# HORTICULTURAL CROP PRODUCTION

## Level -III

# Learning Guide -68

**Unit of Competence**: - Co-ordinate Horticultural Crop Harvesting

**Module Title: -** Co-ordinating Horticultural Crop Harvesting

**LG Code:** **AGR HCP3 M16 LO1-LG-68**

**TTLM Code:** **AGR HCP3TTLM 0120v1**

## LO 1: Maintain harvest requirements

| Instruction Sheet | Learning Guide #-68 |
|---|---|

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

- Maintaining enterprise tools, equipment and machinery
- Providing harvest workers sufficient tools, equipment and machinery
- Removing full and loading emptied containers

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

Specifically, upon completion of this Learning Guide, **you will be able to –**

- Maintain enterprise tools, equipment and machinery
- Provide harvest workers sufficient tools, equipment and machinery
- Remove full and loading emptied containers

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 5.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1,2 and 3” **in page -5,13 and15**
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).

| Information Sheet-1 | Maintaining **enterprise tools, equipment and machinery** |
|---|---|

## 1.1. Harvesting tools, equipment and machinery

Because the supply of fresh produce to domestic markets in Ethiopia comes mainly from relatively small-scale producers, mechanical systems for crop harvesting are likely to be rare. There is scope, however, for the use of mechanical aids in modest commercial operations where a tractor can be used in harvesting potatoes, sweet potatoes, onions, and other root crops by lifting up the crops and leaving them on the soil surface. Many fruits (for example mangoes and avocadoes) and vegetables (for example tomatoes) are adequately harvested by hand, without mechanical aids. Will invariably increase the speed of harvesting for crops such as grapes, lemons and oranges.

A neat cut of the stem will also eliminate rough edges created when the stem is hard with produce, which does not break easily. This will also have the advantage of reducing the incidence of mechanical post-harvest damages. Sharp knifes are indispensable for harvesting of commodities like lettuce, cabbage and broccoli. Most tools are specifically designed for each commodity and have to be as practical as possible to facilitate its utilizations by the workers.

At the end of the harvesting day they have to be cleaned and sharpened to prevent them being a source of microorganism contamination and have them ready for the following harvest. The desirability and need of harvesting tools increases as the size of the plant increases Many fruit trees, like new grafted varieties of mango and avocado, and old varieties of golden apples, are too large to allow manual harvesting from the ground and it is more efficient to use a suitable harvesting tool from the ground rather than have to harvest by climbing the tree.

### 1.1.1. Selecting tools, equipment and machinery according to harvest requirements

Selections of appropriate tools, equipment and machineries which are important for horticultural crop harvesting have a key role in safe handling, harvesting and keeping the quality of the product. Some of the major uses of the selecting appropriate tools, equipment and machineries include;

- Keeping the quality of matured products during harvesting
- Reducing crop damage during harvesting
- Speeding up the task of harvesting

- Keeping the health of mother plant for the next season (if it is fruit) …etc.

The tools, equipment and machineries appropriate for horticultural crop harvesting includes knives, machetes, rubber bands, string, calipers or sizing rings, specification charts or aids, gloves, bags, ladders, tractors, trailers, forklifts, powered ladders, containers, buckets, grading machinery, treatment chemicals, dip tins and bins. Therefore, you should have to know these tools and equipment by their names and should identify physically. Each of these materials, tools, and equipment has different functions and used depending on the type of horticultural crop harvesting activities.

Figure. 1 horticultural tool

### 1.1.2. Maintaining tools, equipment and machinery in effective working order

All materials, tools, equipment and machinery required for the different operations under taken under harvesting operation should be maintained and prepared in advance manner required by the enterprise work procedure Some of the major importance's of maintaining tools, equipment and machinery in effective working order is to:-

- ☞ Minimize the buying cost of new materials
- ☞ Facilitate and speed up the given work in effective manner.
- ☞ Reduce OHS hazards and risks
- ☞ Maintain and keep the quality of harvesting products
- ☞ Minimize the insufficiency of materials during harvesting.

- Then check and report to your supervisor the condition of these materials. After reporting the condition of materials, your supervisor will guide you what to do if there is insufficient of materials to perform this particular work.

| Self-Check -1 | Written Test |
|---|---|

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

1. List the tools, equipment and machineries appropriate for horticultural crop harvesting(5)

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

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-2 | Providing harvest workers sufficient tools, equipment and machinery |
|---|---|

## 2.1. Providing sufficient tools, equipment and machinery for the harvest workers

To retain the beauty of horticultural garden or farm, you need to put in commensurate efforts that require time, money and energy. The right tools and right attitude are functions of money and time while energy involvement will make horticultural project easy and quicker to accomplish. Having the right tools, knowing how to use them and management decisions Relating to the selection of horticultural tools and equipment, choice of practice, market availability, and availability of storage facilities among others are essential factors can affect Horticultural operations and production profits in several ways.

Depending on the type of horticultural crop to be harvesting and number of workers required for the work, it is the most important to provide harvest workers with sufficient tools, equipment and machinery to match harvest output and to prevent unnecessary interruptions. When undertaking any activity, selecting tools, equipment and machineries is essential to accomplish a given task successfully. During harvesting horticultural crops, tools, equipment and machinery may include:

- **Picking knives and shears**

In crops such as lettuce and cabbage, harvesting knives are usually used. The knife is placed between the first and second leaves and a single clean cut removed the head from the stem. The knives must be sharp at all times; otherwise it will not give a clean cut. The knife must be kept clean at all times. In between cutting, the knife must be dipped in a sanitizing solution. This will ensure that potential post-harvest diseases are carried from one head to the next.

In the case of fruit harvesting, fruit are harvested either by hand or some form of harvesting shears or cutter. These are used to cut the fruit stem from the branch. In this way you ensure that the fruit stem is not torn from the fruit. If the fruit tears, it will enable entry of disease and lead to rotting of the fruit. It is important that the fruit stem is not left too long as it could puncture the accompanying fruit in the bags on bins. All equipment must be cleaned and stored in a designated storage area for the harvesting equipment. The equipment must be kept dry and should not be kept on a dirty floor. Harvesting equipment must not be stored in close vicinity to pesticides, pesticide application equipment or fertilisers. The equipment could become contaminated and thereby contaminate the harvested produce. All tools and

equipment used in the harvesting process must be properly cleaned and sterilized before and after use as well as at regular intervals during harvesting. Workers must also wear clean and suitable protective clothing.

**pruning shear**

The most common tools used for harvesting fruit are steel pruning shears. They are used to cut the stem of the fruit as close to the button, or calyx, as possible without injuring the shoulder of the fruit. Some vegetable fruits, like tomatoes, can easily be picked by a simple twist of the hand, while pruning shears are used on others like peppers.

Fig 2.1 **Pruning shear**

In some crops, specialized shears and snips are used for harvesting. Pruning shears fit comfortably into the palm of the hand have a rounded point and curved blade to avoid damaging the fruit. A spring keeps the blade in an open position and ensures fast recovery for efficient picking. In preparation for harvesting, all pruning shears must be checked to ensure that the spring action is working well, and that the blades are sharp and closely aligned. This should also be checked on a regular basis during picking. Pruning shears must also be cleaned and sterilised and prior to harvesting and regularly during picking

**Harvesting Knives**

Knives are used in harvesting leafy crops such as cabbage heads, Swiss chard leaves and lettuce. A good quality knife with a strong blade should be supplied to the harvesters. The blade should be sharp enough to facilitate easy cutting. A blunt knife will not only reduce the harvest speed, but can cause unnecessary damage to the produce. Knives should be regularly cleaned and disinfected whilst harvesting to prevent the spread of post-harvest decay organisms.

**Fig 2.2 Harvesting Knives**

## Ladders

Ladders are used during harvesting of tree crops depending on the height of trees. Ladders are placed alongside trees, or rested against the canopy in the case of larger trees. Ladders vary from home-made, single-sided, two-legged ladders made from locally grown wood to factory-manufactured, two- or three-legged ladders generally made from aluminium or wood. In preparation for harvesting, ladders must be checked for sharp edges, splinters, loose components and dirt to ensure fruit is not damaged when the ladders are placed alongside the trees or against the canopy. The ladders should also be checked for defects that may compromise the safety of the harvesters

Fig 2.3 harvesting by using ladder

## Pruning shear

The most common tools used for harvesting fruit are steel pruning shears. Varieties of styles are available as hand held or pole models, including shears that cut and hold onto the stem of the cut product. This feature allows the picker to harvest without a catching bag and without dropping fruits.

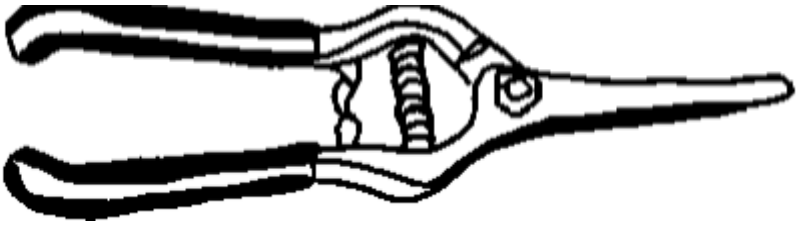


Fig 2.4 Thin curved blade for grapes and fruits:

Fig 2.5 Straight bladed hand shears for fruits and flowers

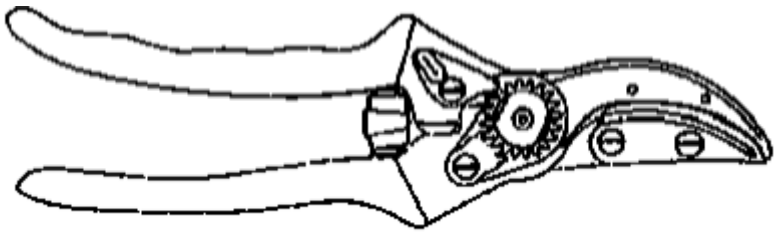


Fig 2.6 Cut and hold hand shears

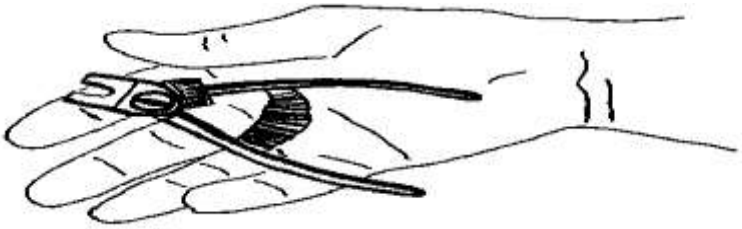


Fig 2.7 Clipper for citrus fruits

Using a cutting tool attached to a long pole can aid picking of crops such as mangoes and avocados when the fruit is difficult to reach. Cutting edges should be kept sharpened and the catching bag should be relatively small The angle of the cutting edge and the shape of the catching bag can affect the quality of the fruit harvested, so it is important to check performance carefully before using any new tools.

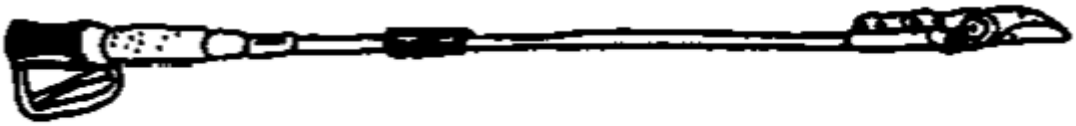


Fig 2.8 Pole mounted cut and holds picking shears

Picking poles and catching sacks can be made by hand or purchased from horticultural supply companies. The collection bags illustrated below were hand woven from strong cord or sewn from canvas. The hoop used as the basket rim and cutting edges can be fashioned from sheet metal, steel tubing or recycled scrap metal.

Fig 2.9 Using a picking pole

**Picking containers**

A number of receptacles are used to collect picked fruit, but the most common is a picking bag. Picking bags are generally made from canvas or polyvinyl. They have a single strap and are slung over the shoulder of the picker. As the picker picks the fruit, it is placed inside the bag until it is full. It is then taken to a general collection point in the orchard where the bags are emptied into bulk bins or picking trailers. A number of different bag designs, are available and used in various industries. In preparation for harvesting, all picking bags and containers must be checked for holes and/or tears. The containers must be cleaned before harvesting is initiated. When cotton is hand-picked, the cotton is placed in picking bags before being emptied into metal baskets. Unlike for tree crops the bags are non-woven bags (material or polyvinyl) as the strands of these bags contaminate the cotton fibre. Cotton picking bags most often used are empty plastic fertilizer bags. Because these bags are not porous and the cotton will still contain moisture, picked cotton should not be left in these bags overnight as the cotton may rot. Fruits and vegetables, which damage easily, are picked into picking crates taken to the cold rooms or packing sheds as soon as possible. These crates are usually made from durable plastic and are well ventilated. They are also designed to be stacked. Clean, dry and sterilized crates should be used to prevent disease contamination. Crates, which are damaged in such a way that bruising or puncturing of the crops could occur should be discarded.

**Fig 2.10 Picking containers**

### Garden fork

In the case of smaller production areas, where mechanical harvesters cannot be used, a fork can be used instead for lifting produce. The fork is inserted into the soil at an angle, close to the crop plant and then the plant and soil are lifted. Take care not to push one of the fork teeth into a tuber, bulb etc.


