:** This involves separating the produce based on size, color, maturity, and other attributes to remove damaged or diseased produce.
2. **Washing:** This involves cleaning the produce to remove dirt, debris, and pesticide residues. Care should be taken to not damage the produce while washing.
3. **Cooling:** Rapid cooling of produce after harvest is important to maintain quality. Cooling slows down metabolic processes and reduces respiration rates that lead to deterioration.
4. **Packaging:** Packaging is used to protect the produce from physical damage, moisture loss or gain, and contamination. The packaging material should be appropriate for the produce being handled.
5. **Labelling and Traceability:** Proper labelling of the harvested produce helps in identifying the product during shipping and storage. It also helps in traceability, in case of any food safety concerns or recalls.

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**6. Transportation:** Produce should be transported in clean, well-maintained vehicles to prevent damage and maintain quality during transit.

**7. Storage:** The harvested produce should be stored in cool, dry environments with appropriate humidity levels to minimize loss of quality and spoilage.

**8. Handling:** Produce should be handled as carefully as possible to avoid bruises, cuts, and other mechanical injuries that can result in quality loss or spoilage. Overall, it is important to handle harvested produce with care throughout the entire post-harvest supply chain, from field to market, to ensure freshness, quality, and safety.

## **2.2. Selecting materials, tools, equipment and machinery**

**Materials** may include

- Preservatives
- Chemicals
- Gases
- Cleaning agents,
  
- Packaging materials and containers
- Labels
- Adhesives and proformas.

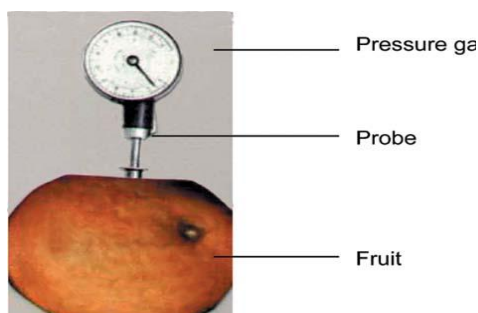


Figure 2.1 penetrometer

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### 2.3. pre-operational and safety check

- The effort to achieve an economic reward through the marketing of organic produce must begin well before harvest
- Seed selection can be a critical factor in determining the postharvest performance of any commodity
- Individual cultivars vary in their inherent potential for firmness retention, uniformity, disease and pest resistance, and sensory shelf life
- In addition to genetic traits, environmental factors such as soil type, temperature, and wind during fruit set, frost, and rainy weather at harvest can have adverse effects on storage life, suitability for shipping, and quality.

Planning for post harvest food safety should be included in any crop management plan.

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**Figure 2.1 safety check**

### **Assess Maturity**

The first step in the post harvest handling process is assessing maturity you want to make sure you pick the crop at the appropriate stage, and you want to make sure the pickers are trained on evaluating maturity. There are plenty of resources online that provide maturity indices with specific information for each crop detailing the appropriate harvesting stage.

### **Check your water quality**

Check your water source, and make sure that it's excellent quality before use. Be sure to evaluate the water quality frequently, using tests strips to evaluate chlorine content etc.

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As time goes on and more produce is comes in from the field, the water can become contaminated and spread to the other fruit. To sanitize, use sodium hydrochloride, bleach, hydrogen peroxide, peroxy acetic acid, or ozone.

All of these can be used for either conventional or organic crops. This way you are making sure you are not transferring the pathogen from one fruit to the other. You need to effectively kill them and make sure that any lesions do not allow for the pathogens to enter. The packinghouse manager should know after how many loads the water should be changed. If there is a bad quality load, you'll need to change the water immediately after that.

### **Avoid injury**

When you have cuts or cracks in the fruit, it creates entry points for microorganisms. To avoid this, make sure that knives are sharp, and that your crew is trained properly. The knives must not only be sharp, but they should be clean.

When transporting from the field to the packinghouse, make sure you don't overload the truck, because the fruit at the bottom can get compressed.

Also, make sure to gently load the produce onto trucks. Do not toss or throw produce onto the truck. This will help you avoid bruising.

### **Arrangement of Proper Storage room**

Make sure that the storage area is separate from the processing area. Make sure the area is properly sanitized, and that racks are away from walls to allow for cleaning and air circulation.

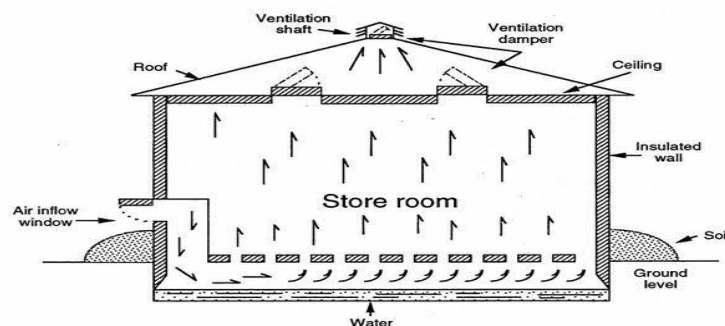


Figure 2.2. produce storage room

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## 2.4. Identifying, risks assessing, controls implementing and reporting OHS hazards

### .2.4.1 Identifying hazards

The term “hazardous” refers to anything which can affect an employee’s health. Effects can range from mildly irritating to potentially highly carcinogenic.

Occupational health and safety (OHS) is concerned with health and safety in its relation to work and the working environment.

#### **Types of hazards**

There are four main types of hazards associated with post harvest operation.

**Physical hazards:** These hazards arise from physical elements that make the food unsafe. Examples include rocks, glass, metal fragments, wooden particles, bones, noise, radiation (ionizing, electromagnetic or non-ionizing), heat, cold, vibration , pressure.

and other foreign objects that may contaminate the food during production, processing, or packaging.

**Chemical hazards:** Chemical hazards occur when poisonous or harmful substances are present in food. chemicals can cause damage to health and property. Some of these actions are mycotoxins in grains and processed food additives such as preservatives, pesticides.explosiveness, flammability, corrosion, oxidation, poisoning, toxicity, carcinogenicity...

**Biological hazards:** Mainly from infection or allergic reaction. Biological hazards include viruses, bacteria, fungi, and other organisms. Some biological hazards are potentially life threatening.

**Ergonomic hazards:** These are hazards from poor work design, layout or activity. Examples of ergonomic problems include manual handling, workplace layout and task design.

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**Psychological hazards:** Stress, violence at work, long working hours, lack of control in decision making about work can all contribute to poor work performance.

### **Assessing the Risks**

Risk is the likelihood that harm or injury from a hazard will occur to specific individuals or groups exposed to a hazard. For the risk to be real:

- ✓ the threat must exist;
- ✓ there is likely to be a magnitude of effect;
- ✓ There is the potential for occurrence.

### **Effects of hazards**

#### **Individually;**

- Death,
- Disease,
- Injury, Disability

#### **Effects on the Workplace:**

- Building damage
- Equipment Damage
- Loss of resource

#### **Effects on the Environment**

- Degradation Pollution

#### **Hazard control**

The recommended hierarchies of control measures for managing hazards are:

#### **1. Elimination**

Whenever possible, remove the hazard completely through elimination.

For example, when a task is automated and performed by a machine, the hazards associated with manually performing this task are eliminated.

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## **2. Substitution**

Where the hazard cannot be eliminated, consider alternatives to the substances, processes, machines and equipment currently being used.

Could any of these be replaced with a less hazardous substitute? Always realize, of course, that although a substitute may be considered “safer”, that does not necessarily mean it is completely safe or hazard-free.

Substitution reduces the risk of injury or illness to an acceptable level.

## **3. Engineering Controls**

Engineering controls involve the design of the workplace and it’s related processes. These controls include such factors as ventilation, isolation, containment and process control. Exhaust ventilation employed during welding operations can be considered an example of an engineering control. Other good examples would be the enclosing of noisy machinery or the isolation of a worker from excessive noise by providing a noise-insulated work booth.

## **4. Administrative Controls**

Where the hazard cannot be eliminated and where substitution and engineering controls do not adequately manage the hazard, administrative controls are frequently introduced to lessen the risk.

These measures may include changing work procedures, developing and implementing new policies and requiring personal protective equipment to be used. A typical example of an administrative control is the provision that suitable hearing protection be properly worn in areas

where noise cannot be reduced to acceptable levels through elimination, substitution or by engineering controls. Depending on the nature of the activity or task, it is not always possible or practical to eliminate all hazards. Nevertheless, all potential hazards must be identified and the risks controlled by the use of appropriate procedures or devices. Additionally, some tasks may have specific hazards that are beyond the scope or experience of local management. Examples

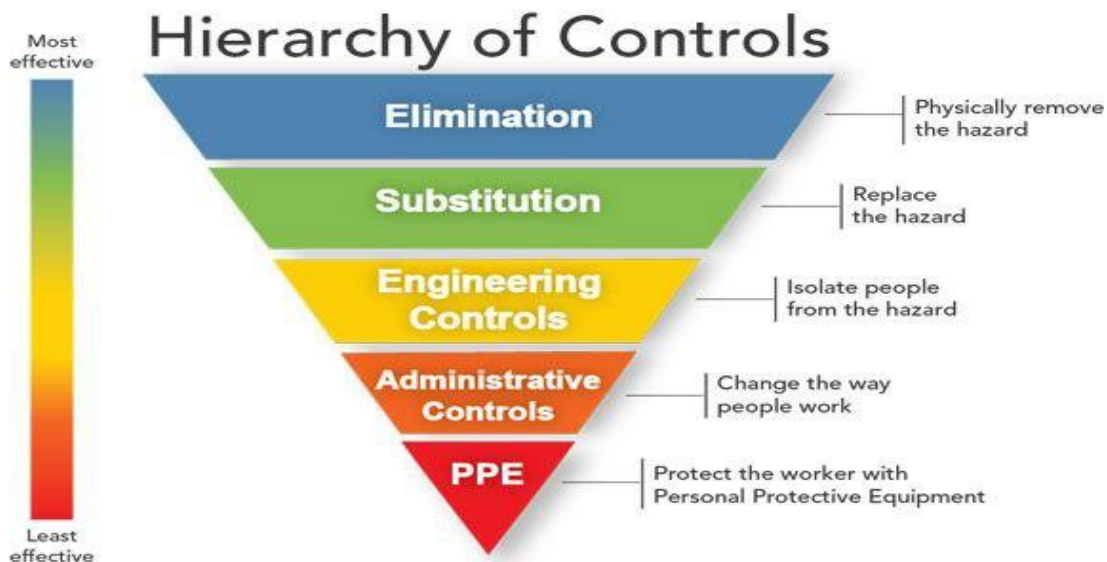
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would be work station design, specialty chemicals, radioactive materials, etc. In these cases managers must seek appropriate expertise to assist with the assessment and development of hazard controls.

When it is determined that administrative controls (i.e. Personal Protective Equipment) must be used to control a hazard, the documentation must be specific and include the selection criteria, instructions for proper use, care and maintenance, and employee training.

If employees may be potentially exposed to hazardous chemicals, the employer is required to develop a written hazard communication program that includes the following:

1. A MSDS (Material Safety Data Sheets) for each known hazardous chemicals used in the farm or business, along with container labelling or other forms of warning.
2. A written plan which outline the method that will be used inform employees, workers, and outside contractors of hazardous chemical to which they may be exposed while working on the site.
3. A program which explain the dangers of hazardous chemicals in the work area at initial work assignment and provides information about any new hazard introduced work area.



**Figure 2.3. method of hazard cont**

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## **2.5 Selecting, using and maintaining suitable safety and personal protective equipment (PPE)**

### **Definition**

PPE, as defined by the Occupational Safety and Health Administration (OSHA). OSHA is “specialized clothing or equipment worn by an employee for protection against injury by blunt impacts, chemicals, infectious materials etc.