Fig 2.11 **Garden fork**

### Mechanical harvesters

Vegetables produced for industrial purposes, potatoes, onions, and oil crops are harvested mechanically. The different types of harvesters are specially designed to for a specific crop or group of crop Onions, potatoes and groundnuts grow below the soil surface. Commercially these crops are harvested by lifting the bulbs, tubers or pods from the soil before. Once lifting has been completed the crop is picked up by hand, sorted and packed. Lifting is done using specialized implements containing a blade, which is attached to the back of a tractor. The “blade” is then inserted into the soil at one end of a row and drawn just below the soil surface.

The next step can be manual or mechanical. In both cases it involves the pulling of the plants from the soil and removing the tubers etc. from the plant. Potato tubers can be placed in bulk trailers or bulk bins on trailers and transported to the pack houses. In the case of onions the bulbs are first left on the field for at least a week to cure before the dry leaves are cut (with sharp knives) from the bulbs and the bulbs placed in onion bags, ready for the market. Peanut plants are also left on the field for a week or two in heaps or in windrows to cure. Then only will the plants will be threshed and the pods placed in woven material bags or bulk trailers and transported to where the peanuts will be processed

**Fig 2.12 potato harvester**

- **Generally during harvesting horticultural crops, tools, equipment and machinery are used** :-
    - knives, machetes, rubber bands, string, sickle, calipers or sizing rings, specification charts or aids, gloves, bags, ladders, tractors, trailers, containers, buckets, dip tins and bin.

| Self-Check -2 | Written Test |
|---|---|

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

1. at least list three tools and equipment of harvesting and discus their function(10)

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

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-3 | Removing full and loading emptied containers |
|---|---|

### 3.1. Removing or loading full containers after harvesting

Appropriate production practices, careful harvesting and proper packaging, storage and transport all contributes to the good produce quality. Once a crop is harvested it is impossible to improve its quality. The horticultural crops, because of their high moisture content are inherently more liable to deteriorate. Moreover, they are biological active and carryout transpiration, respiration, ripening and other biochemical activities, which deteriorate the quality of the produce.

- Poor handling,
- unsuitable containers,
- Improper packaging,
- poor managements, and
- Transportation can easily cause:-

  - bruising,
  - cutting,
  - breaking,
  - impact of wounding and
  - Other forms of injury.

Therefore, special care and attention has to be given for safe handling of produces so as to reduce these losses. Safe handling of harvested products and containers (like boxes, trays, crates, bulk bins or net) plays very important role in shelf life of harvested products and remunerative market income. Since most the harvested horticultural products are perishable, careful handling of these products and storage or transporting containers have a central role in reducing the post- harvest losses which are caused by poor handling of the products.

As soon as products are harvested with whole plant or part(s), they immediately undergo certain physiological and biochemical changes and certain losses with respect to loss in weight, appearance, color, texture, nutritive value and etc. therefore, to avoid these extent losses, there is the need to handle the storage/transporting materials and the products as a whole in well-organized manner.

| Self-Check -3 | Written Test |
|---|---|

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

1. List the activity that affecting the quality of horticultural crop product(5)

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

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

**Reference**


1. Dhatt, A.S., Mahajan, B.V.C., Sandhu, K.S., Garg, A and Sharma, S.R. (2007) Handbook on Post-harvest Handling of Fruits and Vegetables. 3rd edition, PHPTC, PAU, Ludhiana

2. Friend Manufacturing Corporation, Prospect Street, P.O. Box 385, Gasport, New York 14067, USA.

3. Kader Adel A (2002). Post-harvest Technology of Horticultural Crops. 3rd Edition, University of California, Agricultural and Natural Resources.

4. Kader Adel A and Merita Cantwell (2006). Produce Quality Rating Scales and Color Charts. Postharvest Horticulture Series No 23. Post-harvest Technology Research & Information Center University of California, Davis.

5. MoARD (Ministry of Agriculture and Rural Development). 2005. Vegetables and Fruits Production and Marketing Plan (Amharic Version), Ministry of Agriculture and Rural Development, Addis Ababa, Ethiopia.

# HORTICULTURAL CROP PRODUCTION

# Level -III

# Learning Guide -69

**Unit of Competence**: - Co-ordinate Horticultural Crop Harvesting

**Module Title: -** Co-ordinating Horticultural Crop Harvesting

**LG Code:** **AGR HCP3 M16 LO2-LG-69**

**TTLM Code:** **AGR HCP3TTLM 0120v1**

## LO2:Co-ordinate Harvesting activities

| Instruction Sheet | Learning Guide #-69 |
|---|---|

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

- Identifying harvesting crop and the requirements
- Determining crop maturity
- Establishing suitable weather conditions
- Selecting tools, equipment and machinery
- Carrying out pre-operational and safety checks
- Identifying and controlling OHS hazards
- Selecting and maintaining suitable safety and personal protective equipment

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

Specifically, upon completion of this Learning Guide, **you will be able to –**

- Identify harvesting crop and the requirements
- Determine crop maturity
- Establish suitable weather conditions
- Select tools, equipment and machinery
- Carry out pre-operational and safety checks
- Identify and control OHS hazards
- Select and maintain suitable safety and personal protective equipment

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 7.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1,2,3,4,5,6 and 7” in page -24,47,51,57,60,62 and 64 and operational sheet 1 and 2 on page:65
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Do LAP Test available on page-66

| Information Sheet-1 | Identifying harvesting crop and the requirements |
|---|---|

## 1.1. Understanding harvesting

**Harvesting** is the act of removing a crop from where it was growing and moving it to a more secure location for processing, consumption, or storage. It is the final agricultural operation but the first in the post-harvest system and one of the major activities in horticultural crop production.

**Generally harvesting** :

- is the removal of entire plant or economic portion of plant after maturity
- Is defined as the removal of whole or part(s) of the plant at a time or at different interval depending on kind of crops to be harvested and consumers demand.
- Is also defined as the separation of fully or partially matured horticultural crop product from the mother plant.
- Is may be also defined as the separation of the crop from the site of immediate growth.
- Is considered as the last step in crop production, but the first step in the post production system.

It is done in different ways and time for different crops. Also, harvesting is essential part of crop production that it determines the final quality of the products. Fruits harvested too early may lack flavor and may not ripen properly, while produce harvested too late may be fibrous or have very limited market life. Similarly, vegetables are harvested over a wide range of physiological stages, depending upon which part of the plant is used as food. For example, small or immature vegetables possess better texture and quality than mature or over-mature vegetables.

Therefore harvesting of fruits and vegetables at proper stage of maturity is of paramount importance for attaining desirable 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.

## 1.2. Principles of harvesting

- Harvest should be completed during the coolest time of the day, which is usually in the early morning, and produce should be kept shaded in the field.
- The produce has to be handled gently.

- Crops destined for storage should be as free as possible from skin breaks, bruises, spots, rots, decay, and other deterioration.
- Bruises and other mechanical damage not only affect appearance, but provide entrance to decay organisms as well.

**1.3. Communicating ideas and information to work team members, supervisors, contractors and clients**

Before starting harvesting operation, communicating ideas and information to work team members, supervisors and other concerned bodies is the most important part of harvesting work. Communicating and sharing of ideas and information to work team members and supervisors regarding the horticultural harvesting operation is important to:-

- ❖ Reduce work load among workers
- ❖ Reduce work place hazards and risks
- ❖ Successfully complete the harvesting operation
- ❖ Have quality and quantity harvested product
- ❖ Reduce disagreement and biasness among workers
- ❖ Operate the harvesting activities based on crop type, part of the plant harvested, time of harvest, skill level and enterprise work procedures.
- ❖ Solve different problems that may occur during harvesting operation.

**Interpreting harvest specifications and schedules**

Timing of harvest is complicated because there are often great differences in the rate of development and maturation of individual plants in the field or even between fruits on the same tree. The harvesting methods used are also important here, because if you use mechanical harvesting methods you usually harvest all the plants at the same time, by hand-harvesting you can distinguish and pick only those with the right maturity level. The proper time of harvesting is ascertained from the type of crop (i.e. maturity, size, texture, color, sweetness, flavor etc), the weather condition when harvesting and the purpose of production. Different crops have different criteria for maturity and quality. Harvesting too early or delayed too late may cause some problems, harvesting too early result in low yields for tubers are not in full size, while harvesting too late may cause the tubers to become fibrous or woody, and increase the risk of tuber loss due to rotting and pests in vegetables. Harvesting under a good weather condition are necessary, because it is desirable from the standpoint of disease and keeping quality that the tubers go into storage in a clean and dry condition.

❖ **Factors to be considered in harvesting**

Maintaining orderly production operation-horticultural crops should be produced and harvested to make optimum utilization of resources like land, labor and equipments. Setting up orderly marketing sequence- horticultural crops should be harvested to maintain regular supply in the market. Ultimate quality and appearance of the produce- horticultural crops should be harvested at optimum stage of maturity to maintain quality and appearance for getting maximum returns, Suitable weather condition and storage facilities. Available labor force depending on farm size and type of crop to be harvested and so on.

✓ The factors that considered during harvesting are:

1. Time of harvesting
2. Method of harvesting

1. Time of harvesting: - The optimum time for harvesting of vegetables and fruits are

i. Early morning in the day: - maintains the full turgidity of leaves and other plant parts

ii. During dark hours:-Transpiration is minimum during dark hours and early in the day

The crop must be harvested at the proper maturity stage unless it reduce the quality.

➢ **Effect of early harvesting**:-

- Loss of weight and total yield
- Loss of food value
- Reducing storage quality
- Edible quality

➢ **Effect of late harvesting**:-

- Over-ripening:-
- Loss of sale value (market price
- Loss of quality
- Reduced shelf life:-.

2. **Methods of harvesting**

The crop type and expected harvest volume will determine the harvesting method that is to be used. Certain crops are harvested by hand, while others are harvested either manually or mechanically. Hand harvesting usually provides a better quality product than mechanical harvesting. Harvesting by hand is however more time consuming and expensive than mechanical harvesting and is not always practical or economical feasible.

⇨ Harvesting methods depend on:-

- The type of crop
- The part of plant to be harvested.

- The stage of optimum development (maturity)
- The moisture content during the time of harvesting

Different kinds of fruit and vegetables require different methods of harvesting. The methods of harvesting are:

1. **Manual Harvesting**

Manual Harvesting means the crop picking or harvesting by hand

**Advantages**

- Humans can accurately select for maturity, allowing accurate grading and multiple harvest
- Humans can handle fruit with a minimum of damage
- Rate of harvest can be easily increased by hiring more workers
- Hand harvest requires a minimum of capital investment (although some fanners provide housing for their employees)

Quality is an important aspect in successful marketing of fresh market commodities that hand harvest is still the dominant method of harvest. Effective use of hand labor requires very careful management. In most circumstances, harvesting by hand, if done properly, will result in less damage to produce than will machine-harvesting. Hand-harvesting is usual where fruit or other produce is at various stages of maturity within the crop, that is, where there is need for repeated visits to harvest the crop over a period of time.

The main benefit of hand harvesting over mechanized harvesting is that humans are able to select the produce at its correct stage of ripening and handle it carefully. Hand harvesting is particularly suitable for crops with an extended harvest period results in a higher quality product with minimum damage.

**Disadvantages**

- It is a time consuming process.
- More labour is required during harvesting season

*Fig 1.1 Hand harvesting*

Fig.1.2 Pole fruit piker

Fig 1.3 Ladder / bag picking method

Fig1.4 Fig potato harvesting

Fig 1.5 berry piker

## 2. Mechanical Harvesting

Machine-harvesting is usually viable only when an entire crop is harvested at one time.

**Advantages**

• The produce can be harvested at a faster rate.

• Less manpower is required as compared to hand harvesting.

**Disadvantages**

• Damage can occur to crops.

• Not suitable for marketing of fresh commodities.

The fruits required for processing may be harvested mechanically, but it is important to process them soon, otherwise deterioration can take place.

*Figure-1.6 Mechanical Harvesting*

### a. Harvesting operation

Harvesting practices should cause as little mechanical damage to produce as possible. Gentle digging, picking and handling will help reduce crop losses.

Pick carefully to avoid damage:

For some crops, a natural break point forms at the junction of the stem and the stalk when produce is mature. Harvesters should grasp the product firmly but gently and pull upward.

Wearing cotton gloves, trimming fingernails, and removing jewelry such as rings and bracelets can help reduce mechanical damage during harvest.

Harvesting and preparation for market

If a small amount of leafy vegetables are being harvested for home use or for sale at a nearby roadside or farmers' market, a small tub of cold water can be useful for cooling the produce. The tub can be brought directly to the field and used by the picker as a field container. Clean water should be used with each lot of produce. Chilling leafy vegetables by using cold water at harvest will help maintain quality and prevent wilting.

- **Cares (precautions) at harvesting:-**
  - ✓ Harvest only at the proper stage of maturity.
  - ✓ Harvest as per the demand, purpose of consumption and distances of marketing.
  - ✓ Do not harvest vegetables after spraying fungicides and insecticides for at least a week.
  - ✓ Do not cause injury to the plants or produce while harvesting.
  - ✓ Wash the vegetables after harvest and grade them before marketing.
  - ✓ Ensure whether the fruits are to be harvested

Harvesting of fruits should be done at optimum stage of maturity. During harvesting operation, a high standard of field hygiene should be maintained. It should be done carefully at proper time without damaging the fruits.