### **Personal protective equipment (PPE)**

It is interesting to note that PPE because it only offers protection to the wearer and has a number of other limitations. PPE is the ultimate means of isolating a worker from a hazard by simply placing a barrier between him and his workplace environment. Thus, it represents a safe-worker rather than a safe-workplace policy, and the latter should always be given preference.

Nevertheless, personal protective equipment is widely accepted as an important option for controlling certain occupational risks, and is used widely as a precaution. Its precautionary role is to act as a last line of defence to prevent injury if any of the other control measures in the hierarchy of control fail. For example, you would still wear eye goggles when handling dangerous chemicals in a fume hood, just in case the fume hood failed or something broke or exploded.

PPE is widely used in many proactive industries as a tool to make workers more safety aware, many sites have specific requirements that certain forms of PPE are always worn in all work areas.

Basically, personal protective equipment is considered to be any article offering skin and/or body protection.

### **Types of PPE Used**

- **Gloves –**
- **Masks and respirators–**
- **Overall– protect**
- **Goggles –**

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- Face shields –
- Ear protectors-
- Protective clothing; -overalls, apron, waterproof clothing
- Head protection; -hat, sunscreen lotion and hard hat
- Eye protection; -goggles, eye glass
- Hearing protection; - ear muffs, ear plugs
- Respiratory protection; -respirator or face mask, face guard, self-contained breathing apparatus.
- Skin protection; - spray clothing
- Hand protection; - gloves
- Foot protection - boots
- Other safety equipment (e.g. harness).

### **Key Points about PPE**

- Do before going to work site
- Use carefully – don't spread contamination
- Remove and discard carefully, after finishing work

Immediately perform hand hygiene

### **Checking suitability of personal protective equipment**

Checking involves many things such as the checking in faultiness of the personal protective equipment, checking the size, and checking the sufficiency in number of the materials for the available work force. If one of these is missing based on the level of the risk that occurs the expected risk could occur. Therefore don't precede a job until the problems with the PPE will be solved. The size of PPE should be fit with your size, if the PPE is faulty it should be maintained or a new one should be provided, and if the number is not sufficient only people with the PPE should work the job.

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A high standard of personal hygiene is essential and should be encouraged amongst all workers using PPE. A personal hygiene policy should promote:

- Awareness of hazards at the workplace;
- Awareness of decontamination facilities provided;
- reporting of any injury, however minor, so it can be properly dressed;
- washing of hands thoroughly before eating or smoking in designated clean areas;
- Provision of clearly labelled drinking water in clean areas only;
- Awareness of importance of keeping personal sanitary facilities;
- Awareness of types of cleaning products available, and their applications.

A system for the appropriate selection (tests for effectiveness), use (training), maintenance (cleaning and storage) needs to be developed by the organization using PPE.

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<b>Self-Check 2</b>	<b>Written test</b>
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Name..... ID..... Date.....

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

**Test I: Write True or False**

1. Biological hazards are Mainly from infection or allergic reaction. Biological hazards include viruses, bacteria, fungi, and other organisms.
2. Engineering controls involve the design of the workplace and it's related processes.
3. Regular maintenance of equipment is an important and necessary activity.

**Test II: Fill in the black space**

4. \_\_\_\_\_ is types of hazard control method but can not be eliminated, consider alternatives to the substances, processes, machines and equipment currently being used.

**Test III: Short Answer Questions**

4. What does it mean PPE?
5. Write at least five the most popular PPE
6. When you plan protection strategy, what you consider?

## Operation Sheet -2

### 1.1 Techniques of personal protective equipments application and personal hygiene

#### A. Tools and equipment's

- Boots
- Overalls
- Gloves
- Respirator
- Facemask
- Sunscreen
- Hat
- Goggles

#### B. Procedures/Steps/Techniques

- Identify your tasks which protective equipment are needs and which does not needs
- Identify different types of protective equipment
- carry out how to wear protective equipments and clothing,
- Wear and Start your tasks
- In case of a pesticides spill or splash at work site, wash your body immediately after contact.
- Clean protective equipments and and clothing after application
- Wash your hands or take shower at the end of the application

## LAP TEST 2

Name.....ID.....Date.....

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

**Instructions:** Given necessary templates, tools and materials you are required to perform the following task within **30** minutes. The project is expected from each student to do it.

Task 1: Perform application techniques of PPE?

## LG #3

## LO #3 Co-coordinating post-harvest activities

### Instruction Sheet 3

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

- Identifying and tasks work team
- undertaking post-harvest operations to OHS requirements and environmental implications
- 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 tasks work team
- undertake post-harvest operations to OHS requirements and environmental implications
- 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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

## Information Sheet 3

### 3.1. Identifying and tasks work team

Work procedures will be based on sound horticultural principles and practices and include

- oral or written instructions of supervisors,
- post-harvest program or production schedule,
- marketing plan
- The cool chain concepts.,
- enterprise standard operating procedures (SOPs)
- specifications
- routine maintenance schedules
- OHS procedures
- Post-harvest program includes
- ✓ 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.
- work notes
- industry best practice guidelines on quality
- food safety and hygiene
- product labels and Material Safety Data Sheets (MSDS)
- manufacturers service specifications and operators manuals
- waste disposal,
- recycling and re-use guidelines, and



### **3.2. Undertaking post-harvest operations to OHS requirement and environmental implication**

#### **3.2.1 Environmental impact of waste disposal**

Waste disposal has a significant environmental impact that can affect our planet in various ways. The improper disposal of waste can lead to soil, water, and air pollution, which can cause serious health risks and harm to natural habitats. Landfills and incineration facilities can release harmful chemicals into the air, such as greenhouse gases that contribute to climate change. Additionally, the accumulation of waste in landfills can lead to soil and groundwater contamination, which can affect both the land and surrounding bodies of water. It is important that we properly dispose of our waste through methods such as recycling and composting in order to minimize the negative environmental impact.

#### **Environmental impact of excess noise**

Excess noise can have several environmental impacts. It can cause hearing damage or loss in humans and animals, especially those exposed to it on a regular basis. Furthermore, it can negatively affect wildlife, particularly those living in urban settings. For example, birds and insects that rely on sound for communication may struggle to survive in noisy environments. Excessive noise pollution can also disrupt sleep patterns, leading to a range of health issues such as stress and fatigue. Finally, noise pollution can also contribute to air pollution, as it can increase the emissions from vehicles and other sources by causing congestion and longer times spent on the roads. Overall, reducing excess noise is crucial for protecting both human and environmental health.

#### **Detrimental environmental impacts may arise where post-harvest activities**

Detrimental environmental impacts can arise from various post-harvest activities. For example, the use of chemical pesticides and fertilizers can lead to soil and water contamination, which can have long-term effects on the environment. In addition, the use of heavy machinery such as

tractors and harvesters can cause soil compaction, which can limit plant growth and biodiversity. The transportation of harvested crops can also contribute to greenhouse gas emissions and air pollution, especially if the crops need to be transported over long distances. Finally, improper storage and disposal of harvested crops can lead to food waste, which contributes to greenhouse gas emissions and takes up space in landfills. Overall, it is important that post-harvest activities are managed in an environmentally responsible manner to minimize their impact on natural ecosystems and mitigate greenhouse gas emissions.

**Occupational safety is crucial during post-harvest operations as workers are exposed to various hazards. Some of the safety requirements include:**

- Personal protective equipment (PPE) such as gloves, goggles, and boots should be worn by all workers to protect them from injuries and exposure to chemicals.
- Proper handling and storage of equipment such as tractors, harvesters, and conveyors is essential to prevent accidents.
- Workers should be trained on how to safely operate equipment and machinery used during post-harvest activities.
- . Labelling of hazardous chemicals is important to prevent accidental ingestion or exposure.
- Adequate lighting should be provided in storage facilities to prevent trips and falls.
- Workers should be aware of the risks associated with working at height in silos or grain elevators, and proper safety measures should be put in place, including the use of fall protection equipment.
- Regular maintenance and safety checks on equipment should be carried out to ensure safe operation.
- Emergency response protocols should be established and communicated to all workers in case of an accident or injury.

### 3.3. Maintaining a clean, safe and hygienic work area

Maintaining a clean, safe, and hygienic work area is important to ensure the health and safety of all workers. Some tips for achieving this include:

- **Regular cleaning** – all surfaces, equipment, and workspaces should be regularly cleaned to prevent dirt and debris from accumulating.
- **Proper storage** – all tools and equipment should be stored properly to prevent clutter and tripping hazards.
- **Waste management** – proper disposal of all waste is crucial to maintain hygiene in the workplace. All garbage should be disposed of in tightly sealed bins and removed regularly.
- **Personal hygiene** – workers should be encouraged to maintain personal hygiene by providing access to hand washing stations and other hygiene facilities.
- **Pest control** – regular inspections for pests like rodents and insects should be conducted to prevent contamination of the workspace.
- **Proper ventilation** – good ventilation is important to promote air circulation and prevent the build-up of dust and other harmful particles.
- **Safety equipment** – all workers should have access to safety equipment such as gloves, masks, and other protective gear as necessary. By implementing these measures, you can help create a safe and hygienic workspace for everyone at your workplace.

Tasks may include disabling unused tools, equipment and machinery and storing neatly out of the way of post-harvest activities, safely storing materials including chemicals on-site, using sign-age and safety barriers during and removing after post-harvest activities are completed, cleaning, fumigating or sterilizing post-harvest equipment and storage facilities, and swiftly and efficiently removing and processing debris and waste from the work area.

Next to tidiness, cleanliness is one of the most essential elements in maintaining a healthy and safe work environment. Not only does a clean workplace reflect the professionalism of a business or facility and help motivate employees, it also promotes a healthy workforce as a clean environment prevents accidents and the spread of germs. It is clear that hand washing and specific cleaning regimes in shared work environments and break-out areas help maintain a healthy workforce.

Many office managers strive to maintain a clear desk policy, few succeed. However, each employee should be responsible for keeping their individual work area tidy and clean. It takes very little time to adopt a “clean and tidy as you go” policy and it needn’t hinder work performance. Furthermore, there is no reason why employees shouldn’t contribute to keeping the common work areas clean and tidy. Simple acts such as putting rubbish in the correct bin, placing cups in the dish-washer or washing them up and putting them away would contribute greatly to achieving a better working environment.



Self-Check 3	Written Test
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Name..... ID..... Date.....

**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

**Test I: Write True or False**

1. proper disposal of all waste is crucial to maintain hygiene in the workplace. All garbage should be disposed of in tightly sealed bins and removed regularly.
2. regular inspections for pests like rodents and insects should be conducted to prevent contamination of the workspace. (1pt)

**Test II: Short Answer Questions**

1. What does it mean team work? .
2. Write the ways of Maintaining a clean, safe and hygienic work area

## LG #4

## LO #4 Implementing post-harvest treatments

### Instruction Sheet 4

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 produce that not meet specification.
- Selecting post-harvest treatments
- Integrating pest management strategy and marketing plan
- Conforming timing, rate, application method and environmental requirements
- Establishing post-harvest practices that meet economical and methodical
- 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 produce that not meet specification.
- Select post-harvest treatments
- Integrate pest management strategy and market plan
- Conform time, rate, application method and environmental requirements
- Establish post-harvest practices that meet economical and methodical
- 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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

**Information -4**

## 4.1. Grading and labelling harvested produce

### 4.1.1 Grading

is the process of sorting produce into different categories, for example size, shape, colour, freedom from pest and disease damage. Its purpose is to ensure that produce that goes on to market meets defined regulatory and retailer criteria.