- The harvesting operation includes.
  - i) Identification and judging the maturity of fruits.
  - ii) Selection of mature fruits.
  - iii) Detaching or separating of the fruits from tree, and
  - IV) Collection of matured fruits.

| Self-Check -1 | Written Test |
|---|---|

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

1. List the activity included in harvesting operation (5)

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

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-2 | Determining crop maturity |
|---|---|

## 2.1. **Horticultura**l **Crop maturity**

It is as one of the stages of plant growth and development which indicates the time when a given crop has its own optimum flavor and texture for fresh eating or processing. It is also defined as an indication of the crop's development and its progress toward becoming a marketable product. There are different definitions of crop maturity depending on type of crop and maturity. Some of these are:

- It is the time when a fruit or vegetable should be picked so that it will keep for the longest period in cool storage.
- It is also the stage at which the crop will develop optimum quality up on ripening (after harvest for banana, avocado, tomatoes…etc).
- The stage at which, when harvested, the fruit will develop optimum quality up on ripening (this apply to banana, avocado and other fruits that must be ripened after harvest before they can be consumed)

❖ The proper stage of maturity in different horticultural crops is ascertained from size, colour, tenderness, succulence, texture, sweetness and flavor. Definitions related to maturity and ripening:

i) **Mature**: It is derived from Latin word 'Maturus' which means ripen. It is that stage of fruit development, which ensures attainment of maximum edible quality at the completion of ripening process.

ii) **Maturation**: It is the developmental process by which the fruit attains maturity. It is the transient phase of development from near completion of physical growth to attainment of physiological maturity. There are different stages of maturation e.g. immature, mature, optimally mature, over mature.

iii) **Ripe**: It is derived from Saxon word 'Ripi', which means gather or reap. This is the condition of maximum edible quality attained by the fruit following harvest. Only fruit which becomes mature before harvest can become ripe.

iv) **Ripening**: Ripening involves a series of changes occurring during early stages of senescence of fruits in which structure and composition of unripe fruit is so altered that it becomes acceptable to eat. Ripening is a complex physiological process resulting in softening, colouring, sweetening and increase in aroma compounds so that ripening fruits are ready to eat or process. The associated physiological or

biochemical changes are increased rate of respiration and ethylene production, loss of chlorophyll and continued expansion of cells and conversion of complex metabolities into simple molecules.


*Figure-2.1 type of mature*

v) **Senescence**: Senescence can be defined as the final phase in the ontogeny of the plant organ during which a series of essentially irreversible events occur which ultimately leads to cellular breakdown and death**.**

**2.2. Maturity type of a horticultural crop.**

**2.2.1. Physiological maturity**

It is the stage of development when maximum growth and maturation of the crop has occurred. A given crop is considered to be at physiological maturity when the translocation of photosynthesis is stopped to the economic parts and produce gains characteristic size and shape.

**2.2.2. Commercial (horticultural maturity)**

It is the stage of development required by the market. Commercial or complete maturity generally occurs 4-7 days after physiological maturity. After identifying the maturity status of a given horticultural crop, it is important to select the crop to be harvested depending on maturity level and enterprise market requirements which meets the consumer's need. The basic reason behind this is there are a number of horticultural crops which are quite different in their maturity indices, quality parameters, harvesting indicators, plant organs to be harvested and methods of harvesting. In this case some of the crops to be selected for harvest may include fruit, vegetables, herbs, flowers, foliage, bulbs, tubers, nuts, mushrooms, wild harvest plants.

When identifying different horticultural crops for harvest depending on their maturity status and crop type, careful attention has to be given for:

- Types of crops to be harvested(fruit, vegetables, herbs, flowers, foliage, bulbs, tubers, nuts)
- Nature of crop to be harvested (pertiable, stony, leafy…)

- consumers need
- enterprise market requirements which includes variety, size weight, length, shape, color, health and quality depending on seasonal and market forces
- quality of product to be harvested
- the health of plant to be harvested and
- methods of harvesting
- The level of maturity etc.

## 2.3. Determining crop maturity

Determining the maturity stage of a given crop plays a central role on crop's marketability and storage life. This is because the nutritional content, freshness, and flavor that vegetables and fruits possess depend on the stage of maturity and the time of the day at which they are harvested. Different crops have different criteria for maturity and quality. The way of determining crop maturity depends on different morphological changes and crop maturity parameter that indicates proper maturity stage of a given crop to be marketed or stored. Some of these maturity parameters include size, weight, length, shape, color, ripeness, texture, skin condition, ease of removal and moisture content.

These characteristics may be measured by observation and maturity testing tools and equipment such as knives, sizing rings, color charts, refractometers, and penetrometers and produce firmness testers. The results are interpreted and analyzed by comparison with specification charts and enterprise and industry maturity standards. The major importance of determining the maturity level of a given horticultural crop is to:-

- Reduce over or delayed maturity
- have an adequate shelf life after storage
- develop an acceptable flavor or appearance
- reduce deterioration of the products
- maintain the quality of the products and
- Satisfy consumers need and market requirements.

### 2.3.1. Harvesting maturity determination

✪ Color: losses of green color, development of red, yellow or purple color. For most fruits and some vegetables.

✪ Shape: Ex. For banana, angularity. For mango, "full cheeks".

✪ Size: To many vegetables.

- Firmness: As fruit mature and ripen they soften by dissolution of the middle lamella of the cell walls. The degree of firmness can be estimated subjectively by finger or thumb pressure, but more precise objective measurement is possible with pressure tester or penetrometer. In many fruits such as apple, pear, peach, plum, guava, know etc. firmness can be used to determine harvest maturity. Penetrometer measures the pressure necessary to force a plunger of specified size into the pulp of the fruit. Such pressure is measured in pounds and kilograms force. Softening often occur by ripening, esp. For fruits. Exist specialized instruments for pressure testing.

*Figure- 2.2 Penetrometer Plate*

Chemical measurements: As fruits ripen the starch to sugar content decreases. Starch is converted into sugar and this alters the texture of the product and makes it softer. It also makes the product sweeter and of better taste. Starch content is tested using iodine. Sugar is tested as total soluble solids in the juice of the product. Sugars are the major soluble solids in fruit juices and therefore soluble solids can be used as an estimate of sweetness. A hand-held refractometer can be used outdoors to measure % SSC (equivalent degrees Brix for sugar solutions) in a small sample of fruit juice. Temperature will affect the reading (increasing about 0.5% SSC for every 5 ºC or 10 ºF), so you should adjust the measurement for the ambient temperature. A garlic press works well to squeeze the juice from fruit samples. For small fruits, use the whole fruit. For large fruits, take a wedge for the stem end to the blossom end and to the center of the fruit. Remove any pulp by filtering the juice through a small piece of cheesecloth. You must clean and standardize the refractometer between each reading with distilled water (should read 0% SSC at 20 ºC or 68 ºF).

*Figure-2.3 Refractometer*

If your reading indicates a higher % SSC, then your produce is better than the minimum standard. Strawberries which are of excellent flavor, for instance, would measure 8% SSC or above. Table 2.1 Minimum %SSC

| | |
|---|---|
| Apricot | 10% |
| Blueberry | 10 |
| Cherry | 14-16 |
| Grape | 14-17.5 |
| Kiwifruit | 6.5 |
| Mango | 10-12 |
| Muskmelon | 10 |
| Nectarine | 10 |
| Papaya | 11.5 |
| Peach | 10 |
| Pear | 13 |
| Pineapple | 12 |
| Plum | 12 |
| Pomegranate | 17 |
| Strawberry | 7 |
| Watermelon | 10 |

- ✪ Respiratory behavior: In climacteric fruits (see later).
- ✪ Calendar date: For perennial fruits grown in climates which are uniform from year to year. Based on the producer's experience. For perennial fruit crops grown in seasonal climate which are more or less uniform from year to year, calendar date for harvest is a reliable guide to commercial maturity. Time of flowering is largely dependent as temperature and the variation in number of days from flowering to harvest can be calculated for some commodities by use of degree-day concept. Such harvesting criteria can be developed by the growers based on their experiences.

**Maturity indices and picking specifications for selected fruit and vegetables**

**Table-2.2 Index of selected Fruits**

| | |
|---|---|
| **Apples**<br>  | Harvest season ranges from midsummer to late fall, depending upon the variety.<br><br>Most apples are ready to pick when they separate easily from the tree and the fruit comes off when you give it a gentle lift and twist. Another indicator is the color of the seeds in the core. When apples are ripe, the seeds turn dark brown.<br><br>If you're still in doubt, take a sample bite. An underripe apple will taste green or starchy, while ripe apples are sweet and juicy. Overripe apples get mealy.<br><br>To avoid pulling out the stem when you harvest, don't yank the apple to pick it; instead hold the apple in your hand, tilt it upward, and twist to separate it from the branch with a rotating motion.<br><br>Length of storage varies, ranging from only a few weeks to 6 months depending upon the variety. Store apples at near-freezing temperatures and at high humidity; a good root cellar for storage is ideal. |
| **Asparagus**<br>  <br>  | If you started your asparagus bed from crowns, you should be able to harvest lightly for a week or two in the spring of the second season, but waiting until the third season lets the plants establish healthy root systems.<br><br>The third year should bring a moderate harvest for 3 or 4 weeks and then heavy picking for 6 weeks or more every year thereafter.<br><br>Pick sparingly the first time - over about 2 weeks. Extend your harvest gradually in subsequent season, until you are harvesting for about 8 weeks. In more temperate climates this can last up to 12 weeks.<br><br>Always gauge the length of your harvest by the previous season's growth. Select only those spears that are thicker than a pencil; anything thinner should be allowed to grow into ferns.<br><br>Harvest spears in early spring when they are 6 to 8 inches (15-20 cm) tall and the tips are still firm and |

| | |
|---|---|
| | closed. Cut or snap the spears off at, or just below, ground level. If you opt to cut your asparagus be careful not to injure the plant crown.<br><br>When the emerging spears get progressively thinner, it's time to stop harvesting.<br><br>Asparagus is best when fresh, but you can refrigerate it for up to 1 week. Set asparagus upright in 1 to 2 inches (2.5-5 cm) of water and refrigerate. Don't let the spear tips get wet, or they'll rot. Surplus asparagus freezes really well, so that is always another option. |
| **Beans**<br><br>  <br><br>  <br><br>  | You can harvest beans up until frost starts.<br><br>**Snap Beans**<br>**Green, Yellow - come in both bush and pole varieties**<br><br>Pods should be firm and crisp at harvest and about as thick as a pencil; they should snap when you break one in half. The seeds inside should be very small and underdeveloped, because beans are over mature if the seeds have begun to fill out the pods. Hold the stem with one hand and the pod with the other to avoid pulling off branches that will produce later pickings. You can carefully pinch the pods with your fingers or use a scissors. Pick all pods to keep plants productive.<br><br>**Shell Beans**<br>**Romano, Lima, Southern Peas, Soybeans, Fava, etc. - come in both bush and pole varieties**<br><br>Shell beans can also be grown as dried beans. Pick these varieties when the pods change color and the beans inside are fully formed but not dried out. Pods should be plump, firm, and tender. Quality declines if you leave them on the plant too long. Pick every couple of days to keep the plants productive.<br><br>With both shell and snap beans, you can keep the pods in plastic bags for 1 or 2 weeks in the refrigerator, or freeze the surplus. |

| | |
|---|---|
| | **Dried Beans**<br>**Great Northern, Navy, Pinto, etc.- come in both bush and pole varieties**<br><br>Let the pods get as dry as possible in the garden, and pick pods of dry beans when they have turned brown and the seeds have hardened. You'll be able to hear the seeds rattling inside the pods. If the weather is too damp for the beans to dry, harvest the plants and hang them upside down indoors.<br><br>Pods when thoroughly dry will split readily, making seeds easy to remove. Shell the beans when they are completely dry, and place them in an airtight jar with a desiccant to absorb moisture; store in cool, dry spot for up to a year. |
| **Broccoli**<br>  | Harvest while heads are a deep green, still compact, and before buds start to open into flowers. If the buds start to separate and the yellow petals inside start to show, harvest immediately. Cut the stem at a slant about 4 to 6 inches (10-15 cm) below the head. Removing the head on some varieties will produce sideshoots in the axils of leaves and you can get 4 to 6 cuttings of shoots per plant over several weeks. The thick stems are edible, but they should be peeled first. The leaves are tough, but usable in soups and stews.<br><br>When you bring your broccoli inside, soak the heads in a salt water mixture (1 to 2 tablespoons (15-30 ml) of salt per gallon (3.8 l) of water for 20-30 minutes before cooking or storing. This will drive out any cabbageworms hiding in the heads. Broccoli will keep for a week or so in the refrigerator if wrapped in plastic. The best way to store broccoli for longer periods is to blanch and freeze it. |
| | |
| **Cabbage**<br>Red and Green | Cabbage is ready to harvest when the head is full and firm. Cut the stalk at the base of the head with a sharp knife and discard the outer leaves. It's best to harvest them in the morning, when heads are cool.<br><br>After the center head has been removed, small heads may develop where the base leaves meet the stem. Let one of them grow and you'll often get another head weighing around 1 or 2 pounds (.5-.9 kg). |

| | |
|---|---|
|  | Keep heads in a cold, moist area, just about freezing and around 90% humidity. |
| **Carrots**<br>  | Carrots are generally ready for harvest in 2-3 months or when they are large enough to use.<br><br>Pull a few to check their size. Loosen the soil with a fork, and then gently pull them out of the ground. Watering before harvest can make pulling them out easier. Brush off excess soil and twist off the tops.<br><br>You can leave carrots in the ground until you need them because even mature carrots will retain their quality in the ground unless the weather gets extremely hot. After the first hard frost, but before the ground freezes, you'll want to harvest the rest of your carrots.<br><br>Refrigerate unbruised carrots or layer them in moist sand or sawdust and store them in a root cellar for up to 4 months. You can also can, freeze, or dry carrots. |
| **Cauliflower**<br>  | Pick cauliflower when the heads are full, but before the curds begin to separate. Cut through the stem under the head, leaving a few "wrapper" leaves for protection. Curds bruise easily, so handle them with care.<br><br>Before preparing or storing cauliflower, soak it in a salt water mixture (1 to 2 tablespoons (15-30 ml) of salt per gallon (3.8 l) of water for 20-30 minutes before cooking or storing. This will drive out any cabbageworms hiding in the heads.<br><br>Cauliflower will keep for about a week in the refrigerator if wrapped in plastic. It does not store well in a root cellar. The best way to store cauliflower for longer periods is to blanch and freeze it. |

**Cucumber**

Cucumbers mature very quickly. Pick them often so the plants continue to produce. Fruits may become oversized if left on the vine even a day too long.

**Slicing Cucumbers**

Can be harvested whenever they are big enough to use, but before they begin to turn orange or yellow. If your vines bear more than you can use at one time, pick them anyway because allowing them to ripen to the orange stage on the vine will cause the plant to stop producing.

With slicing cucumbers (as opposed to pickling cucumbers) keep fruits picked so that each plant has only 2 or 3 fruits growing at a time.

To pick, hold the stem with one hand and pull the fruit with the other. Harvest fruits when they are young and the seeds inside have not begun to harden.

Cucumbers contain mostly water, so the key to storing them after the harvest is to keep that water in, a reason many cucumbers in supermarkets are waxed. Wrap the fruits in plastic wrap or bag them and they'll keep a week or more in the refrigerator. The best storage temperature is 45 to 50° F (7.2-10° C).

**Pickling Cucumbers**

Gather pickling cucumbers when they are very young and the seeds are still quite soft, about 4 to 5 inches (10-12 cm) long. If possible, harvest fruits in the morning because they'll be at their firmest condition at this time of day, and refrigerate immediately. Don't wash them until you're ready to use them.

**Eggplant**

The best eggplant fruits are so young that the seeds are barely visible when you cut them open and are about 4 to 5 inches (10-12 cm) long for standard varieties, a bit smaller for mini types.

The skin should be glossy and tight. If the skin is dull, that is sign the eggplant if overripe and the flesh will be tough and losing its flavor. Overripe eggplant also have black seeds forming inside.

Cut fruits from the plants with 1 inch (2.5 cm) of stem

| | |
|---|---|
| | attached, and store them in the refrigerator. |
| **Lettuce**<br>  <br>  | **Leaf Lettuce**<br><br>Leaf lettuce matures about 40 days from seeding. Start harvesting as soon as the leaves are big enough to eat, about 4 to 5 inches (10-12 cm) long. You can pick the large outer leaves or slice the entire plant off about 1 inch (2.5 cm) above the soil line, prompting the plant to send out new growth, which will reach eating size in another 3 to 5 weeks. Harvest in the morning when the leaves are crisp and full of moisture. If your crop begins to bolt or is threatened by a hard frost, harvest the entire plant.<br><br>**Head Lettuce**<br><br>Head and romaine lettuce mature about 70 days from seeds and 20-35 days from transplants. When the heads are firm, harvest by cutting the plant to ground level. For crisp lettuce, harvest in the morning and eat that day. You can store most lettuce in the refrigerator for 1 to 2 weeks; iceberg lettuce keeps up to 3 weeks. |
| **Melons**<br>  | Always allow melons to ripen on the vine.<br><br>**Muskmelons (also called cantaloupe, rock melon)**<br><br>Picking muskmelon when they are ripe is crucial to getting good flavor since the plants provide the fruit with much of the natural sugar during the last few days of ripening. Melons that are ripened off the vine (most store-bought melons) just don't taste as sweet.<br><br>Muskmelons are ripe when the rind is tan rather than green between the surface netting. Many will have a strong melon fragrance, and the surest sign that the fruit is ready is a crack that forms on the stem right |

near the point of attachment with the melon. This crack signals the "slip" stage, and in a few days the melon will slip off the vine with minimal pressure. If you have to work to separate the melon from the vine, chances are the fruit is not ripe.

Muskmelons are overripe when the outer skin softens, making it easily penetrable by birds and bees.

**Watermelons**

When ripe the curled tendril at the stem end dries to brown, the underside of the melon turns yellow or cream-colored, and the melon will give a deep, resonant sound then thumped. The melon's skin also becomes dull and is difficult to penetrate with your fingernail.

Most melons will ripen a little bit more for 2 or 3 days after they're picked. Store melons at room temperature until they are totally ripe, then refrigerate for several weeks. Melons can be pureed or cut into pieces and frozen.

**Honeydews**

The number 1 mistake home gardeners make is picking honeydews too early. Keep a record of your variety's maturity date and keep the melons on the vines at least until then, a bit longer if you've had a cool spell during the season. They will improve for a few days after picking if kept at room temperature.

**Bulb Onions and Garlic**

**Bulb Onions**

You can begin to harvest onions as soon as they are big enough to use as green onions.

Bulbing onions are fully mature when the tops turn yellow and start to fall over. To speed the maturation process, knock the tops over with back of your rake, just bending them over, not snapping them. Wait a few

days until the tops turn brown, then carefully lift the bulbs out of the ground with a spading fork. Gently brush off the soil, but don't wash them.

To reduce the risk of rotting in storage, cure the bulbs by letting them dry in a warm, airy place out of direct sun or rain for a week or two. When the papery outer skins are completely dry and brittle and the tops are withered looking, cut the tops off about 1 inch (2.5 cm) about the bulb and put them in mesh bags or braid the tops together. Hang braids or mesh bags of onions in a cool, dry spot to store them.

**Garlic**

Harvest when leaves begin to turn brown. Pull several bulbs and break them apart. If it's too early, cloves will be unsegmented and difficult to separate. Leave the remaining bulbs for a week a two, and check again. If you leave bulbs in the ground too long, the outer skins begin to deteriorate, resulting in lower quality and poor storage. A rule of thumb is to harvest when 75% of the foliage is brown.

Use a pitchfork to harvest the bulbs, and let them dry outside in the sun for a few days, then store in a cool, dry place. You can braid the dried leaves and hang the bunches or trim away the leaves and roots, and put into mesh bags and hang them in a well ventilated room.

**Pea**
**Snow and Snap**

Peas are ready to pick about 3 weeks after flowers appear. Harvest plump pods that are just beginning to look bumpy; if the pods are discolored or shriveled, the peas are past their prime.

The best time to harvest is early in the morning because the pods are crispest then and will store better and stay fresh longer.

Use scissors to cut pods from the plant, or pull them off very carefully or you may uproot the plant. Try and harvest daily to keep the plants productive.

It is always best to eat fresh peas immediately because, like corn, their sugars turn to starches very quickly. Refrigerate extra peas for up to one week in brown paper bags that are then put inside a plastic bag and seal with a twist tie. The paper bag will absorb any extra moisture so that the peas aren't actually sitting in water, and the plastic bag holds in enough moisture so

| | |
|---|---|
|  | the peas stay fresh. You can also freeze or can them. |
| **Pear**<br>  | Pears should be harvested when they are mature, but still hard, and ripened **off** the tree for best eating and canning qualities. If you wait until the fruit is ripe on the tree, it will be mushy inside within a day or two.<br><br>A pear is ready for harvest when the green color lightens and the stem of the fruit parts easily from the spur when you lift up on the fruit with a slight twist.<br><br>Allow pears to soften and ripen indoors at a temperature of 65-70° F (18-21° C).<br><br>Check the neck for ripeness. To do this, apply gentle pressure to the stem end of the pear with your thumb. When it yields to the pressure, it's ready to eat (this process usually takes a few days depending upon the variety, some may take a few weeks).<br><br>For storage, keep fruit at a high humidity and near freezing. The length of storage varies with each different cultivar. |
| **Pepper**<br>  | Begin harvesting when peppers reach a usable size. Steady harvesting after that will keep plants producing new fruits.<br><br>Most peppers can be eaten when they are green and underripe, although the flavor and vitamin C content improves as they ripen on the plant.<br><br>Cut bell peppers from the plants with a sharp knife or pruning shears, leaving at least ½ inch (1.3 cm) of stem attached. Cayennes, and some other peppers usually come off with enough stem attached when pulled from the plants. Always use a scissors or shears if you find yourself having to twist and tug to get peppers picked. |

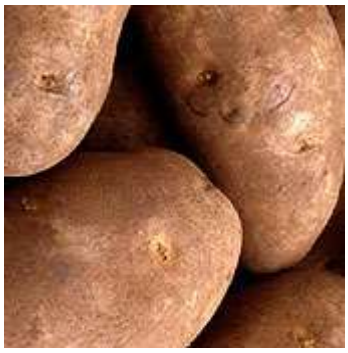
You don't want to break or damage the delicate branches.

Ripening will continue after harvest if kept in a warm room; ripening stops when peppers are refrigerated. Most peppers change color when ripe. Small, thin-walled peppers, like cayennes, tend to color up quickly. Sweet bell peppers can show strips of yellow, red, or orange and will continue to ripen when harvested and stored at room temperature.

Store thick-walled peppers in plastic bags in the refrigerator for up to 2 weeks, or wash, cut into strips, and blanch them for 30 seconds in boiling water, and freeze them. You can also pickle peppers if you want.

Small-thin-walled peppers start drying the moment you pick them. To dry hot peppers like cayennes, lay them in a single layer in a very warm place until they are beyond leathery but not quite crisp. Then store them in airtight jars.

**Potato**



As tubers become fully mature, the potato plant's stems and leaves turn brown. You don't however, have to wait for the plants to die back to start eating your potatoes. Harvest when the potatoes reach the size you want. If you plan to store them, make sure the skins are very tough, and don't peel off easily when you gently rub them with a finger at harvest time.

If your soil is loose, simply pull up the brown foliage and use your fingers to explore the soil and find more potatoes. You can also use a pitchfork to gently loosen the soil and lift the tubers out by hand.

Leave the potatoes outdoors for an hour or two to dry off on the ground. There's no need to wash or brush them before storing, although you can wipe away any clumps of soil. Keep the potatoes in complete darkness after they've dried in the open for a short time. Don't leave them in any container that light can penetrate or the potatoes will turn green.

If you plan to store your potatoes, you'll be better off if you cure them for a week or two. Put potatoes in a single layer on newspapers in the dark around 50-60° F (10-15° C) for 2 weeks to cure. After curing, store in

| | |
|---|---|
| | boxes or bags at about 40° F (4.4° C). |
| **Pumpkin, Winter Squash**<br>**Summer Squash, Zucchini**<br><br>  <br><br>  | **Pumpkins and Winter Squash**<br><br>Harvest pumpkins and winter squash when the rind is hard enough to resist puncturing with a fingernail, or wait until the plants begin to die back. When handling any kind of pumpkin, try not to pick it up by the stem because if the stem gets broken off, this is a weak spot for decay.<br><br>Cure winter squash and pumpkins in a warm (75-80° F (24-27° C), dry, well-ventilated place for 10 to 12 days.<br><br>After curing, you may want to dip them in a weak bleach solution (10 parts water to 1 part bleach) to kill fungi and bacteria on the skin and prolong storage. Allow to drip dry and then move pumpkins and winter squash to a cool, dark, dry, and well-ventilated storage area where temperatures range between 50-55° F (10-13° C). Don't store in a damp root cellar.<br><br>Spread squash out singly or, if you have to stack them, try not to do more than 2 deep so they have plenty of air circulation and don't rot.<br><br>**Summer Squash and Zucchini**<br><br>Harvest summer squash when immature and still tender, and not more than 6 to 8 inches (15-20 cm) long and 2 inches (5 cm) in diameter. Harvest patty pan, or scallop types when they are 3 or 4 inches (7.6-10 cm) in diameter. Keep plants harvested to prolong production of fruit.<br><br>Harvest all squash by cutting fruits with 1 inch (2.5 cm) of stem attached. Pick summer squash when they are small, harvesting every day because fruit quality deteriorates with age. Store in the refrigerator. |
| | |

| | |
|---|---|
| **Tomato**<br>  | Tomatoes are ripe when they change color. For best flavor, harvest tomatoes when firm and fully colored. Some cultivars drop their fruits when they are ripe, just pick these up and use them.<br><br>Store at room temperature, never store tomatoes in the refrigerator because cool temperatures cause them to lose flavor and textures. |

✪ Heat units: A certain number of degree-days are necessary to mature a crop. If cool, longer. If hot, shorter time.

### 2.3.2. Practical uses of Maturity Indices

1) State and Federal regulations often include a guide for minimum and maximum maturity that is acceptable for a given commodity

2) Marketing strategies to obtain premium prices for commodities “Supply and demand” delaying or expediting harvesting and shipping of a particular crop at the beginning or end of the season requires a measure of maturity if quality is to be maintained

3) Efficient use of labor – A measure of maturity is important for organizing start and end dates for harvesting to ensure labor and equipment availability and reduce harvesting costs.

**Physiological maturity versus horticultural maturity**

- **Physiological maturity**

✓ Plant (part) has completed natural growth and development

✓ Certain stage of development so that upon harvesting from the plant commodity will continue to develop as if still on plant.

✓ Quality has reached minimum acceptable standards.