Figure 4.1:- grading

Grading during post-harvest operations has several advantages, including:

- Quality control – grading helps to identify and separate produce that does not meet the specified quality standards, ensuring that only the best-quality products reach the market.



- Fair pricing – by assigning grades based on quality, producers can ensure they receive fair prices for their produce, and consumers can be confident they are receiving a product that meets their expectations.
- Marketing – grading allows producers to differentiate their products in the market and target specific consumer segments, such as those who are willing to pay more for higher-quality produce.
- Increased value – grading allows producers to add value to their products by meeting specific consumer demands, such as organic or locally sourced, and charging a higher price for these labelled produce. Reduced waste – grading allows for better utilization of harvested produce, reducing waste by identifying the produce that is not fit for market and directing it towards other uses, such as animal feed or processing.

Consistency – grading promotes consistency in the quality of produce delivered to the market, which helps build goodwill and trust between producers and consumers.

**sorting:**is removing out-of-type plants or physically damaged,unhealthy, rotten or immature produce.

#### 4.1.2 Labelling

**:- it is** written, electronic, or graphic communications on the packaging or on a separate but associated label Container number, packing date, produce details such as grade, number, brand,origin, variety, weight, producer details, quality assurance and handling instructions.



figure 4.2 packing and labelling

Grading and labelling harvested produce is an important process that ensures that consumers receive high-quality products and that the growers receive fair prices for their produce. Here are some tips for grading and labelling harvested produce:

- Sort the produce into uniform sizes and grades based on factors such as color, size, and shape.
- Use a grading system that is appropriate for the type of produce being harvested. For example, most fruits and vegetables are graded using a scale of A, B, or C, based on quality and appearance.
- Label the containers with the name of the produce, grade level, size, weight, date of harvest, and any other relevant information such as organic or locally sourced.
- Place labels in visible locations to make it easy for consumers to identify the product.
- Keep accurate records of each harvest to help track its quality over time.
- Train workers in proper handling and grading procedures to ensure consistency in the grading processes.
- Grading and labelling harvested produce is important for meeting consumer expectations and ensuring that growers get fair prices for their produce.

#### **4.2. Identifying and disposing produce that does not meet specifications and enterprise standards**

Removing out-of-type plants or physically damaged, unhealthy, rotten or immature produce is recommended.

- selecting characteristics influenced by seasonal and market forces such as: bud count, colors, health, maturity, moisture content, ripeness, shape, size, weight and length, texture, skin condition and blemishes, variety

Identifying and disposing produce that does not meet specifications and enterprise standards is crucial for ensuring the quality and safety of horticultural commodities. Here are some steps that producers and distributors can take to effectively identify and dispose of substandard produce:

- **Establish clear specifications and standards for your produce:** It's important to establish clear criteria for what is considered acceptable produce. This may include factors such as size, weight, appearance, ripeness, and freedom from pests or diseases.
- **Conduct regular inspections:** Regular inspections of the produce can help identify any substandard items before they are shipped to customers or distributed to stores. This can be done by trained personnel who have a thorough understanding of the specifications and standards for the produce.
- **Sort substandard produce:** Once identified, substandard produce should be sorted and separated from acceptable produce. This will help prevent contaminated or damaged items from being shipped along with good produce.
- **Dispose of substandard produce properly:** There are several options for disposing of substandard produce, depending on the severity of the issue.
- For minor issues, such as cosmetic blemishes or slight deviations from standard size or weight, the produce may be salvaged and sold at a lower price point or marketed for specific uses (e.g. making juice or canned goods).
- For more serious issues, such as contamination or disease, the produce should be immediately disposed of in a way that minimizes any potential risks to human health. Producers and distributors have a responsibility to ensure that their horticultural commodities meet high standards of quality and safety.
- By establishing clear specifications, conducting regular inspections, sorting substandard produce, and disposing of it properly, these businesses can help ensure that their products are safe and appealing to consumers while minimizing any potential risks associated with contaminated or substandard items.

### 4.3 selecting post- harvest treatment

#### **Post-harvest treatments**

**Post-harvest treatments** are a set of practices and techniques used to maintain the quality and safety of harvested crops, either before or after they are stored. They involve various processes such as cleaning, grading, sorting, packaging, and storing of agricultural produce. These treatments aim to reduce spoilage, minimize losses due to pests or diseases, and extend shelf life. Post-harvest treatments can also help to enhance the appearance, taste, and nutritional value of crops, making them more desirable for consumers or buyers.

#### **A. Special uses**

some crops which are seasonal and subject to long-term storage, or are highly perishable and transported over long distances to market, require special treatments in order to slow deterioration and minimize losses.

These treatments may be applied before, during or after packing and are supplementary to the routine measures, such as temperature and moisture control, which aim to reduce losses in all fresh produce.

#### **B. Curing**

Curing is one of the post-harvest treatments used primarily in the agricultural sector to extend the shelf life of crops, especially fruits and vegetables. It is a process of drying or dehydrating fresh produce like tobacco, coffee beans, potatoes, onions, garlic, sweet potatoes, and others. The curing process can be done either naturally or artificially. During natural curing, the crops are exposed to sunlight or heat for a specific period to dry out excess moisture and preserve the quality of the produce. Artificial curing may involve the use of heaters, fans, or other equipment to speed up the drying process. The curing process not only reduces spoilage but also enhances the flavor of crops and helps to maintain their nutritional value for long periods.

## **I. Root crop curing.**

- Root crop curing is a post-harvest treatment that is commonly used for crops like yams, cassava, and sweet potatoes to preserve their quality, extend their shelf life, and prevent infestation by pests.
- The curing process for root crops typically involves leaving the harvested crops in a shaded area for several days to dry out and heal any cuts or bruises on the skin. This helps to reduce the moisture content of the root crops, making them less susceptible to spoilage by fungi, bacteria, and other micro-organisms.
- Once the curing process is complete, the root crops are typically stored in cool, dry places to maintain their freshness and quality. Curing is an essential step in the post-harvest processing of many root crops and helps to ensure that they remain safe, nutritious, and flavourful for an extended period after harvest.
- the roots and tubers must be kept at an appropriate temperature, normally some what higher than ambient, in order to stimulate new skin growth;
- the atmosphere must be kept moist but without free water on the surface of the roots or tubers; no new skin will be formed in dry air on injured surfaces.
- some ventilation is needed for new skin growth, but an excessive air flow will dry the atmosphere and cause a drop in temperature;
- The temperature must be kept steady; if it falls, water will condense on the surface of the roots and tubers and will encourage bacterial soft rot.

Although details vary from crop to crop (Table 1), the following conditions must always be observe

**Table 4.1. Conditions suggested for the curing of roots and tubers**

<b>Crop</b>	<b>Temperature (°C)</b>	<b>Relative humidity (%)</b>	<b>Curing time (days*)</b>
Irish potato	13-17	above 85	7-15
Sweet potato	27-33	above 90	5-7
Yam	32-40	above 90	1-4
Taro (dasheen)	30 -35	above 95	4-7
Cassava	30 -35	above 80	4-7

**I. Curing dry bulb onions.** The curing of dry bulb onions, carried out immediately after harvest, is a drying-out process. Under dry, warm conditions harvested onions are left in the field for a few days until the green tops, outer skins and roots are fully dried. Under wet conditions, it may be necessary to dry onions on racks or trays under cover.

The curing of onions is necessary because:

- the necks of onions are very sensitive to decay if they remain wet, especially if the green tops are cut off before harvest;
- drying the outer skins of the bulbs reduces decay and water loss;
- Roots damaged during harvesting are a common entry point for decay unless they are dried quickly.

NB Cutting off the green tops of bulb onions is not recommended for small-scale producers because it greatly increases the risk of losses from decay if the bulbs cannot be dried quickly under controlled conditions.

In large-scale commercial production, where the green tops are cut off mechanically before harvest, drying is often carried out using artificial heat with forced ventilation. This technique is

not economical for small-scale production. Field-dried onions can be stored up to two months under ambient conditions in well-ventilated trays on pallets or in a field windbreak. Dried onions should never be allowed to come into contact with damp soil.



Figure 4.3:- curing of onion

## II. Inhibition of sprouting

Sprouting is the process of germinating tubers and bulb crops etc.

Sprouting of both potatoes and onions is a problem in temperate countries, where they are stored for up to eight months.

- Two methods are employed to reduce sprouting:
  - ✧ the selection of varieties with long dormancy periods; suppliers of seed and planting material can be asked to provide information on storage characteristics of varieties produced under local conditions;
  - ✧ The use of chemical sprout suppressants for potatoes and onions to be stored. Some suppressants have to be applied to the growing crop before harvest (e.g. maleic hydrazide). Others such as tecnazene (which has both suppressant and fungicidal properties) are mixed as a dust or granules with potatoes as they are loaded into store. Suppressants are rarely used except in large-scale production and storage; they should be used only after consultation with extension workers. Little is known about the



effectiveness of sprout suppressants when used on tropical root and tuber crops.



**Figure 4.4:-Sprouting of potato**

#### **4. Fungicide applications**

Post-harvest application of fungicides to control decay is used on several major crops which are either stored or undergo long periods of transport to distant markets (citrus, bananas, apples, etc.). Fungicides are normally used only on produce which is washed and drained dry before packing.

##### **Application method**

Fungicide applications in post-harvest treatment is a common practice in agriculture to prevent the growth and spread of fungi on harvested crops. Here are some examples of fungicide applications in post-harvest treatment:

- **Dipping:** In this method, harvested crops are dipped into a solution of fungicide, which is designed to control the growth and spread of fungi on the surface of the produce.
- **Fumigation:** This involves exposing harvested crops to fungicidal gases, which destroy the spores of fungi present on the crops.
- **Spraying:** Fungicides are applied to harvested crops using a sprayer or a misting system. This method is effective in controlling the growth of fungi on the surface of harvested crops.



● **Dusting:** In this method, powdered fungicide is applied to the surface of harvested crops using a dusting machine.

● **Drenching.** A simple mechanized recirculating system pumps fungicide in a cascade over produce passing beneath it on a belt or roller conveyor. This system has no spray nozzles to wear out or become blocked, and the high flow rate through the pump keeps the mixture agitated. It may be necessary to add a non-foaming wetting agent in the suspension to counteract possible drag-out of the fungicide if foaming occurs.

This method is commonly used for controlling fungi growth on grains. Fungicide applications in post-harvest treatment can help prevent fungal infections from spreading during transportation and storage. These applications are essential for ensuring the quality and safety of agricultural produce during storage and distribution.

Users of post-harvest fungicides must observe that the fungicide for any crop is:

- permissible (i.e. not prohibited) for use on the crop after harvest;
- effective in controlling the post-harvest diseases of that crop;
- used in accordance with the manufacturers' instructions and at their recommended concentrations (excessive residues on produce may lead to its rejection);
- Agitated continuously during use to prevent its settling out.

Those in charge of operations must make sure that employees using fungicides observe all the precautions applicable to their use and that they wear the necessary protective clothing.

### **Requirements of controlled environment during after and before storage**

Controlled environment storage for horticultural crops has specific requirements to ensure that the crops remain fresh and of high quality throughout storage. Here are some of the key requirements:

#### **Ventilation**

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There should be free circulation of air through the stored produce. Air contains oxygen which is needed for respiration to occur in stored produce and carbon dioxide gas is produced as a waste product. An accumulation of carbon dioxide gas encourages the process of fermentation which breaks down the produce forming alcohol. This is undesirable because the quality of produce is affected. An increased rate of respiration also results in a greater production of carbon dioxide gas. The circulation of fresh air through the produce is important to reduce the carbon dioxide concentration of stored air.