- **Horticultural maturity**

- ✓ Stage of development when a plant possesses the quality prerequisites for use by consumers for a particular purpose
- ✓ All plant (parts) are harvested when horticultural mature but may be physiologically immature or mature
  - ♥ Examples of mature hort. / immature phys. crops: sweet corn, peas, snap beans, summer squash, cucumber and bean sprouts
  - ♥ Examples of mature hort. / mature phys. crops: winter squash, melons, tomato, pepper, eggplant, carnations, and rose

☞ **What is fruit ripening?**

A mature fruit undergoes physical and chemical changes before it becomes edible. During ripening it often loses its green color, there is decrease in acidity, softening of the tissues, increase in sugar content and the development of characteristic flavor.

☞ **Types of fruit ripening**:

There are two types of fruit ripening:

- ❖ Climacteric: climacteric fruits are those in which ripening of fruits takes place after harvest, e.g. mango, banana,
- ❖ Non-climacteric: Non-climacteric fruits, on other hand, are those in which the ripening of fruit is only complete while on the plant and they fall to ripen if they are harvested from the plant, e.g. grapes.

Table 2.3. List of climacteric and non-climacteric fruits

| climacteric | Non-climacteric |
|---|---|
| Apple | carambolla |
| Apricot | Cherries |
| Avocado | Citrus |
| Banana | Grape |
| Passion fruit | Litchi |
| Papaya | Loquat |
| Fig | Olive |
| Guava | Pineapple |
| Kiwifruit | Pomegranat |
| Mango | Strawberry |
| Melons,Pear,Peach,Plum,Persimmon and Sapota | - |

♥ **Age-related**

1) Number of days from planting to maturity
2) Days from full bloom to harvest

Subject to environmental influences season to season variation

Can be modified by incorporating heat units with the chronological index to take account of the weather pattern during the growing season

- **Physical properties**

Table2.4 Physical properties of the crops

| Crop | Index |
|---|---|
| **Root, bulb and tuber crop** | |
| Radish and carrot | Large enough and crispy (over-mature if pithy |
| Potato, onion, and garlic | Tops beginning to dry out and topple down |
| Yam and ginger | Large enough (over-mature if tough and fibrous) |
| Green onion | Leaves at their broadest and longes |
| **Fruit vegetables** | |
| Eggplant, cucumber and bitter gourd | Desirable size reached but still tender (over-mature if color dulls or changes and seeds are tough) |
| Muskmelon | Easily separated from vine with a slight twist leaving clean cavit |
| Tomato | Seeds slipping when fruit is cut, or green color turning pink |
| Water melon | Color of lower part turning creamy yellow, dull hollow sound when thumped |
| Sweet pepper | Deep green color turning dull or red |
| okra | Desirable size reached and the tips of which can be snapped readily |
| Honeydew melon | Change in fruit color from a slight greenish white to cream; aroma noticeable |
| **Seed vegetables** | |
| pea Cowpea, yard-long bean, snap bean, batao, sweet pea, and winged bean | Well-filled pods that snap readily |
| bean | Well-filled pods that snap readily |
| Sweet corn | Exudes milky sap from kernel if cut |
| **Leafy vegetables** | |
| Cabbage | Head compact (over-mature if head cracks) |

| | |
|---|---|
| Lettuce | Big enough before flowering |
| Celery | Big enough before it becomes pithy |
| **Flower vegetables** | |
| Cauliflower | Curd compact (over-mature if flower cluster elongates and become loose |
| Broccoli | Bud cluster compact (over-mature if loose |

- **External and internal color**;

The loss of green colour of many fruits is a valuable guide to maturity. There is initially a gradual loss in intensity of colour from deep green to lighter green and with many commodities, a complete loss of green colour with the development of yellow, red or purple pigments. Ground colour as measured by colour charts, is useful index of maturity for apple, pear and stone fruits, but is not entirely reliable as it is influenced by factors other than maturity. For some fruits, as they mature on the tree, development of blush colour, that is additional colour superimposed on the ground colour, can be a good indicator of maturity. Examples are red or red-streaked apple cultivars and red blush on some cultivars of peach Size. May not be a good indicator of maturity as can be influenced by many factors but useful for peas, beans, potatoes, celery Shape;

- **Shape**

For example banana (3/4 full, full ¾ and round full), cucumber

- **Solidity**- head lettuce and cabbage are harvested on the basis of the solidity of the head
- **Texture -**

1) Firmness - (apples, pears, and peaches) used to determine harvest date and quality

2) Tenderness - measured with tenderometer – peas.

| **Maturity indicator** | **Crop** |
|---|---|
| Firmness | Apples, pears, stone fruits |
| Tenderness | Peas |
| External Color | All fruits and most vegetables |
| Internal color and structure | Formation of jelly-like material in tomato fruits flesh color of some fruits |

*Table2.5 Compositional factors of the crops*

☞ **Morphological changes**

1) Development of an abscission layer – muskmelons Morphological changes

2) Development of a waxy layer on the epidermis – plums, grapes, honey dew melons

3) Development of netting on the surface – muskmelons

4) Internal structure - formation of gel-like material surrounding the seeds of tomatoes

5) Prior to tip opening – asparagus

☞ **Chemical composition**

1) Starch - apples, pears

2) Soluble solids /Sugars - apples, pears, stone fruits, grapes

3) Acids; sugar/acid ratio – citrus, pomegranates, kiwifruit

4) Juice content - citrus fruits

5) Per cent dry weight- avocado

6) Astringency – persimmon, dates – low levels desirable

7) Ethylene production – apples, pears (particularly those destined for long term storage) Starch content in apples particularly useful for green apples eg. Granny Smith Stage depends upon the use.

| **Maturity indicator** | **Crop** |
|---|---|
| Starch content | Apples, pears |
| Sugar content | Apples, pears, stone fruits, grapes |
| Acid content, sugar/acid ratio | Pomegranates, citrus, papaya, melons, kiwifruit |
| Juice content | Citrus fruits |
| Oil content | Avocados |
| Tannin content | Persimmons, dates |
| Internal ethylene concentration | Apples, pears |

*Table2.6 Compositional factors of the crops*

✪ **Non-destructive maturity analysis**

- **Electronic Nose**
  - Used to detect aroma volatiles in a range of food types.
  - Has been used for determining fruit maturity based on the production of aroma volatiles
  - Statistical analysis must be performed to interpret data. Most research literature is based upon method verification and comparing data with more established methods of evaluating maturity.

- **Acoustic firmness sensor**

Method taps the fruit and then “listens” for vibrations (resonance attenuated vibration). Fruit of different maturities produce different vibration profiles. Measures whole product not just a restricted area.

- **Spectroscopic analysis**

Various different methods based upon the interaction of atoms or molecules with the electromagnetic spectrum.

1) **Visible spectral imaging (380 – 770 nm):** Measuring surface color based on absorption of light energy by reactive groups in chlorophylls, carotenoids and anthocyanins. Used in packing lines to detect color of apples and peaches.
2) **Fluorescence imaging:** Achieved by measuring electromagnetic radiation in the visible range following excitation with short wavelength radiation. Greatest use of application is in the measurement of chlorophyll fluorescence.

| Self-Check -2 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. Define maturity? (5 pt)
2. List &Explain the types of maturity? (5pt)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-3 | Establishing suitable weather conditions |
|---|---|

### 3.1. Estimating optimum time to harvest crop

Harvesting at optimum time of maturity plays a key role in the shelf life and marketability of a given harvested products. Crops that are immature lose water rapidly and don't store well, in addition to not tasting their best. Crops that are over-matured can be tough and starchy, like beans and corn, or too soft and easily damaged, like plums. Both immature and mature crops are subject to decay. Harvesting during the coolest part of the day is important because high temperatures lead to deterioration in highly perishable crops. The term "field heat" refers to the heat stored in crops from being out in the sun. In harvest and post-harvest handling you want to manage for reducing/taking out the field heat in your crops. Timely harvesting of the crop; reduce crop loss due to birds, insects, rodents and wild animals which implies better return to the farmer in terms of quality & quantity.

❖ **Time of harvesting**

The proper time of harvesting is ascertained from the type of crop (i.e. maturity, size, texture, color, sweetness, flavor etc), the weather condition when harvesting and the purpose of production. The optimum time for harvesting of succulent or fleshy vegetables;

- Early in the day
- During dark hours

The harvesting is usually carried out very early in the morning with following objectives;

- To maintain the full turgidity of leaves and other fleshy parts of the plant.
- Transpiration is minimum during dark hours and early in the day.

❖ **Factors affecting determination of time and methods of harvesting:-**

1. Species of crops:- Root and tuber vegetables can be harvested during any time of the day; whereas leafy should be harvested only early in the morning.
2. Purpose of consumption: - Ripe fruits should be harvested for processing industries.
3. Changing market demand: - Some crops such as carrots and beets may be harvested over a period of several weeks depending on market demand.

➢ **Harvest and the weather**.

Fruits and vegetables contain significant levels of biologically active components that impart health benefits beyond basic nutrients. Increased CO2, temperature and water stress can

affect photosynthesis, reproductive growth and mineral uptake, which may result in poor growth of vegetable crops. Climate change affects agriculture in a number of ways, including through changes in average temperatures, rainfall, and climate extremes (e.g., heat waves); changes in pests and diseases; changes in atmospheric carbon dioxide and ground-level ozone concentrations; changes in the nutritional quality of some foods.

- Favorable weather condition- do not harvest on rainy day
- During hot conditions wilted fruit should not be picked and the orchard should be, irrigated before harvest.

General safety inspections should be conducted daily before the equipment is being used. So checkpoints for equipment such as tractors and forklifts are: 

- Check water, fuel, fan belts, etc. 
- Once engine is running, check hand and/or air brakes, this ensures that brakes will hold while loading.  I
- Inspect hydraulic lines for kinks, cracks, and general wear and tear. 
- Inspect the frame for hairline cracks, or fatigue in the metal. Cracks in the metal may cause the equipment to break either completely or parts coming off.
- Pickers must be at a safe distance from the equipment when loading or unloading bins.
- Operators must be aware of the location of the harvesters at all times. Drivers and

Operators must be on the look out for harvesters on ladders while driving through an orchard.

- Operators must look out for overhead power lines during loading and unloading of fruit.

Always discuss unsafe acts seen during the day with the supervisors so that preventative measures can be developed and implemented.

❖ **Cares (precautions) at harvesting**

- ☞ Harvest only at the proper stage of maturity.
- ☞ Harvest as per the demand, purpose of consumption and distances of marketing.
- ☞ Do not harvest fruits or vegetables after spraying fungicides and insecticides for at least a week.
- ☞ Do not cause injury to the plants or produce while harvesting.
- ☞ Wash the harvested products after harvest and grade them before marketing.
- ☞ Harvest only in the morning when the produce is cool.

- ☞ Avoid harvesting during or immediately after rain as it creates favorable conditions for spread of pathogens
- ☞ Harvest at proper maturity stage
- ☞ Time of day to harvest. Most crops (with the exception of dry storage crops) are best harvested in the cool of the morning to avoid moisture stress at time of harvest and preserve marketability
- ☞ Crop turgor, soil moisture, and irrigation considerations prior to harvest.
- ☞ Leafy crops (e.g., lettuce, carrots, beets, spinach, greens, etc). Soil at 75% of field capacity to assure good turgor pressure and avoid soil compaction due to wet soil. Irrigating 24 hours prior to harvest is often ideal.
- ☞ Storage crops (e.g., onions, garlic, potatoes, winter squash, etc.). Soil and crops should be thoroughly dry prior to harvest and storage.

❖ **Keys for successful handling**

Harvest at proper maturity stage

- ☞ Select, eliminate and separate products: with damage, for immediate sale, storage.
- ☞ Harvest during the coolest part of the day, keep products in shade after harvest. Protect from high temp. And sunlight throughout the post-harvest chain.
- ☞ Handle products with care to avoid mechanical injuries. Use correct packaging material and avoid overstocking. Avoid drops, impacts, and vibration and surface injuries.
- ☞ Keep good sanitation procedures. Clean harvest containers, display and storage facilities etc.

### 3.2. Suitable weather conditions for picking

After careful determination of maturity status of a given horticultural crop for harvest, it is better to establish suitable weather conditions for harvesting and storage. Some of the weather conditions to established for picking may include optimum temperature depending on type of horticultural crop to be picked, relative humidity, moisture, sun light and wind.

✓ **Adjusting and establishing of these and other weather conditions is important to:-**

- ❖ Extend storage or marketable life of crops
- ❖ Maintain the full turgidity of leaves and other fleshy parts of the plant.
- ❖ Reduce transpiration rate of harvested produces
- ❖ Increase sale value (market price)

| Self-Check 3 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. List the importance of establishing suitable weather conditions for harvesting horticultural crop(10)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-4 | Selecting tools, equipment and machinery |
|---|---|

4.1. Harvesting **tools, equipment and machinery**

Selections of appropriate tools, equipment and machineries which are important for horticultural crop harvesting have a key role in safe handling, harvesting and keeping the quality of the product. Some of the major uses of the selecting appropriate tools, equipment and machineries include;

- Keeping the quality of matured products during harvesting
- Reducing crop damage during harvesting
- Speeding up the task of harvesting
- Keeping the health of mother plant for the next season (if it is fruit) …et

When undertaking any activity, selecting tools, equipment and machineries is essential to accomplish a given task successfully. During harvesting horticultural crops, tools, equipment and machinery may include

✓ **Picking knives and shears**

In crops such as lettuce and cabbage, harvesting knives are usually used.

Using ways of knives:

- The knife is placed between the first and second leaves and a single clean cut removed the head from the stem.
- Must be sharp at all times; otherwise it will not give a clean cut.
- Must be kept clean at all times.
- In between cutting, the knife must be dipped in a sanitizing solution.

In the case of fruit harvesting, fruit are harvested either by hand or some for of harvesting shears or cutter. These are used to cut the fruit stem from the branch.

Generally the harvesting equipment:

- The equipment must be kept dry and should not be kept on a dirty floor.
- Harvesting equipment must not be stored in close vicinity to pesticides, pesticide application equipment or fertilizers.
- The equipment could become contaminated and thereby contaminate the harvested produce.
- All tools and equipment used in the harvesting process must be properly cleaned and sterilized before and after use as well as at regular intervals during harvesting.
- Workers must also wear clean and suitable protective clothing.

✓ pruning shear

The most common tools used for harvesting fruit are steel pruning shears. They are used to cut the stem of the fruit as close to the button, or calyx, as possible without injuring the shoulder of the fruit. Some vegetable fruits, like tomatoes, can easily be picked by a simple twist of the hand, while pruning shears are used on others like peppers.

*Fig 4.1 Pruning shear*

- ✓ **Harvesting Knives**

Knives are used in harvesting leafy crops such as cabbage heads, Swiss chard leaves and lettuce. A good quality knife with a strong blade should be supplied to the harvesters. The blade should be sharp enough to facilitate easy cutting. A blunt knife will not only reduce the harvest speed, but can cause unnecessary damage to the produce. Knives should be regularly cleaned and disinfected whilst harvesting to prevent the spread of post-harvest decay organisms.

*Fig 4.2 Harvesting Knives*

- ✓ **Ladders**

Ladders are used during harvesting of tree crops depending on the height of trees. Ladders are placed alongside trees, or rested against the canopy in the case of larger trees. Ladders vary from home-made, single-sided, two-legged ladders made from locally grown wood to factory-manufactured, two- or three-legged ladders generally made from aluminium or wood. In preparation for harvesting, ladders must be checked for sharp edges, splinters, loose components and dirt to ensure fruit is not damaged when the ladders are placed alongside the trees or against the canopy. The ladders should also be checked for defects that may compromise the safety of the harvesters.

*Fig 4.3 metallic ladder for harvesting*

- ✓ **Pruning shear**

The most common tools used for harvesting fruit are steel pruning shears. A variety of styles are available as hand held or pole models, including shears that cut and hold onto the stem of the cut product. This feature allows the picker to harvest without a catching bag and without dropping fruits.

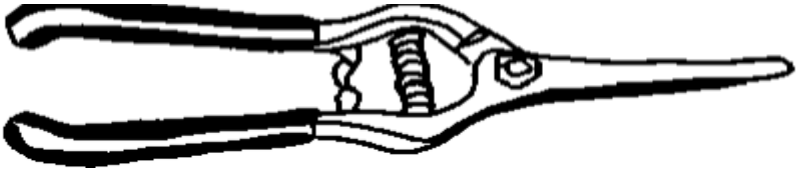


*Fig 4.4 Thin curved blade for grapes and fruits*:

*Fig 4.6 Cut and hold hand shears*

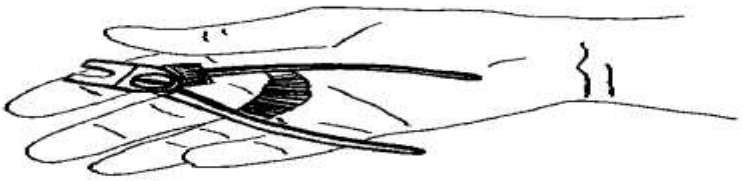


*Fig 2.7 Clipper for citrus fruits*

Using a cutting tool attached to a long pole can aid picking of crops such as mangoes and avocados when the fruit is difficult to reach.

Figure-2.8 *a collection bag made of cloth with knife at the tip integrated with a picking pole for harvesting.*

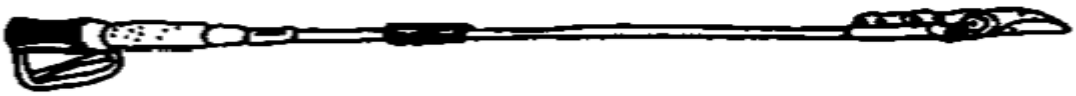


*Fig 4. 9 Pole mounted cut and hold picking shears*

Picking poles and catching sacks can be made by hand or purchased from horticultural supply companies. The collection bags illustrated below were hand woven from strong cord or sewn from canvas.

*Fig 4.10 using a picking pole*

- ✓ **Picking containers**

A number of receptacles are used to collect picked fruit, but the most common is a picking bag. Picking bags are generally made from canvas or polyvinyl. They have a single strap and are slung over the shoulder of the picker. As the picker picks the fruit, it is placed inside the bag until it is full. The containers must be cleaned before harvesting is initiated strands of these bags contaminate the cotton fibre. Fruits and vegetables, which damage easily, are picked into picking crates taken to the cold rooms or packing sheds as soon as possible.

*Fig 4.11 Picking containers*

- ✓ **Garden fork**

In the case of smaller production areas, where mechanical harvesters cannot be used, a fork can be used instead for lifting produce. The fork is inserted into the soil at an angle, close to the crop plant and then the plant and soil are lifted.

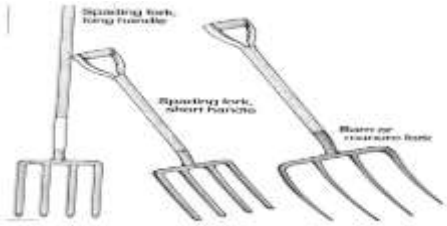


*Fig 4.12* ***Garden fork***

- ✓ **Mechanical harvesters**

Vegetables produced for industrial purposes, potatoes, onions, and oil crops are harvested mechanically. The different types of harvesters are specially designed to for a specific crop or group of crop Onions, potatoes and groundnuts grow below the soil surface.

*Fig 4.1 potato harvester*

| Self-Check 4 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. Why select tools for harvesting. (5 points)
2. Mention at list three tools for harvesting? (5 points

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-5 | Carrying out pre-operational and safety checks |
|---|---|

## 5.1. Pre-operational and safety checks on tools, equipment and machinery

- **Harvesting equipment**.
  - Maintain ladders, bins, picking bags and crates in good condition.
  - Check the number of materials sufficient for the work
  - Wash and clean all equipment used for picking fruit.
  - Crop maturity in readiness for harvest
  - Staff requirements•

- **Harvest and the weather**.
  - Favorable weather condition- do not harvest on rainy day
  - During hot conditions wilted fruit should not be picked and the orchard should be, irrigated before harvest.

General safety inspections should be conducted daily before the equipment is being used. So checkpoints for equipment such as tractors and forklifts are: 

- Check water, fuel, fan belts, etc. 
- Once engine is running, check hand and/or air brakes, this ensures that brakes will hold while loading.  I
- Inspect hydraulic lines for kinks, cracks, and general wear and tear. 
- Inspect the frame for hairline cracks, or fatigue in the metal. Cracks in the metal may cause the equipment to break either completely or parts coming off.
- Pickers must be at a safe distance from the equipment when loading or unloading bins.
- Operators must be aware of the location of the harvesters at all times. Drivers and operators must be on the look out for harvesters on ladders while driving through an orchard.
- Operators must look out for overhead power lines during loading and unloading of fruit.
- Always discuss unsafe acts seen during the day with the supervisors so that preventative measures can be developed and implemented.

After the election of appropriate tools, equipments and machineries which are important for horticultural crop harvesting, carrying out pre-operational and safety checks on tools, equipment and machinery is an essential part of horticultural crop harvesting.

Check all the tools and equipments before use.

- Are all the materials functional and sufficient enough in number?
- Are all free from any contaminants?
- Is there any material which needs maintenance?
- Is the material function coincides with the given horticultural crop to be harvested?

Then check and report to your supervisor the condition of these materials. After reporting the condition of materials, your supervisor will guide you what to do if there is insufficient of materials to perform this particular work.

### 5.1.1. Identifying OHS hazards

When performing horticultural crop harvesting, care has to be given for the worker and products that are harvested so as to reduce some OHS hazards. Identifying of different OHS hazards regarding horticultural crop harvesting is appropriate to take the corresponding care. Poor handling of different harvested products and equipment will leads to:

- Loss of quality
- Color and shape change
- Reduce marketability and the shelf life of the product
- Contamination with disease and it highly affects the worker in different ways.

Therefore, strict care has to be given for workers and harvested products when operating different horticultural crop harvesting activities. Some of OHS hazards which may be occurred during horticultural crop harvesting includes: solar radiation, dust, noise, soil and air-borne micro-organisms, chemicals and hazardous substances, sharp hand tools and equipment, manual handling, ladders, moving vehicles, machinery and machinery parts, slippery or uneven surfaces, potholes and flying objects.

| Self-Check 5 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. List the impact of Poor handling of different harvested products and equipment (10)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-6 | Identifying and controlling OHS hazards |
|---|---|

## 6.1. Identifying OHS hazards

When performing horticultural crop harvesting, care has to be given for the worker and products that are harvested so as to reduce some OHS hazards. Identifying of different OHS hazards regarding horticultural crop harvesting is appropriate to take the corresponding care. Poor handling of different harvested products and equipments will leads to:

- Loss of quality
- Color and shape change
- Reduce marketability and the shelf life of the product
- Contamination with disease and it highly affects the worker in different ways.

Therefore, strict care has to be given for workers and harvested products when operating different horticultural crop harvesting activities. Some of OHS hazards which may be occurred during horticultural crop harvesting includes: solar radiation, dust, noise, soil and air-borne micro-organisms, chemicals and hazardous substances, sharp hand tools and equipment, manual handling, ladders, moving vehicles, machinery and machinery parts, slippery or uneven surfaces, potholes and flying objects.

| Self-Check 6 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. List the importance of identifying OHS hazards (10)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-7 | Selecting and maintaining suitable safety and personal protective equipment |
|---|---|

## 7.1. Identifying suitable safety and personal protective equipment(PPE)

Basically, selecting and using suitable personal protective equipments during horticultural crop harvesting activity is important to:-

- ✓ Protect from different OHS hazards
- ✓ Reduce harvesting losses
- ✓ Improve the quality of the harvested products
- ✓ Reduce contamination from disease
- ✓ Keep workers safety
- ✓ Perform the task in well-organized manner
- ✓ Have marketable products.

Suitable safety personal protective equipment (PPE) that are used in horticultural crop harvesting include;

- ❖ Boots
- ❖ Overalls
- ❖ Gloves
- ❖ Goggles
- ❖ Face mask
- ❖ Hearing protection, and
- ❖ Sun hat and sunscreen lotion.

Therefore, before starting the harvesting operation make sure that you have all these suitable personal protective equipment in order to have successful harvesting operation

| Self-Check-7 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. List the importance of selecting and using suitable personal protective equipments during horticultural crop harvesting (10)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

| Operation sheet-1 | Determining crop maturity |
|---|---|

✓ **Procedure**

**Determining crop maturity**

1. Select the type of horticultural crop (fruit, vegetables, flower, tubers…etc)
2. Select materials and tools depending on type of crop you have selected.
3. Observe the maturity indices or parameters
4. Test the maturity of the crop by either using tools or equipment or observation
5. Interpret and analyze the results by comparison with specification charts.
6. Finally, report to your supervisor.

| Operation sheet-2 | **undertaking harvesting the** crop |
|---|---|

✖ Harvesting fruits/vegetable

✓ Procedures

Step1. Identify fruit/vegetable to be harvested.

Step2. Determine maturity based maturity indexes.

Step3. Prepare containers and labor used for harvesting

Step4. Prepare transportation and storage facilities

Step5. Prepare harvesting schedule which is used as guideline for harvesting activities

Step6. Undertake harvesting activities

Step7. Maintain the temperature of the product immediately after harvesting

Step8. Sort the harvested fruits

Step9. Transport the product in a safe way to processing or storage area

Step10.Storage properly if stored and deliver as quickly as possible for processing industry if processed.

| LAP Test | Practical demonstration |
|---|---|

Name: _____ Date: _____

Time started: _____Time finished: _____

Instructions:

**Task 1.** Determining crop maturity

**Task 2.** Harvesting fruits/vegetable

## References


Lee, i., kang, j., lee k. J., lee, m. K. & lee, y-j. 2014. Applicability of rotary uav for Vegetable crop investigation.