Some fruits store better at reduced oxygen and increased carbon dioxide concentration. A controlled atmosphere should then be created (you are actually controlling the ratio of oxygen and carbon dioxide). This requires careful monitoring to ensure that the levels do not vary causing damage to the produce.

Ethylene is a gas produced naturally by plants. It promotes even ripening of fruits. Some fruits such as tomatoes and apples produce more ethylene than others so care must be taken when selecting types of crops that can be stored together.

### **Temperature**

It is advisable to harvest crops early in the morning when the temperature in the field is cool. At this time the rate of transpiration (water loss) is low. Produce should be shaded and kept cool by wetting with clean water to ensure that quality would be maintained. Produce that are harvested later in the day when the temperature in the garden is high experiences an increase in the rate of processes taking place in the plant. Under hot conditions during the day humans also have an increase in the rates at which processes are taking place. The body becomes “hot” and a person would perspire a lot to make the body cool. At this time the person will also reach for a cold drink. For this reason when the temperature in the garden is “hot” the harvested produce would be experiencing what is known as “field heat” and will begin to transpire a lot in an effort to cool down. For this reason you probably observed farmers giving the produce a good wetting of cold water. When the produce is cool they would not wilt and lose shape and size.

## **Humidity**

Humidity refers to the moisture content of the atmosphere. The air becomes moist when water evaporates or changes to water vapour. High humidity refers to air that is fully saturated or filled with water vapour, moist air. Under cold conditions the air is moist and the humidity is said to be high. This would certainly be desirable in the storage of fruits and vegetables. Do you know why? This ensures that they don't lose too much water by transpiration thus preventing drying out which results in shrivelled fruits and vegetables. It must be noted however that too much moisture encourages the growth and reproduction of some insect pest, fungi and micro-organisms. They are responsible for food spoilage in the storage unit.

Under warm conditions the air has the capacity to hold moisture then humidity is low. Although the risk of fungal attack is reduced, the rate at which the produce loses water increases causing drying out.

Sweet potatoes and pumpkin requires warm dry air (60- 70% relative humidity), Onions and garlic need a cool dry atmosphere in storage. Have you ever observed the sprouting of garlic and onions in your refrigerator? Consumers will not purchase sprouting onion and garlic. To prevent germination of dried grains or the growth on moulds on produce a low humidity is required.

The desired humidity level varies depending on the crop, but most horticultural crops require high humidity levels ranging from 80-90%.

## **Light**

Horticultural products should be stored in a dark environment to prevent the breakdown of chlorophyll, which can lead to discoloration and decreased quality.

## **Shelving**

Proper shelving is essential to avoid damage during storage and transport. Crops should be organized to prevent squeezing or crushing that may lead to bruising, which reduces their quality and shelf life.

## **Cleanliness**

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The storage environment should be clean to prevent any potential contaminants that may affect the freshness and quality of stored crops. Following these requirements will help maintain the quality and shelf life of horticultural crops during storage, ensuring that they are able to reach markets in good condition.

#### **4.4. Integrating pest management strategy and marketing plan**

some strategies for integrating pest management after the harvest of horticultural produce:

- A. Sanitation:** Proper sanitation is crucial in preventing pest infestations after the harvest. The storage area should be thoroughly cleaned before storing the harvested produce. Any debris, such as leaves or roots, should be removed to minimize potential hiding spots for pests.
- B. Temperature Management:** Controlling temperature and humidity levels within the storage facility is an excellent way to prevent pests during storage. Most horticultural produce do well at a temperature of 50-60°F and low humidity levels. Maintaining proper temperatures and humidity can slow down insect activity and prevent disease development.
- C. Ventilation:** Proper ventilation is an essential part of pest management after harvesting horticultural produce. Adequate ventilation can help to remove excess moisture that may attract insects or help mold and mildew develop, which can reduce the shelf life of the crop.
- D. Monitoring for Pests:** Regularly monitoring the stored produce for pests, such as rodents, insects, or fungal diseases, is critical in managing post-harvest issues by using Chemical, biological, physical etc
- E. Chemical control:** If pest infestations are too high and cannot be managed by other means, pesticides may need to be applied. However, it is important to use them only as a last resort due to possible negative effects on health, environment and taste of the product.

When developing a marketing plan that addresses client specifications that may include quality of plant produce, the following steps can be taken:

- a. Determine the Target Audience:** The first step is to identify the target audience and understand their needs and expectations. Knowing your target clients is essential to tailor your marketing message to them.
- b. Research Product Quality Expectations:** Next, research the quality specifications that are important to your target audience. These could include the size, shape, color, texture, taste, shelf life, and pesticide-free certification of the produce.
- c. Address any Quality Issues:** It is important to ensure that the quality of the product meets or exceeds the required specifications. Any quality issues need to be addressed immediately before delivering the product to clients.
- d. Develop a Compelling Marketing Message:** The marketing message should highlight the unique selling point(s) of your product, such as being sustainably produced, organic and/or pesticide-free. It should also emphasize the high quality of the produce, while addressing any other factors that are important to your target clients.
- e. Determine Marketing Channels:** Choose appropriate marketing channels tailored to reach the intended audience effectively. Some channels that can be used for promoting high-quality horticultural produce include print, social media, email marketing, and events.
- f. Measure and Analyze Results:** Finally, measure and analyze the results of your marketing efforts to determine which strategies are effective and which ones need improvement.

The marketing plan will address client specifications that may

include 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:

### **3.5 Conforming timing, rate, application method, environmental requirements and handling techniques of harvested produce.**

#### **generalized advice for post harvest handling of fresh produce:**

- Harvest produce during the coolest part of the day to reduce field heat which can damage the quality of the produce.
- Handle produce gently to prevent bruising and other forms of mechanical damage.
- Keep harvested produce in shaded areas to reduce exposure to direct sunlight which can accelerate deterioration.
- Maintain a constant temperature in your storage facility to slow down respiratory activity and prolong shelf life.
- Avoid storing produce with ethylene-producing fruits or vegetables, as they can cause ripening and spoilage of surrounding produce.
- Use appropriate packaging materials to prevent moisture loss, control humidity and humidity build-up which can promote fungal growth and other forms of decay.
- Practice good hygiene by sanitizing all equipment and surfaces used for post-harvest handling to prevent contamination.

- Monitor produce regularly for signs of decay, discoloration or other quality defects and remove any affected produce immediately. 9. Rotate stock regularly to ensure that older produce is used first and avoid spoilage of the entire lot due to one bad apple. Always follow recommended storage conditions for each type of produce to ensure maximum freshness, quality and shelf life.

### 3.5. Determining post harvest practices are economical, methodical, meet established work schedule and minimize damaged to produce.

some considerations to keep in mind during harvesting:

- **Conduct a cost-benefit analysis:** Before determining post-harvest practices, it is important to consider the costs associated with each practice, including labor, equipment, and materials. Choosing practices that are cost-effective can help minimize expenses and maximize profits.
- **Develop a schedule:** It is important to develop a schedule for post-harvest activities, taking into account the volume of produce harvested, the expected demand, and the time required for post-harvest handling. This can help ensure that all necessary activities are completed in a timely and efficient manner. **Use established protocols:** Established protocols for post-harvest handling can help ensure that practices are consistent and effective. These protocols can include procedures for sorting, washing, packaging, labeling, storage and transportation.
- **Focus on quality and safety:** Practices that focus on quality and safety can help minimize damage to produce, reduce waste, and maintain consumer confidence.
- **Prevention and early detection of problems:** Monitoring produce regularly for signs of decay or other quality defects can help prevent spoilage and minimize losses. It is also important to implement preventative measures such as good sanitation practices to reduce the risk of contamination.

**Ultimately**, determining post-harvest practices that are economical, methodical, meet established work schedules and minimize damage to produce requires a balanced approach that considers both economic factors and best practices for quality and safety. Ongoing evaluation and adjustment of post-harvest practices may also be necessary to optimize outcomes.

### **3.6. Cleaning and maintaining tools, equipment and machinery.**

#### **Sanitation**

All handling, storage, cleaning and washing equipment for horticultural products should be kept in a sanitary condition in order to minimize the risk of spreading infection. Diseased or damaged units should be sorted out and properly disposed of because their presence promotes the growth of fungi and bacteria. Insects infesting cull piles may fly to good produce and introduce pathogenic organisms and increase losses. Wash water should be changed at regular intervals before it becomes heavily contaminated with fungi and bacteria and spreads infection. In some cases the wash water is treated with chlorine or some other chemical in order to reduce the count of viable organisms. The environmental effects of good sanitation practice are minimal. Inspecting stored produce and cleaning storage structures on a regular basis will help reduce losses by minimizing the buildup of pests and discouraging the spread of diseases.



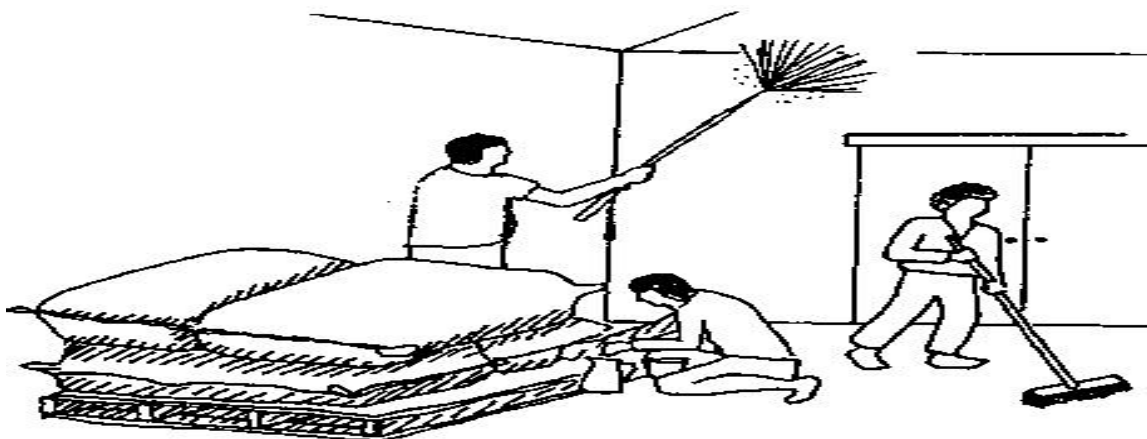


Figure:- Inspect produce and clean the storage structure:



Figure 4.5 :-Clean and maintain the storage structure:

<b>Self-check 2</b>	Written test
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Name..... ID..... Date.....

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

**Test I: Write True or False**

1. the quality of fruit and vegetables can be improved after harvest. (1point)
2. Practices that focus on quality and safety can help minimize damage to produce, reduce waste, and maintain consumer confidence. (1point)

**Test II: Fill in the black space**

3. \_\_\_\_\_ removing out-of-type plants or physically damaged,unhealthy, rotten or immature produce.
4. \_\_\_\_\_ is refers to the moisture content of the atmosphere.

**Test III: Short Answer Questions**

5. Write types of post harvest treatment
6. What does mean curing
7. What does it mean sprouting? How to solve?

<b>Operation Sheet 3</b>	<b>determine maturity index</b>
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## 1.1 techniques of post harvest treatment

### ● Tools and equipment' .

- ✓ Containers
- ✓ Cooling systems
- ✓ Sanitizing agents
- ✓ Packaging materials
- ✓ Humidity and temperature sensors
- ✓ Ethylene absorbent materials
- ✓ Pesticides and fungicides:
- ✓ Sorting and grading equipment
- ✓ Markers for labelling

### ● Procedures of techniques of post harvest treatment

1. Harvest the the produce correctly
2. Sort unwanted or does not meet specification
3. Grade the produce based on the specific criteria
4. Ripe the commodity if the commodity is climacteric
5. Clean the storage room
6. Store at Pre-cooling room if may be necessary
7. Store final Cooling room
8. Pack the produce
9. Label each relevant information
10. Store the produce at recommended storage room
11. Finally Handling and transportation:



**LAP TEST-4**

Name..... ID.....

Date.....

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1 hour. The project is expected from each student to do it.

Task-4.1 Perform post harvest treatment

<b>LG #5</b>	<b>LO #5 Implementing hazardous waste disposal guidelines</b>
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### Instruction Sheet

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

- Reviewing principle of waste disposal
- Monitoring, collection and disposal of waste
- Reporting conditions impact 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 principle of waste disposal
- Monitor, collection and disposal of waste
- Report conditions impact on business viability

### Learning Instructions:

7. Read the specific objectives of this Learning Guide.
8. Follow the instructions described below.
9. Read the information written in the information Sheets
10. Accomplish the Self-checks
11. Perform Operation Sheets
12. Do the “LAP test”

## Information Sheet 5

### 5.1. Reviewing principle of waste disposal

**Waste** is any material or substance that is discarded or unwanted and no longer serves any useful purpose. Waste can take the form of solid, liquid, or gas and can come from a variety of sources during post harvest activities.

Waste material may include small to medium branches, foliage, leaves, sticks, buds, flowers, fruit, bark, plant debris and chipped material.

There are several principles of waste disposal that are important to follow throughout the entire process from harvesting to consumption. These include:

**a) Minimizing waste at the source:** This involves reducing the amount of waste generated in the first place through efficient harvesting and processing methods.

**b) Separating waste:** Different types of waste should be separated and dealt with accordingly. For example, organic waste can be composted while non-biodegradable waste should be recycled or disposed of in a landfill.

**c) Proper storage:** Waste should be stored in a way that prevents contamination and transmission of disease.

**d) Safe transportation:** Waste should be transported in a safe and secure manner to prevent spillage and contamination.

**e) Disposal:** Waste should be disposed of in an environmentally responsible manner, whether it be through composting, recycling, or proper disposal in a landfill.

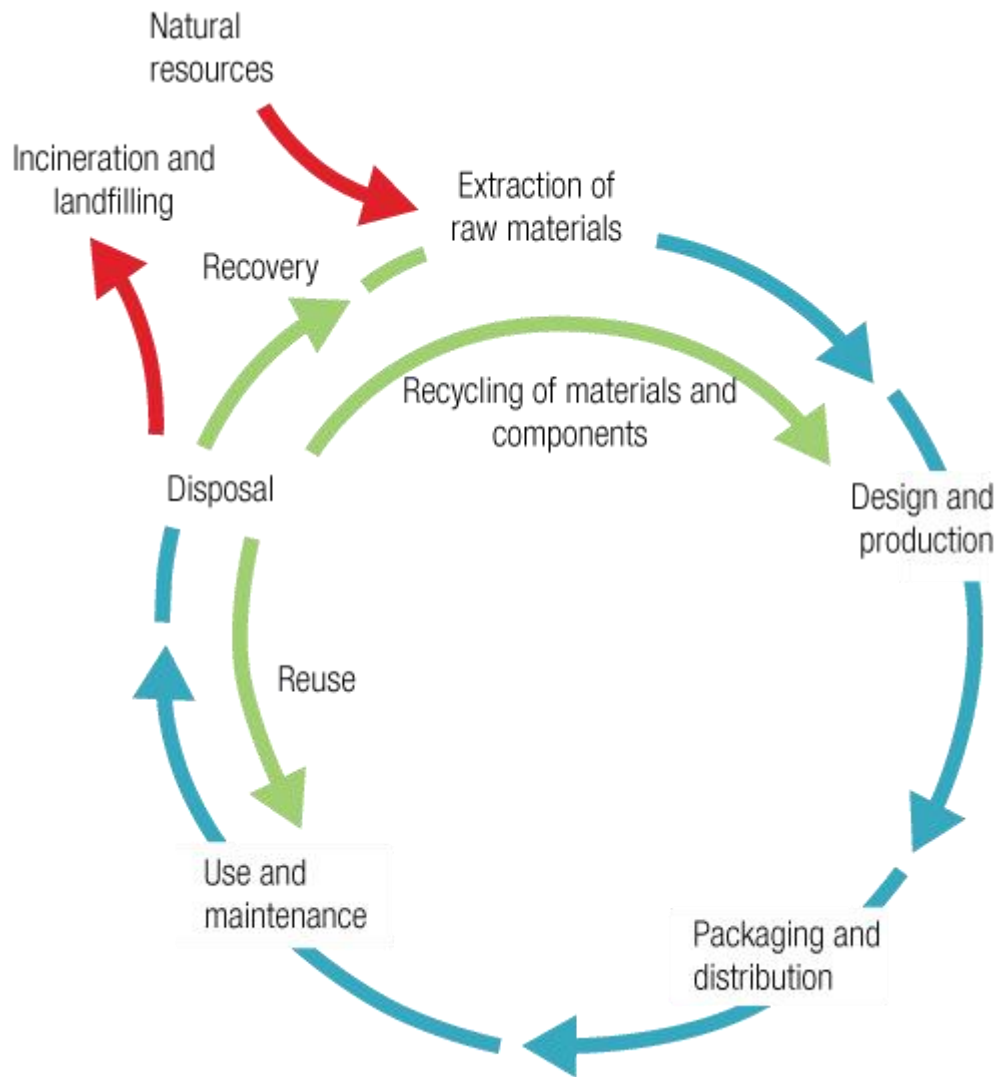


Figure 5.1 :- waste material management.

### Characteristics of wastes

Characteristic Hazardous Wastes are defined as wastes that exhibit the following characteristics: ignitability, corrosivity, reactivity, toxicity, infectious or pathogenic.

### **Ignitability**

Ignitable wastes can create fires under certain conditions, are spontaneously combustible, or have a flash point less than 60 °C (140 °F). Examples include waste oils and used solvents.

## **Corrosive**

Corrosive wastes are acids or bases (pH less than or equal to 2, or greater than or equal to 12.5) that are capable of corroding metal containers, such as storage tanks, drums, and barrels. Battery acid is an example.

## **Reactivity**

Reactive wastes are unstable under "normal" conditions. They can cause explosions, toxic fumes, gases, or vapours when heated, compressed, or mixed with water. Examples include lithium-sulphur batteries and explosives. There are currently no test methods available.

## **Toxicity**

Toxic wastes are those containing concentrations of certain substances in excess of regulatory thresholds which are expected to cause injury or illness to human health or the environment.

## **5.2. Monitoring collection of waste and disposal**

### **Waste management**

is the collection, transport, processing, recycling or disposal, managing and monitoring of waste materials. The term usually relates to materials produced by human activity, and is generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is also carried out to recover resources from it. Waste management can involve solid, liquid, gaseous or radioactive substances, with different methods and fields of expertise for each.

Waste management practices differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers.

Monitoring the collection of waste and its disposal is important to ensure that waste is being managed in a safe and responsible manner. The following are some key aspects of monitoring waste collection and disposal:

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- **Collection schedules:** Regular collection schedules should be established and adhered to, to ensure waste is collected on a timely basis.
- **Collection routes:** Waste disposal routes should be mapped out, ensuring efficient and safe transportation of waste.
- **Volume and type of waste:** The volume and type of waste generated should be monitored to identify trends and areas for improvement.
- **Recycling and composting rates:** Recycling and composting rates should be monitored to ensure that these practices are being implemented effectively.
- **Disposal methods:** The methods used to dispose of waste should be monitored to ensure that they are safe and comply with local regulations.
- **Environmental impact:** The environmental impact of waste disposal practices should be monitored, including air quality, water quality, and land use impacts.

Overall, monitoring the collection of waste and its disposal is important to ensure that waste is managed in a way that protects human health, the environment, and natural resources



**Figure 5.1. Waste management system**

### **5.3. Reporting conditions likely to impact on business viability**

There are different factor that impact on the business viability of post harvest operation thus factor must be reported to the supervisor and to the respected body or stakeholder to get reliable solution.

- Report should be reliable, true and easily understand by the reader.
- Reporting provide possible solution to the problem.



Self-check 5	Written test
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Name..... ID..... Date.....

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

**Test I: Write True or False**

1. The environmental impact of waste disposal practices should be monitored, including air quality, water quality, and land use impacts. (1point)
2. Waste should be transported in a safe and secure manner to prevent spillage and contamination.
3. Report should be not reliable, true and easily understand by the reader. (1point)

**Test II: Fill in the black space**

1. \_\_\_\_\_ is equipment worn by a worker to minimize exposure to specific hazards.
2. Performing a \_\_\_\_\_ of the workplace to identify and control physical and health hazards.

**Test II: Short Answer Questions**

- 3) How to manage waste?
- 4) How to dispose waste?
- 5) What does it mean waste recycle?



## Operation Sheet 5

### 5.1 techniques of waste management and disposal

#### C. Tools and equipment' .

- Cart
- truck:
- Grinder machine
- water
- Personal Protective Equipment (PPE) such as overall, Boots, Gown, helmets and Hand glove.

#### Procedures of waste management and disposal

1. Identify the Wastes : provides safe, effective, and efficient waste management services for managing non hazardous solid waste, recyclable waste, and hazardous waste.
2. Evaluate the Waste
3. Manage Wastes
4. Re Use and Redistribute
5. Incinerate and landfills



LAP TEST 4

Name..... ID.....

Date.....

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1 hour. The project is expected from each student to do it.

Task-1 Perform techniques of waste management and disposal

## LG #6

## LO #6 Implementing packing and presentation requirements of produces

### Instruction Sheet 6

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

- Specifying package and presentation requirement
- Conforming packing and presentation of produce
- Monitoring and remedial action for package and presentation processes
- Recording packing and presentation 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:

- Specify package and presentation requirement
- Conform pack and presentation of produce
- Monitor and remedial action for package and presentation processes
- Record pack and presentation 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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

**Information sheet-6**

### **6.1 Specifying package and presentation requirement**

Specifying package and presentation requirements is important to ensure that products are properly protected during transportation, storage, and handling, as well as to meet customer expectations. Some key factors to consider when specifying these requirements include:

- a) Size and weight:** The size and weight of the product, as well as the number of units per package, will affect the type of packaging required.
- b) Fragility:** If the product is fragile, it may require additional protection such as cushioning materials or shock-absorbing packaging.
- c) Temperature sensitivity:** If the product is temperature-sensitive, it may require special packaging materials or temperature-controlled transport and storage.
- d) Customer expectations:** The desired image or branding of the product can also affect packaging and presentation requirements.
- e) Sustainability:** Increasingly, customers are interested in sustainable packaging options, so this may be an important consideration when specifying packaging and presentation requirements. Overall, by considering these factors and identifying specific package and presentation requirements for each product, you can ensure that your products are safely transported and stored while also meeting customer expectations.

Fresh fruits and vegetables are generally packed in bamboo baskets, plastic crates, plastic bags, or nylon sacks for transportation, in many developing countries. Often, they are transported in an unpackaged form. After harvest, fresh fruits and vegetables are generally transported from the farm to either a packing house or distribution center. At the retail level, fresh produce is sold in an unpackaged form, or is tied in bundles. This type of market handling of fresh produce greatly reduces its shelf life if it is not sold quickly.



Packaging systems are available in a variety of materials such as plastic, corrugated fiberboard, wood, and even sustainable materials such as bioplastics and fibbers that decompose. other plastics using mechanical or vacuum thermoforming. Although plastic containers are necessary for certain commodities, corrugated and non-corrugated fibreboard is the dominant material used in fresh produce packaging.