Tapas. 2005. Fruit and vegetables production. Survey on direct sales. Tapas project. Final report. Agriculture and fisheries unit national statistics office, Malta

A.S. dhatt and b.v.c. mahajan punjab horticultural postharvest technology centre punjab agricultural university campus, ludhiana (16-07-2007)

Http://www.agriinfo.in/default.aspx?page=topic&superid=2&topicid=2008

https://www.google.com/search?q=image+of+Mechanical+Harvesting:&client=firefox-a&rls=org.mozilla:en-

Kader, A. A., 2003. A perspective on postharvest horticulture (1978–2003). *HortScience, 38, 5:1004–1008.*

# HORTICULTURAL CROP PRODUCTION

# Level -III

# Learning Guide -70

**Unit of Competence**: - Co-ordinate Horticultural Crop Harvesting

**Module Title: -** Co-ordinating Horticultural Crop Harvesting

**LG Code:** **AGR HCP3 M16 LO3-LG-70**

**TTLM Code:** **AGR HCP3TTLM 0120v1**

**LO 3:** Monitor crop quality throughout harvest

| Instruction Sheet | Learning Guide #-68 |
|---|---|

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

- Using suitable safety and personal protective equipment
- Complying harvesting procedures and the harvested crop
- Handling crop
- Sorting and grading
- Storing crop
- Transporting crop
- Calculating and recording harvest yields

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

Specifically, upon completion of this Learning Guide, **you will be able to –**

- Use suitable safety and personal protective equipment
- Comply harvesting procedures and the harvested crop
- Handle crop, Sort and grading, Store crop, Transport crop and
- Calculate and record harvest yields

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 7.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1,2,3,4,5,6 and 7” in page 71,82,86,90,93,100 and 102 and operational sheet on page:103
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Do LAP Test on page:103

| Information Sheet-1 | Using suitable safety and personal protective equipment |
|---|---|

### 1.1. Requirement of PPE

Personal protective equipment, more commonly referred to as PPE, is required for many farm tasks. It is important to purchase quality products that meet safety standards and are appropriate for work you will be doing. **PPE** is **equipment** that will protect workers against health or **safety** risks on the job. The purpose is to reduce employee exposure to hazards when engineering and administrative controls are not feasible or effective to reduce these risks to acceptable levels.

Selecting and wearing of proper personal protective equipment is required when working to minimize the health hazards. Always wear the protective equipment that is necessary for the respective task when working. Follow the instructions on personal protective equipment that is posted in the work area. Also, when using personal protective equipment, periodic maintenance is required to check and enhance safeties of the personal protective equipment. Basically, selecting and using suitable personal protective equipments during horticultural crop harvesting activity is important to:

- ✓ Protect from different OHS hazards
- ✓ Reduce harvesting losses
- ✓ Improve the quality of the harvested products
- ✓ Reduce contamination from disease
- ✓ Keep workers safety
- ✓ Perform the task in well-organized manner
- ✓ Have marketable products.

Suitable safety personal protective equipment (PPE) that is used in horticultural crop harvesting includes;

- ❖ Boots
- ❖ Overalls
- ❖ Gloves
- ❖ Goggles
- ❖ Face mask
- ❖ Hearing protection, and
- ❖ Sun hat and sunscreen lotion.

Therefore, before starting the harvesting operation make sure that you have all these suitable personal protective equipment in order to have successful harvesting operation

### 1.2 Types of PPE

- Respiratory protection - for example, disposable, cartridge, air line, half or full face.
- Eye protection – for example, spectacles/goggles, shields, visors.
- Hearing protection – for example, ear muffs and plugs.
    - Hand protection – for example, gloves and barrier creams.

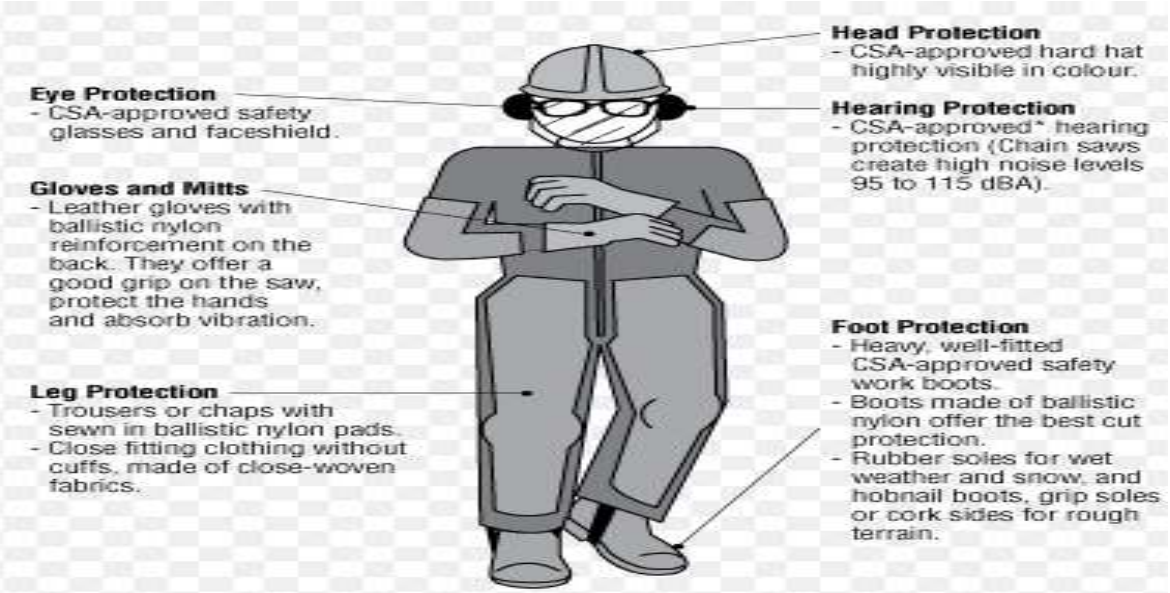



*Figure-1.1 PPE TYPE*

| Self-Check 1 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. List the type of PPE and discus on their advantage (10)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

## 2.1. Undertaking harvesting practices

### 2.1.1 Picking Procedures

Once a fruit is plucked from a plant, or a root or leaf vegetable is harvested it is cut off from its source of food and particularly water. In general the quality of fruit and vegetables cannot be improved after harvest. Harvesting practices therefore aim to cause as little mechanical damage to produce as possible. Gentle digging, picking and handling will help reduce crop losses. Picking of fruit and vegetables can be carried out mechanically or by hand.

*Fig 2.1 fruit picking*

Tuber and root crops are normally harvested with forks or hoes. The digging should start some 15cms away from the base of the plant. In general, it is preferable to handle and pull the roots rather than attempt to dig the roots out. Harvesting is easiest when the soil is relatively dry as both damage and the need for washing is reduced. Most staple roots and tubers that grow beneath the soil are likely to suffer mechanical injury at harvest because of digging tools even if harvested by hand. Other root crops, such as carrots, turnips or radishes can be loosened from the soil in a similar manner by inserting the tool into the soil at an angle and levering the roots upwards.

Fig 1.2 harvested root and tuber crops

**Vegetables:** Hands only, sharp knives or clippers can harvest either the whole vegetable or a part of the vegetative growth. Harvesting methods vary according to the vegetable to be harvested:

- ⇨ With vegetables where the plants grow above ground (e.g. cabbage, lettuce, sweet pepper, eggplant and honeydew melons) the main stem can be cut through with a heavy knife and trimming is carried out in the field (the cut stem must not be placed on the soil). Knives must be kept sharp and clean at all times or they may spread virus diseases from plant to plant. Tools like this are used for harvesting lettuce, cabbage,
- ⇨ Bulb vegetables (e.g. onions. leeks and garlic) can usually be pulled from the soil by hand or loosened by using a digging fork and then cutting the leaves about 3cms from the bulb.
- ⇨ Root crops (e.g. carrots) can be lifted by hand or simple tractor implements used to undermine bulbs and bring them to the surface

Fig.2. 2 flowering vegetables

**Fruit:** can be picked carefully by hand, clipped or cut from the tree. Clippers or knives should be kept well sharpened. Protruding parts, woody stems or spurs should be trimmed as close as possible to prevent fruit from damaging neighboring fruits during transport.

Fruit trees are sometimes quite tall and letting fruit fall to the ground when it is cut from the tree will cause severe bruising. If two pickers work together, one can clip or cut the fruit from the tree, and the other can use a sack to break its fall. The catcher supports the bag with his hands and one foot, catches the falling fruit and then lowers the far end of the bag to allow the fruit to roll safely to the ground.

Fig. 2.3 fruit harvesting

### 2.1.2 Mechanizations and produce damage

Harvest mechanization is particularly useful in certain circumstances and in particular for:

- Harvesting potatoes, onions, celery and some other root crops and where simple tractor-drawn harvesters lift up the crops and leave them on the soil surface for later hand picking and grading
- In transporting produce from the harvesting point to the assembly area to await further transport. Normally involving tractors and trailers with laden containers, pallets or bins.

Machine harvesting equipment is usually only economically feasible

- Only for producers with larger fields
- With crops that are harvest only once (e.g. legumes) and
- Where labor is difficult to obtain or relatively expensive.

Damage during harvest can become a serious problem, as injuries

- Make produce decay faster,
- Increase water loss and respiratory and
- Ethylene production rates and leading to rapid deterioration.

Containers used by pickers in the field should be clean, have smooth inside surfaces and be free of rough edges. Stackable plastic crates, while initially expensive, are durable, reusable and easily cleaned. If baskets are used, they have to be woven "inside out" with sharp edges on the outside of the basket. Plant and crop damage may be minimized by:-

- Wear gloves
- Have short fingernails.
- Empty bags carefully.
- placing rather than dropping the crop into containers
- Do not overfill bags or bins.
- Ensure farm road surfaces are smooth.
- Use minimum trailer tyre pressures to cushion the ride.
- Drive slowly to the packing shed.

- maintaining sharp tools •
    - Protect fruit from the sun.
- Keep harvested out of the sun.
- Erect shelters if necessary.
- Transport full bins directly to the packing facility.
- Bulk dip or spray a suitable post-harvest fungicide onto fruit within 24 hours of harvest where appropriate

### 2.3. Guideline to harvesting crops

The section below summarises harvesting guidelines for selected crops.

- **Citrus**

Once picking starts, a few basics guidelines should be adhered to, as set out below. •

- Picking bags are suspended from the side of the pickers and not in front of them. This prevents damage to the fruit as the picker leans against a ladder or pushes into branches in the canopy. •
- Pickers must walk with full picking bags and not run, as running will bounce and chafe the fruit, leading to the development of oleocellosis. •
- When picking bags are emptied they should be placed close to or on existing fruit lying in the bulk bins or picking trailers before being emptied. This will also limit injury. •
- Once a bag has been emptied, it must be opened and shaken to remove loose twigs, leaves and sand that might have collected during the picking process. •
- Fruit that were dropped during the picking process must not be picked up off the ground and put with export fruit. Similarly, fruit lying on the ground and in contact with the soil should not be picked up and mixed with export fruit. When varieties that are susceptible to oleocellosis are harvested, filling of bulk bins and trailers should be limited. The extent of the limitation will depend on the specific condition, but it would generally never be approximately 50% of the volume of the bin/trailer. As an added precaution, rubber or cardboard sheeting can be used to line bins providing protection

- **Soft fruits such as tomatoes**

Ensure that clear instructions are given on which colour fruits should be harvested and which should be left for the next picking. Follow the site procedures where they are available. Provide examples of some poor quality fruits and what should be done if such fruit are encountered. These fruits bruise easily and should not be thrown into the picking crates from a distance

- **Ears, heads and pods - dry**

As these are already dry, care should be taken to prevent the seeds from falling out of the head or pod before it reaches the threshing area. At this stage some diseases could have attacked the ears, heads or pods. The pickers should know how to identify these and should separate diseased pods and cobs.

### Vegetable Crops

Vegetables should be harvested during the cool part of the morning and should be stored as soon as possible. If the produce is destined for the market, ensure that the storage conditions are correct for the produce. If they are destined for processing, they should be cooled and stored under refrigeration to preserve flavor and quality. You need to ensure that you know the basic harvest practice for each crop you are dealing with. What follows are some examples of harvest practices for different crops.

- • **Beans – green** - Start harvesting before seeds develop in the pod – when the green pods are about the diameter of a pencil. To determine harvest readiness bend them in the middle, if they snap easily, they can be harvested. •
- **Beetroot** - Harvest when they are about 5 to 8 cm in diameter. If the market is for smaller beets they can be harvested at about 2 – 3 cm diameter. The leaves should be about 10 – 15 cm long. The beet tops can also be eaten as greens. •
- **Broccoli** - Harvest the dark green compact clusters or heads when they are about 15 cm in diameter. The buds must be tight and should be harvested before any yellow flower develops. As you harvest the heads, smaller side shoots will develop providing an almost continuous harvest. •
- **Cabbage** - Harvest cabbage when the heads feel hard and solid. If left to late the heads will crack and split. Cut the heads from the stem just below the point of attachment to the stem. Ensure that you use a clean, sharp suitable knife. Always clean the knife using a dip mixture of suitable sanitizer in water. One can harvest the sprouts that develop as a later crop. •
- **Cucumbers** - Harvest when the fruits are deep green and before a yellow colour develops. The cucumber fruit should be 5 – 8 cm long for sweet pickles; 13 – 16 cm for dill pickles, and 16 – 20 cm for slicing pickles. Harvest 4 to 5 times per week to encourage continuous production. Mature cucumbers left on the vine will stop the production of the entire plant. •
- **Lettuc**e - For non-heading types harvest the older, outer leaves from leaf lettuce when they are approximately 12 cm long. For heading types harvest when the heads are moderately firm but well before seed stalks form.

- **Onions** - Harvest when the tops fall over and begin to turn yellow. Dig out the onions and place them to dry out in the open sun for a few days. The onions are sufficiently dry when skin is toughened. Remove the dried soil by brushing the onions lightly. Cut the stem, leaving 4 to 5 cm and store in a net bag in a cool, dry place
- **Tree crops - general •**

Do not shake the branches of the trees to make the fruits fall down as this will lead to bruising. When harvesting for processing, a harvesting stick can be used where fruit are high to reach but allow the fruits drop onto a soft surface, such as a net.