Wooden containers, usually wire bound, are a traditional form of produce packaging. They are an option for growers, although their use has gradually diminished over time because they are relatively heavy, expensive, and abrasive to the fruits and vegetables, and because they can present disposal issues. Sustainable packaging options are becoming increasingly more common and offer many advantages over traditional packaging containers. While there are a variety of functional packaging options available to growers of fresh fruits and vegetables, it is important to select the appropriate format for each specific commodity.

Regardless of the material used, for a given commodity, it is important to use standard packaging sizes during the post harvest process so that growers can readily calculate total harvest by weight, count, and volume and thus more easily communicate production volumes to their buyers.

### **Characteristics of good Package for horticultural crop**

- It will facilitate cost-effective transportation of empty boxes and convenience in storage while not in use, e.g. collapsible plastic crates and corrugated fibre board boxes. •
- It should be easy to assemble, fill and close either by hand or by use of a simple machine. Semi-skilled labour can also fill and close comfortably.
- It must provide adequate ventilation and overall protection for contents during transportation, storage and marketing.
- Its capacity and size should be designed according to the market demands.
- It should have the proper dimensions and design which are suitable for transport systems to prevent any vibration damage.

- It should have sufficient strength in order to protect the contents against physical injury (impact, abrasion and vibrations) during entire distribution chain.
- It should not damage while doing special treatments like precooling, fumigation etc.
- It should be resistant to moisture and free from any sort of smell.
- It should have attractive shape, size and color and should have consumer appeal.
- It should provide information desired by consumers
- It must be cost-effective in relation to the market value of the commodity and the cost of packaging material.

## **6.2 Conforming packing and presentation of produce**

### **6.2.1. Advanced packaging systems**

Appropriate packaging materials and advanced packaging systems need to be developed to reduce post-harvest losses and increase the shelf life of fresh fruit vegetables. Actually there are various advanced packaging systems available for the fresh fruits and vegetables packaging.

#### **I. Modified atmosphere packaging (MAP)**

MAP is an effective method for prolonging the shelf life of fresh and minimally processed produce - making it ideal for long haul transport, exporters, the hospitality trade and retail packaging. Because MAP enables processors to extend shelf life without using chemicals it is also ideal for the packaging of organic produce.

MAP for the packaging of fresh fruit and vegetables differs markedly from that designed for meat, fish, poultry and bakery goods in that produce is still "alive" and respiring. The films typically used in the produce industry are selectively breathable films that offer high clarity, good sealing, and anti-fog properties.

Modified atmosphere packaging:

- Has a large application in fresh and cooked chilled foods.
- Is a very effective preservation technique, especially for chilled perishable foods.
- Extends shelf life from 25 – 100%
- Uses common gases of oxygen (O<sub>2</sub>), carbon dioxide (CO<sub>2</sub>) and nitrogen(N<sub>2</sub>). Other gases include carbon monoxide (CO), nitrous oxide (N<sub>2</sub>O), ozone(O<sub>3</sub>) and hydrogen (H<sub>2</sub>).
- Utilizes carbon monoxide for reducing the discoloration of fresh cut produces (highly toxic gas.).

## **II. Active and Intelligent packaging**

Active packaging technologies include materials that absorb shelf life-reducing gases such as oxygen or ethylene in fruit, and the last couple of years have seen increasing numbers of packs using vapour-release mechanisms for antimicrobials.

Active packaging incorporates additives into the packaging film or with in the package containers, which in turn maintains food quality and extends product shelf life. Examples include

- Oxygen scavengers
- Carbon dioxide scavengers/emitters
- Ethylene scavengers (suppresses produce respiration)
- Ethanol emitters (may be used as an antimicrobial agent)
- Preservative releasers
- Moisture absorbers
- Flavor/odor absorbers (to remove undesirable flavors and taints)

But as retailers compete for cheaper rather than more expensive food, the cost issue cannot be ignored.

## **III. Refresh (convex plastics)**

Refresh modified atmosphere packaging is especially ideal for ready-made retail bags for minimally-processed produce such as mixed salads, peeled carrots and stir fry mixes. Custom

designed to exactly match the handling conditions and respiration rate of the specific packaged produce, refresh films extend the life of fresh produce by manipulating the amount of O<sub>2</sub> and CO<sub>2</sub> contained within the packaging. Refresh Lidding offers anti-fog, high clarity, and the ability for the film's permeability to be custom-designed to match the respiration and extend the shelf-life of specific packaged fresh produce.

#### **IV. Edible films and coatings**

In general, the benefits of edible coatings include optimized shelf life, higher margins, product novelty, improved convenience and food safety.

**Ethylene gas** is a plant hormone which initiates senescence or ripening. It is active in very small amounts at 0.1 ppm. Ethylene action and binding to the receptor site is impeded by oxygen levels of less than 8%.

**Fresh produce** is generally packed in plastic crates, plastic bags or corrugated paper boxes. Corrugated paper boxes are used for the packaging of fixed counts of uniformly sized produce such as avocado, mangoes and oranges.

Boxes protect the commodity by cushioning and immobilizing it. They are easily handled throughout distribution and marketing, and can minimize the impact of rough handling. Boxes should serve as moisture barrier and should be designed with appropriate ventilation capacity. Corrugated paper boxes cannot, however, significantly extend shelf life even when used for the low temperature storage of fresh produce.

Much of the plastic material used in the bagging of fresh produce, is unsuitable owing to poor moisture and gas permeability. This often leads to condensation, high CO<sub>2</sub> and low O<sub>2</sub> levels in bagged produce, and results in flavor deterioration and fermentation or failure of the fruit to ripen. Thus use of plastic packaging designed for the marketing of fresh produce should incorporate consideration for factors such as: O<sub>2</sub> uptake, CO<sub>2</sub> production, and the production of heat and ethylene by the produce.

Low density polyethylene film is generally used for the packaging of fresh fruits and vegetables, owing to its high permeability and softness when compared to high density film.

Polyethylene can be easily sealed, has good O<sub>2</sub> and CO<sub>2</sub> permeability, low temperature durability, and good tear resistance and is of a good appearance. This film is therefore used for the production of modified atmosphere packaging (MAP) which can be manipulated to match the characteristic respiration of produce, by: reducing O<sub>2</sub> levels in order to slow down the respiration rate, metabolic rate, and senescence of the produce.

Effective O<sub>2</sub> levels must be maintained at between 2% and 10% in MAP systems, if fermentation of the produce is to be prevented. Elevated CO<sub>2</sub> levels reduce the sensitivity of fresh produce to ethylene, and slow down the loss of chlorophyll. At CO<sub>2</sub> levels ranging between 1% and 5%, however, fruit fail to ripen, internal breakdown occurs and off flavor development ensues. Oxygen and carbon dioxide transmission rates for MAP films should, therefore, match the respiration rate of the produce to be stored.

MAP is very effective in retaining freshness, and for extending the shelf life of fresh fruit and vegetables. MAP is also ideal for the marketing of minimally processed produce, such as mixed salads, fruit salads and fresh cut produce. This type of package is designed to exactly match the handling conditions and respiration rates of specifically packaged produce, by manipulating O<sub>2</sub> and CO<sub>2</sub> levels in the packages, so as to:

- Maintain the green color of leafy vegetables;
- Reduce loss due to the production of respiratory heat by produce;
- Maintain the natural fresh taste of produce;
- Extend the shelf life;
- Delay ripening

### **6.3 Monitoring and remedial action for package and presentation processes**

Packaging is an integral part of our everyday consumption of food, playing a key role in the production, preservation, distribution and marketing of food products. Packaging contains and protects the goods within it, not only from the shop to our home but throughout the supply chain.

**During packaging of horticultural commodities monitor the following activities**

- Size and weight of materials

- Fragility of materials
- Filling techniques
- Temperature sensitivity of material
- Customer expectation
- Sustainability

**Remedial action:** Develop a remedial action plan that outlines steps to be taken in the event that an issue is found during packaging, including how the issue will be addressed and what steps will be taken to prevent it from happening again in the future. for example hiring of skilled man power, give short training before activity, sanitation etc...

#### **6.4. Recording packaging and presentation processes**

##### **Recording**

Records are not widely used. This state of affairs is due to one or both of the following, many farmers are relatively un educated & therefore cannot keep records, and in addition the need for proper record keeping is not widely appreciated within the farmer's community.

##### **Uses of record**

Records assist a farmer to improve his business, b/c such records will enable him to establish whether or not the business being run profitably & whether or not his resource are being put to the best use. Records also help the farmer when he is preparing his budgets and farmers know how much produce are wasted. so, its indicate that help for the future activities.

which are estimates of his annual expenditure & income.

therefore Records can be used for diagnostic purpose & as sources of data for use in budgeting.



Self-check 6	Written test
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Name..... ID..... Date.....

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

**Test I: Write True or False**

1. MAP is very effective in retaining freshness, and for extending the shelf life of fresh fruit and vegetables. (1point)
2. Appropriate packaging materials and advanced packaging systems need to be developed to reduce post-harvest losses and increase the shelf life of fresh fruit vegetables.. (1point)

**Test II: Fill in the black space**

3. \_\_\_\_\_ is a plant hormone which initiates senescence or ripening.

**Test III: Short Answer Questions**

4. What are-specify requirements of packaging?
5. What does mean ethylen gas?
6. What does mean packaging?
7. What are advantage and dis advantage of ethylen gas?



## LG #7

## LO #7 Implement storage requirements of produces

### Instruction Sheet 7

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

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

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

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

- Specify and review storage requirements
- Conform storage and handle of produce
- Monitor storage processes and facilities
- 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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”



## 7.1 Specifying and reviewing storage requirements

### ● Cleaning

Techniques to ensure dust, pests, diseases and waste material are removed, such as dusting, fumigating, and sterilizing, sweeping, washing, techniques to ensure a level of hygiene that protects the quality and health status of stored produce.

### ● Washing and sanitation

**Sanitation** is great concern to produce handlers, not only to protect produce against postharvest diseases, but also to protect consumers from food borne illnesses. **E. coli**, **Salmonella**, **Cryptosporidium**, **Hepatitis**, and **Cyclospora** are among the disease-causing organisms that have been transferred via fresh fruits and vegetables. Use of a disinfectant in wash water can help to prevent both post harvest diseases and food borne illnesses.

Chlorine in the form of a sodium hypochlorite solution or as a dry, powdered calcium hypochlorite can be used in hydro-cooling or wash water as a disinfectant. Some pathogens such as **Cryptosporidium**, however, are very resistant to chlorine, and even sensitive ones such as **Salmonella** and **E. coli** may be located in inaccessible sites on the plant surface. For the majority of vegetables, chlorine in wash water should be maintained in the range of 75–150 ppm (parts per million.) The antimicrobial form, hypochlorite acid, is most available in water with a neutral pH (6.5 to 7.5).

### 7.1.1 Environmental conditions

#### Environmental factors

Following environmental factors are responsible for deterioration

1. Temperature
2. Relative humidity
3. Atmospheric gas compositions
4. Ethylene

5. Light

6. Other factors

## 1. Temperature

Environmental temperature plays very major role in deterioration of produce.

- Every increase of 10°C temperature above optimum increases the deterioration by two times
- Exposure to undesirable temperature results in many physiological disorders like; freezing injury, chilling injury and heat injury etc.
- Temperature influence growth rate of fungal spores and other pathogens.
- It affects the respiration and transpiration rate of produce.

### Cool night temperatures

Buildings should be positioned to intercept the prevailing night-time winds.

Buildings should be protected from the sun's heat (e.g. by using shade from trees, painting the building white or building double-skinned walls).

When the ambient air temperature falls below that of the produce, normally at night, the air has to flow through the stored produce by opening louvers (this process can be automated and fans can be used to increase air flow rates).

Evaporative cooling from the incoming air (i.e. passing through moist air) which assists in cooling and humidifying the store.

## 2. Relative humidity

The rate of loss of water from fruit, vegetables and flowers depends upon the vapor pressure deficit between the surrounding ambient air, which is influenced by temperature and relative humidity.

The rate of deterioration is a combined factor of temperature and relative humidity and affects the produce in following manner:

- Low Temperature & High Relative Humidity -- Low deterioration
- Low Temperature & Low Relative Humidity -- Moderate deterioration
- High Temperature & High Relative Humidity -- High deterioration

High Temperature & Low Humidity -- Very high deterioration

## 3. Atmospheric gas composition

- Build up of undesirably high carbon dioxide and very low levels of oxygen in the storage facility can lead to many physiological disorders leading to spoilage. Eg. Hollow heart disease in potato is due to faulty oxygen balance in storage or during transportation. Exposure of fresh fruits and vegetable to O<sub>2</sub> levels below the tolerance limits or to CO<sub>2</sub> levels above their tolerance limits in storage rooms may increase anaerobic respiration and the consequent accumulation of ethanol and acetaldehyde, causing off-flavours. The other bad effects of unfavourable gas composition include irregular ripening of certain fruits, soft texture, lack of characteristic aroma, poor skin colour development, etc..

Example: CA storage of Apples(0-10C with 1-2%CO<sub>2</sub> and 2-3%O<sub>2</sub>, RH 90-95%) for 6-12 month.

### Examples of ventilated storage

Potatoes can be held through the winter (three to nine months) provided they have been cured and treated with sprout suppressant.

After drying and curing onions can be stored using the same techniques but with lower humidity, (with onions there are great differences between varieties and production locations);

- ✓ Garlic can be held for three to four months.
- ✓ Sweet potatoes need to be cured at 28 to 30°C for a few days. Subsequently they can be stored for up to six months.
- ✓ Cabbages, carrots, pumpkins, apples, pears and lemons have all been successfully stored using ventilated stores (e.g. in Syria, apples can be stored in caves for nearly 10 months).

#### 4. Ethylene

Effect of ethylene on harvested horticulture commodities may be desirable or undesirable. On one hand ethylene can be used to promote faster and more uniform ripening of fruits. On other hand exposure to ethylene can deteriorate the quality of certain vegetables such as destruction of green colour in leafy and other vegetables, early senescence of flowers, bitterness in carrots, increased toughness, accelerated softening, discoloration and off-flavor, etc.

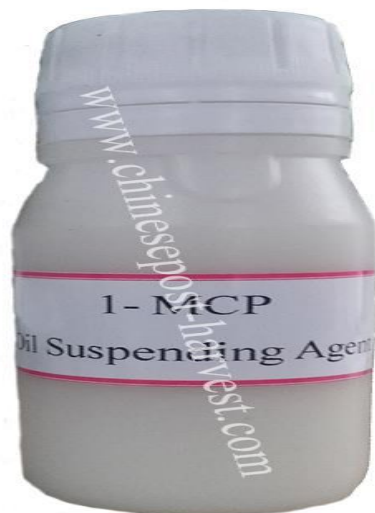


figure 7.1 ;- 1-MCP ethylene gas

## 5. Light

Exposure of potatoes to light results in greening of the tuber due to formation of chlorophyll and solanine which is toxic to human on consumption.

## Cooling

Temperature is the single most important tool for maintaining postharvest quality. For products that are not field-cured or exceptionally durable, the removal of field heat as rapidly as possible is highly desirable.

Harvesting cuts a produce off from its source of water, but it is still alive and will lose water, and therefore turgor, through respiration. Field heat can accelerate the rate of respiration and with it the rate of quality loss.

Proper cooling protects quality and extends both the sensory (taste) and nutritional shelf life of produce. The capacity to cool and store produce gives the grower greater market flexibility. Growers have a tendency to under estimate the refrigeration capacity needed for peak cooling demand. It is often critical that fresh produce rapidly reach the optimal pulp temperature for short-term storage or shipping if it is to maintain its highest visual quality, flavor, texture, and nutritional content.

**The five most common cooling methods are described below**

**Room cooling** – an insulated room or mobile container equipped with refrigeration units. Room cooling is slower than other methods. Depending on the commodity, packing unit, and stacking arrangement, the product may cool too slowly to prevent water loss, premature ripening, or decay.

Refrigerated stores offer the longest storage conditions for produce, however they have some disadvantages.

- They are expensive
- They require high quality technical management.
- They need electricity and, if supply is irregular, a generator.

- Ventilated stores can be extremely cost-effective but require specific conditions

**Forced-air cooling** – fans used in conjunction with a coolingroom to pull cool air through packages of produce.

Although the cooling rate depends on the airtemperature and the rate of airflow, this method is usually 75 to 90% faster than simple room cooling.

**Hydro cooling**– showering produce with chilled water to remove heat, and possibly to clean produce at the same time. The use of a disinfectant in the water is essential. Hydro cooling is not appropriate for all produce.

Waterproof containers or water-resistant waxed corrugatedcartons are required. Currently waxed corrugated cartons have limited recycling or secondary use outlets, and reusable, collapsible plastic containers are gaining popularity.

**Top or liquid icing** – an effective method to cool tolerant commodities, and equally adaptable to small- or large-scale operations.

It is essential that you ensure that the ice is free of chemical, physical, and biological hazards.

**Vacuum cooling** – uses a vacuum chamber to cause the water within the plant to evaporate, removing heat from the tissues. This system works well for leafy crops that have a high surface-to-volume ratio, such as lettuce, spinach, and celery. The operator may spray water onto the produce before placing it into the vacuum chamber. As with hydro cooling, proper water disinfection is essential. The high cost of the vacuum chamber system restricts its use to larger operations.

## **7.2. Conforming storage and handling of produce**

### **post harvest handling**

Losses in quantity and quality affect horticultural crops between harvest and consumption. The magnitude of post harvest losses in fresh fruits and vegetables is an estimated 5 to 25 percent in

developed countries and 20 to 50 percent in developing countries, depending upon the commodity. To reduce these losses, producers and handlers must understand the biological and environmental factors involved in deterioration and use postharvest techniques that delay senescence and maintain the best possible quality.

### **Temperature and Relative Humidity**

Temperature is the most important environmental factor influencing the deterioration of harvested commodities. Most perishable horticultural commodities last longer at temperatures near 0°C. At temperatures above the optimum, the rate of deterioration increases. Temperature also influences how other internal and external factors influence the commodity and has a dramatic effect on the germination and growth of pathogens. Temperatures outside the physiological norm can cause rapid deterioration due to the following disorders:

1. **Freezing injury.** In general, perishable commodities have high water content and large, highly vacuolated cells. The freezing point of the tissue is high, and the disruption caused by freezing usually results in immediate collapse of the tissues and total loss. Freezing is normally the result of inadequate refrigerator design or poor setting or failure of thermostats. In winter conditions, freezing can occur if produce is allowed to remain for even short periods of time on unprotected transportation docks. Susceptibly to freezing injury

These products can be injured by one light freezing:

Apricot	Cucumber
Asparagus	Eggplant
avocado	Lemons
Banana	Lettuce etc...
beans (snap)	berries (except cranberries)

High temperatures are also very injurious to perishable products. In growing plants, transpiration maintains temperatures in the optimal range.



Figure 7.2;-Freezing injured tomato and cauliflower

**2. Chilling injury.** Some commodities (chiefly those native to the tropics and subtropics) respond unfavourably to storage at low temperatures, even temperatures well above the freezing point but below a critical temperature termed the chilling threshold temperature. Chilling injury is manifested in a variety of symptoms including surface and internal discoloration, pitting, water soaking, failure to ripen, uneven ripening, development of off flavor, and highly susceptibility to pathogen attack



Figure 7.3 ;-chilling injured banana



## Dried and bulb crops

Onions, garlic and dried produce are best suited to low humidity in storage. Onions and garlic will sprout if stored at intermediate temperatures. The following table lists the storage conditions recommended for these crops.

**Table 7.1**;-storage temperature requirement of vegetable

	Temperature		RH	Potential storage duration
	°C	°F	%	
Onions	0-5	32-41	65-70	6-8 months
	28-30	82-86	65-70	1 month
Garlic	0	32	70	6-7 months
	28-30	82-86	70	1 month
Dried fruits and vegetables	<10	<50	55-60	6-12 months

For bulk storage of onions or garlic, ventilation systems should be designed to provide air into the store from the bottom of the room at a rate of 2 cubic feet per minute per cubic feet of produce. If produce is in cartons or bins, stacks must allow free movement of air. Rows of containers should be stacked parallel to the direction of the flow of air and be spaced six to seven inches apart. An adequate air supply must be provided at the bottom of each row and containers must be properly vented.

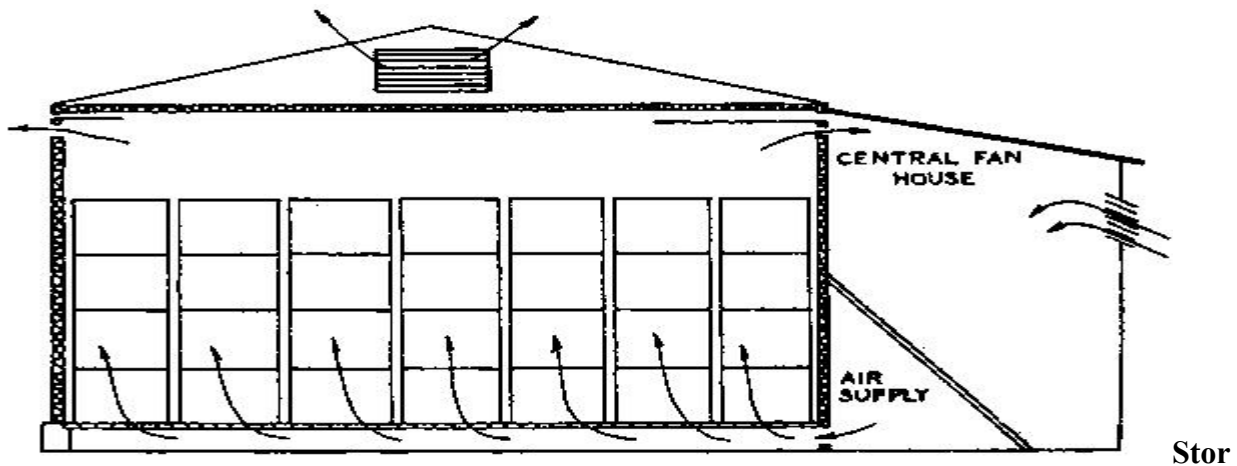


Figure 7.4 ; -Bulk storage

### Root and tuber crops

Potatoes stored for use as "seed" are best stored in diffuse light (CIP, 1981). The chlorophyll and solanine that accumulate will aid to protect the seed potatoes from insect pests and decay organisms.

Tropical root and tuber crops must be stored at temperatures that will protect the crops from chilling, since chilling injury can cause internal browning, surface pitting and increased susceptibility to decay.

Table 7.2 :-The recommended storage conditions for root and tuber crops are listed in the following table.

Types of crop	Temperature		RH (%)	Potential storage duration
	°C	°F		
Seed potatoes	0-2	32-36	95-98	10 months
Cassava	5-8	41-47	80-90	2-4 weeks
	0-5	32-41	85-95	6 months
Sweet potato	12-14	54-58	85-90	6 months
Yam	13-15	55-59	near 100	6 months
	27-30	80-86	60-70	3-5 weeks
Ginger	12-14	54-58	65-75	6 months
Taro	13-15	55-59	85-90	4 months

### Storage structures

**Ventilated stores.** Naturally ventilated structures can be used for the storage of produce with a long storage potential, such as roots and tubers, pumpkins, onions and hard white cabbage. Such stores must be designed and built specifically for each intended location. Any type of building can be used provided that it allows the free circulation of air through the structure and its contents.

The following essentials must be observed:

- the building should be located at a site where low night temperatures occur over the required storage period;
- it must be oriented to take maximum use of the prevailing wind for ventilation;

- the material covering the roof and walls should provide insulation from the heat of the sun; grass thatch on a bush-pole frame can be very effective, particularly if it is wetted to provide evaporative cooling;
- double-skinned walls will provide better insulation, if cost allows;
- white paint applied to surfaces of man-made materials will help to reflect the heat of the sun;
- the structure should be built in the shade of trees if they do not interfere with the prevailing air flow; beware of bush fires and of trees falling during storms;
- provide ventilation spaces below the floor and between walls and roof to give good air flow;
- If the store is subject to cold night temperatures, fit movable louvers and adjust them to limit the flow of warm air into the store during the day.

These are the basic requirements of a ventilated store. Such stores may be constructed to various levels of sophistication, using, where it is economically acceptable, fan-assisted ventilation controlled by differential thermostats. This type of store is in common use in Europe for the bulk storage of Irish potatoes and onions in locations where external winter conditions make possible the accurate control of the storage temperature.

Simple open-sided, naturally ventilated structures may be used to store seed potatoes at high altitudes in warm climates. They cannot be used for table potatoes, which will turn green, develop a bitter taste, or even become toxic if exposed to light for more than a few hours.

**Clamps.** These are simple, inexpensive structures used to store root crops, particularly potatoes.

The potatoes are placed on a bed of straw 1 to 3 m wide, but not more than 1.5 m wide in warm climates. A ventilating duct should be placed along the bottom.

The piled potatoes are covered with about 20 cm of compacted straw which can subsequently be encased in soil, applied without compaction up to 30 cm deep.

The clamp system can be modified for different climatic conditions. In warm climates extra straw casing may be used instead of soil in order to give added ventilation.

**.Other simple storage methods.** Windbreaks are narrow, wire-mesh, basket-like structures about 1 m wide and 2 m high, of any convenient length, on a raised wooden base, and are used for short-term storage of dried onions in the field. The onions are covered on top with a 30 cm layer of straw, which is in turn held down by a polythene sheet fastened to the wire mesh. The windbreak is built at right angles to the prevailing wind to obtain maximum drying and ventilation.

Onions can also be woven into plaits on twine and hung in a cool dry place, where they will keep for several months.

**Refrigerated and controlled-atmosphere storage.** For large-scale commercial operations, refrigerated storage may be used in a cold-chain operation to carry regular consignments from production areas to urban markets and retailers. This can be a highly complex operation requiring expert organization and management.

Cold storage can also be used for long-term storage of seasonal crops such as potatoes and onions. The storage life of some fruits, such as apples, can be extended by combining refrigeration with a controlled environment consisting of a mixture of oxygen and carbon dioxide.

These last are expensive operations with high maintenance and running costs, and demand skilled and experienced management. They have relatively little application to small-scale production in developing countries

**Field storage clamp:** Simple storage houses for potatoes can be constructed for small quantities of produce. The examples provided here can store 1 to 2 metric tons, and are used on farms an

## **Controlled Atmosphere Storage (CAS) of Fruits and Vegetables**

The transportation and storage of fresh fruits and vegetables is an international operation where technology must be used to ensure that produce reaches the consumer in the best possible condition. The use of controlled atmosphere storage has great potential to reduce the postharvest use of chemicals, maintain nutritional quality and organoleptic characteristics and reduce physical losses.

Controlled or modified atmosphere storage should be used as a supplement to, and not as a substitute for, proper temperature and relative humidity management. Air coming into the store room or being recirculated within the room must pass through a monitoring and control system.

### **Factors affecting storage life**

The natural limits to the post-harvest life of all types of fresh produce are severely affected by other biological and environmental conditions:

- A. **Temperature.** An increase in temperature causes an increase in the rate of natural breakdown of all produce as food reserves and water content become depleted. The cooling of produce will extend its life by slowing the rate of breakdown.
- B. **Water loss.** High temperature and injuries to produce can greatly increase the loss of water from stored produce beyond that unavoidably lost from natural causes. Maximum storage life can be achieved by storing only undamaged produce at the lowest temperature tolerable by the crop.
- C. **Mechanical damage.** Damage caused during harvesting and subsequent handling increases the rate of deterioration of produce and renders it liable to attacks by decay organisms. Mechanical damage to root crops will cause heavy losses owing to bacterial decay and must be remedied by curing the roots or tubers before storage. Curing is a wound-healing process.
- D. **Decay in storage.** Decay of fresh produce during storage is mostly caused by the infection of mechanical injuries. Furthermore, many fruits and vegetables are attacked by decay organisms which penetrate through natural openings or even through the intact skin. These

infections may be established during the growth of the plant in the field but lie dormant until after harvest, often becoming visible only during storage or ripening.

### **6.3. Monitoring storage processes and facilities**

If produce is to be stored, it is important to begin with a high quality product. The lot of produce must not contain damaged or diseased units, and containers must be well ventilated and strong enough to withstand stacking. In general proper storage practices include temperature control, relative humidity control, air circulation and maintenance of space between containers for adequate ventilation, and avoiding incompatible product mixes.

Commodities stored together should be capable of tolerating the same temperature, relative humidity and level of ethylene in the storage environment. High ethylene producers (such as ripe bananas, apples) can stimulate physiological changes in ethylene sensitive commodities (such as lettuce, cucumbers, carrots, potatoes, sweet potatoes) leading to often undesirable color, flavor and texture changes.

Temperature management can also be aided by shading buildings, painting storehouses white or silver to help reflect the sun's rays, or by using sprinkler systems on the roof of a building for evaporative cooling. Facilities located at higher altitudes can be effective, since air temperature decreases as altitude increases.

Certain commodities, such as onions and garlic, store better in lower relative humidity environments. Curing these crops and allowing the external layers of tissue to dry out prior to handling and storage helps to protect them from further water loss.

The air composition in the storage environment can be manipulated by increasing or decreasing the rate of ventilation (introduction of fresh air) or by using gas absorbers such as potassium permanganate or activated charcoal. Large-scale controlled or modified atmosphere storage requires complex technology and management skills.

## 6.4. Recording storage processes and conditions

### 6.4.1 Documenting and recording relevant information of storage

#### Definition of terminologies

**Recording** is the state or fact of being recorded or something that records: such as, something that recalls or relates past events or an official document that records the acts of a public body or officer and an authentic official copy of a document deposited with a legally designated officer.

**Reporting** is the presenting of news in newspapers, on radio, and on television, etc. in an honest way and impartial political reporting.

**Crop reporting** is the description of the crop in the growing stage, mentioning the present condition involving yield status and pest management with comments for improvement.

**Documentation** is the act or an instance of furnishing or authenticating with documents. It is the use of historical documents or conformity to historical or objective facts. It also used to accomplish the work profitability in time and in required standard

● Record-keeping and documentation are important processes that facilitate:

- ✓ Accountability
- ✓ Service improvement
- ✓ facilitate communication
- ✓ to provide relevant client information
- ✓ to conduct evidence-based research

The Golden Rules for working with recording documents are:

- write clearly and legibly
- do not rush
- fill out documents following appropriate SOPs, policies and procedures
- use the right document for the job if in doubt - ASK for advice
- do not guess





Self-check 7	Written test
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Name..... ID..... Date.....

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

**Test I: Write True or False**

1. Clamps are simple, inexpensive structures used to store fruits, particularly mango.(1 point)
2. An increase in temperature causes an increase in the rate of natural breakdown of all produce as food reserves and water content become depleted. (1 point)

**Test II: Fill in the black space**

3. \_\_\_\_\_ is types of cooling which are showering produce with chilled water to remove heat, and possibly to clean produce at the same time.
4. \_\_\_\_\_ is simple, inexpensive structures used to store root crops, particularly potatoes..

**Test III: Short Answer Questions**

5. What are requirements of storage facilities?
6. List and discuss types of cooling?
7. What are factor affecting of storage life?



## Operation Sheet 7.1

### 7.1 storage techniques of produce

#### D. Tools and equipment' .

- Storage room
- refrigerators,
- cold rooms,
- climate control systems,
- humidity meters,
- temperature sensors,
- packing materials, crates, pallets, trays, and shelves. Firmness tester:
- Personal Protective Equipment (PPE) such as overall, Boots, Gown, helmets and Hand glove.

#### Procedures of storage techniques

- Harvest the produce at the right time
- Sort and grade the produce .
- Pre-cool the produce if necessary to remove excess field heat and prevent moisture loss.
- Pack the produce in appropriate containers such as crates or pallets. The containers should be clean and made of materials that can withstand the weight and pressure of the produce.
- Store the produce in a cool, dry place with proper ventilation, and maintain temperature and humidity levels appropriate for each type of produce.
- Monitor the storage environment regularly
- Check the quality of the produce periodically
- Finally, transport the stored produce



Figure 7.5 storage techniques of produce

Operation sheet 7.2	Visiting storage structure
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## 7.2. Visiting storage structure:-

**Objectives:** to familiarize the trainee's with common storage structure of horticultural commodities.

**Materials:**

- Note book
- Pen/pencil

**Procedures:**

- Arrange the program.
- Visit the storage house that you have allowed to see.
- Additional/un permitted activity is strictly forbidden.



<b>LAP TEST-7</b>	Performance Test
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Name..... ID.....

Date.....

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1 hour. The project is expected from each student to do it.

Task-1 Perform storage techniques and visit storage structure

## Reference Materials

### Books:

- BY R. Wills, M. Golding, and B. Mc Glasson, 1998 first published, an Introduction to the Physiology and Handling of Fruit, Vegetables and Ornamentals" .
- BY Mirza Hasanuzzaman, et al. (2020), Advances in Post harvest Management of Horticultural Produce .
- BY Mohammed Wasim Siddiqui and Munir Ozturk (2020), Postharvest Management of Horticultural Crops: Practices for Quality Preservation

### Web addresses

- <https://youtu.be/C00m-iH68Z4>
- [https://drive.google.com/drive/folders/1ZQx2izO67L6n6jQ43F9yRMR5ktGnmq\\_-?usp=sharing](https://drive.google.com/drive/folders/1ZQx2izO67L6n6jQ43F9yRMR5ktGnmq_-?usp=sharing)
- <https://www.garri.ai/app/chat#:~:text=.%20Refractometer%3A%20A%20handheld,determine%20their%20maturity.> may 21,2023
- <https://www.garri.ai/app/chat#:~:text=Here%20are%20the,and%20cool%20environment.>
- <https://www.garri.ai/app/chat#:~:text=Occupational%20safety%20is,accident%20or%20injury.>
- <https://youtu.be/TBFHEbvY4bM>
- <https://horticulture.ucdavis.edu/information/webinar-how-improve-postharvest-management-horticultural-crops> -
- <https://www.taylorfrancis.com/books/edit/10.1201/9781003047650/advances-postharvest-management-horticultural-produce-chris-watkins>
- <https://horticulture.ucdavis.edu/information/advanced-postharvest-training-horticultural-crops> -
- <https://www.routledge.com/Postharvest-Management-of-Horticultural-Crops-Practices-for-Quality-Preservation/Siddiqui-Ali/p/book/9781774636084>
- [https://ucanr.edu/sites/Postharvest\\_Technology\\_Center\\_/files/231724.pdf](https://ucanr.edu/sites/Postharvest_Technology_Center_/files/231724.pdf)

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