- When mango and avocados are to be exported or transported for extended periods, leave a portion of the stalk on the fruit. •
- Do not throw fruits out during harvest. •
- When harvesting heavy banana bunches use two people per bunch. •
- Harvest in the early morning or late afternoon. •
- Do the first grading according to market destination during harves
- Ensure that the latex from mango, banana and paw paw does not come into contact with the skin of the fruit. If this happens wash the fruit in clean water. •
- Take care of your eyes, if harvested fruits contain latex juice. •
- Place your fruits on a well-aerated surface or in containers that are not made of rough surfaces. •
- Handle the fruit as little as possible. •
- Pack the fruits as soon as possible into the final transport box or container. •
- Export fruit may have to be cooled. •

- The basic principles or orchard hygiene are:-
  - In order to avoid mould infections and rind damage a number of standard orchard hygiene practices could also be implemented.
  - Prune trees of dead branches twigs.
  - Prune the trees to allow light and air movement through trees.
  - Harvest cultivars that are susceptible to splitting early.
  - Never place fallen fruit into bins together with fresh fruit.

The self-healing of wounds, cut and bruises is known as curing. The term is applied to the measures used to prepare starchy staple root crops and onions for long-term storage. Curing root and tuber crops is an important practice if these crops are to be stored for any length of time. Curing is accomplished by holding the produce at high temperature and high relative humidity for several days. Wounds heal and a new, protective layer of cells

are formed. While curing can be costly initially, the long extension of storage life often makes this practice economically worthwhile.

Root crop curing: - Potatoes and several other roots and vegetables have the ability to heal skin wound when held at moderately warm conditions and high humidity for several days after harvest.

Curing dry bulbs, the storage life of onions, garlic and flowering bulbs is extended by exposure to warm dry conditions for several days to dry the outside skin and prevent the ingress of spoilage organisms. Carried out immediately after harvest it is a drying-out process. The dried layers of skin protect the produce from further water loss during storage.

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

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.

### 2.3.1. curing root, tuber and bulb crops

The self-healing of wounds, cut and bruises is known as curing. Curing root and tuber crops such as sweet potatoes, potatoes, cassava and yarms is an important practice if these crops are to be stored for any length of time. Curing is accomplished by holding the produce at high temperature and high relative humidity for several days while harvesting wounds heal and a new protective layer of cells form. While curing can be initially costly, the long extension of storage life makes the practice economically worthwhile. The best conditions for curing vary among crops as shown in the following.

*Table2.1*

| Commodities | Temperature | | Relative Humidity | Days |
|---|---|---|---|---|
| | °C | °F | (%) | |
| Potato | 15-20 | 59-68 | 90-95 | 5-10 |
| Sweet potato | 30-32 | 86-90 | 85-90 | 4-7 |
| Yams | 32-40 | 90-104 | 90-100 | 1-4 |
| Cassava | 30-40 | 86-104 | 90-95 | 2-5 |

Curing, when used for onions, garlic and flowering bulbs refers to the practice directly following harvest, of allowing the external layers of skin and neck tissue to dry out prior to handling and storage. If local weather conditions permit, these crops can be undercut in the field, windrowed and left there to dry for five to ten days. The dried tops of the plants can be arranged to cover and shade the bulbs during the curing process, protecting the produce from excess heat and sunburn. If forced heated air is used for curing onions and other bulbs, one day or less at 35 to 45 °C (95 to 113 °F) and 60 to 75% relative humidity is recommended. The dried layers of 'skin" then protect the produce from further water loss during storage.

### 2.3.2. Field curing

Yams and other tropical root and tuber crops can be cured outdoors if piled in a partially shaded area. Cut grasses or straw can be used as insulating materials and the pile should be covered with canvas, burlap or woven grass mats. Curing requires high temperature and high relative humidity, and this covering will trap self-generated heat and moisture. The stack should be left for about four days. Curing dry bulbs, the storage life of onions, garlic and flowering bulbs is extended by exposure to warm dry conditions for several days to dry the outside skin and prevent the ingress of spoilage organisms. Carried out immediately after harvest it is a drying-out process. The dried layers of skin protect the produce from further water loss during storage.

- **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 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.

### 2.4. Field packing

When crops are field packed the picker harvests and then immediately packs the produce after minimal handling Strawberries are generally field packed, since even a small amount of handling will damage these soft fruits. When lettuce is field packed, several wrapper leaves are left on the head to help cushion the produce during transport.

#### 2.4.1. Handling Waste

Often much of the harvested produce is lost. This is because fresh produce tends to go into a steady decay almost immediately after harvesting. Although post-harvest treatments will preserve the produce to some extent, there is always some extent of post-harvest wastage. The amount of waste that is generated should be minimized. To minimize such damage, care must be taken to ensure that fruit is not damaged in any way. Losses associated with wastage extend beyond the physical loss the produce itself. Such wastage leads to reduced income, they contribute to environmental pollution. Most fresh produce farms will however have an area set aside where harvest wastage is either stored and later used as animal feed, or is composted. Such areas must be at a distance from both the fields and the processing areas

A simple aid for field packers is a movable cart with a rack for boxes and a wide roof to provide shade. This small cart is designed to be pushed by hand along the outer edge of the field or orchard where harvest is taking place. It has been used to field pack table grapes, small fruits and specialty vegetables.

### 2.5. Waste produced during the harvest process

Waste in this sense is a plant residue left on the field after harvesting. Examples include: •

- The stubble, cobs and leaves of a maize plant. •
- The stem leaves and discarded fruit of tomatoes and other fruit crops. •
- The stem and wrapper leaves of a cabbage crop. Such materials are normally degradable and seldom cause environmental problems. However crops diseases and pests maybe harbored in such material, and should therefore be allowed to completely. After harvesting various non-degrading or slow degradable waste are generated. These include: •

- Damaged plastic bags in which produce were to be packed, plastic bags, which contained the packing material. •
- Cardboard boxes in which packing materials were delivered. •
- Broken/damaged picking containers. •
- Un-repairable harvest tools and equipment

### 2.5.1. Dealing with waste produced during harvesting

Firstly, waste in this case does not necessarily have a negative connotation. The waste or rather plant residue produced during harvesting are the plant parts (leaves, stems, cobs, heads etc.) that do not contribute to the yield of the crop. These are often left on the field after harvesting. The following processes can be followed to deal with such waste: The plant residue can be left on the field where it can be used as:

- Mulch. The plant residue can be chopped into smaller particles with a disc implement pulled by a tractor.
- The plant residue then acts as a mulch to protect the soil against water and wind erosion. •
- The plant residue can be incorporated into the soil during primary cultivation and in this way replace some of the nutrient which were extracted out of the soil during the growth of the crop. • •
- Where diseases are problematic or no there is no other use for the rest, it can be burn to get rid of it in an easy and quick way. •
- The residue, especially if it is still green and moist, can be used in the making of compost, which can be used as an alternative to inorganic fertilizers. •
- Discarded vegetables and fruits can also be used in the making of compost. Do not use diseased material for this. •
- Discarded vegetables and fruits can be used as animal feed. •
- Diseased material should be discarded of in a safe way by burning or burying it in a pit, far away from the crop fields.
- Most of the plant residue can therefore be used successfully in other farming enterprises, contributing to the overall success of the farm.

The non-degradable waste requires extra care. A few examples of process that can be followed to deal with such waste are provided below. •

- Recycling of plastics, cardboard, glass etc. •
- If recycling is not an option, discard waste in a safe way. Away from animals and where children play, ideally making use of purpose build waste disposal areas.

Discard of the waste by putting it in a pit and covering it with soil as soon as the pit is full. Keep record of where such a pit was dug to prevent later problems when the pit is opened up by accident. Some of the waste can be use in alternative ways. Cardboard boxes can for example be used to store gloves, picking bags etc.

| **Self-Check 2** | **Written Test** |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. How to minimize plant and crop damage? (5pts )
2. List the advantages of plant residue left on the field? (5 points)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-3 | Handling crop |
|---|---|

### 3.1. Handling the crop carefully to prevent damage

Harvest containers must be handy for the picker to use while moving through the field and ensure minimal mechanical damage for the product. Baskets or boxes with sharp or rough edges should either be avoided or lined with paper or leaves. Damage is often caused by transferring produce from one container to another. If possible, produce should be harvested into the container in which it will be stored or transported.

- Importance of safe handling
  - To reduce physical damage of the product
  - To remove rotten, unhealthy, or immature products
  - To minimize contamination with diseases and pests
  - To increase the shelf-life of harvested products
  - To meet consumers need and attract market value.

**Different types harvesting bags are available including**:

Harvesting bags with shoulder or waist slings that can be used for fruits with firm skins like citrus and avocados. They are easy to carry and leave both hands free.

*Fig 3.1 harvesting bag*

*Figure3.2. bulk bins*

*Figure 3.3. Plastic create*

To ensure a good quality of the products it is vital that the products are healthy and strong at harvest. If they are weak from wilting, diseases, pest etc. the post-harvest life is shorter. It is estimated that between 25-80% of all perishable crops are lost after harvest. This is because the agricultural products are living structures also after harvest. Therefore, respiration and transpiration continues. They follow the lifecycle: growth - maturity – senescence. Careless harvesting, handling, packing and storage practices may decrease the sales value of harvested products.

⇨ **There are different factors affecting harvesting of horticultural crops. Some of these factors are:**

- ❖ Kind and variety of the crop
- ❖ Weather condition at the time of harvesting
- ❖ Distance to storage area and market
- ❖ Purpose of harvesting
- ❖ Type of material used for harvesting and etc.

In order to have good quality of product and marketable yield, highest attention has to be given to harvesting practices to reduce harvesting losses. Here is some of the ways of controlling harvesting losses.

- ➢ Careful harvesting by
  - Wearing gloves
  - Cutting fingernails
  - Maintaining sharp tools
  - Placing rather than dropping the crop in to the containers
- ➢ Proper sorting, grading and packing
- ➢ Adequate and suitable storage facilities
- ➢ Pre and post-harvest treatment
- ➢ Careful transportation and distribution
- ➢ Harvesting at the right stage of maturity

- Harvesting in early morning or late afternoon to avoid field heat

Thus, careful harvesting and handling of harvested products are extremely important to preserve subsequent quality and the storage life of products.

- **Post-Harvest losses are of two types:**

1. **Quantitative losses**

Expressed in terms of: yield (weight loss), Value of price, Water content, Stored energy (CH2O), Vitamins, minerals, volatiles

2. **Qualitative losses**

Expressed in terms of: Color, Flavor, Odour, Rooting (Cassava), Sprouting (Potato), Seed germination (Tomato), Blemishes/Taints

- **Cares (precautions) at harvesting**

  - Harvest only at the proper stage of maturity.
  - Harvest as per the demand, purpose of consumption and distances of marketing.
  - Do not harvest fruits or vegetables after spraying fungicides and insecticides for at least a week.
  - Do not cause injury to the plants or produce while harvesting.
  - Wash the harvested products after harvest and grade them before marketing.
  - Harvest only in the morning when the produce is cool.
  - Avoid harvesting during or immediately after rain as it creates favorable conditions for spread of pathogens

- **Keys for successful handling**

  - Harvest at proper maturity stage
  - Select, eliminate and separate products: with damage, for immediate sale, storage.
  - Harvest during the coolest part of the day, keep products in shade after harvest. Protect from high temp. And sunlight throughout the post-harvest chain.
  - Handle products with care to avoid mechanical injuries. Use correct packaging material and avoid overstocking. Avoid drops, impacts, and vibration and surface injuries.
  - Keep good sanitation procedures. Clean harvest containers, display and storage facilities etc.

| Self-Check 3 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. List the importance carefully handling of crop (10)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

## 4.1. Carrying out basic sorting and grading of the crop

After harvesting, harvested products are subjected to some essential operations which prepare these products for markets as well as storage, Pre-Storage treatments, Grading/Selection, sorting, Storage, Packaging, Transport, Processing and Marketing are the major ones.

- ✓ ***Grading***

**Grading** is often carried out on the ground, under the shade of a tree. This is both unhygienic and inefficient. Specialist grading areas or sheds are better and are generally open sided, with tin or preferably roofs from natural materials. Grading while standing or sitting at tables enables people to work faster. Tables covered with polythene sheeting are easy to clean and the sheeting can be replaced cheaply. Lighting should be good. Tin roofs can be painted white to reflect heat while water trickled down the outside of a shed helps to reduce the heat inside the building

.

It is expected to precede packaging because it is highly unlikely that items of significantly dissimilar quality would be acceptable in a small retail container. Clustered fruit may have to be split before the actual grading and packaging can take place. When done manually, this causes a lot of repetitive movements of the arm and hand and continuous forward bending of the head and neck. Automatic cutting reduces the high number of hand movements the worker has to make to split the clustered cherries. When the fruit is transported on a conveyor belt, manual grading has to be performed. This causes a continuous forward bending of the neck and very high repetitive arm movements.

Manual grading of cherries: the smallest cherries are picked out and put at the distal section of the conveyor belt. At the end of the belt, the cherries drop into the appropriate trays. Grading relates to sorting of the fruit based on market quality. It is the grouping or sorting of the harvested crops based on some standards to eliminate all unsatisfactory products. The separation of harvested products from the bulk into different categories, on the basis of size, color, shape, etc, is called grading. Grading is done based on some specified standards, such as size, color, shape, texture, varieties, maturity, blemishes and etc. It can be done visually or mechanically.

Grading is often done by visual inspection, but may include a tactile component too, by a human operator who has been given a set of criteria against which to judge the item of produce.

The criteria are:

- variety
- Size
- Shape
- Color
- Surface deformities or blemishes
- Firmness.

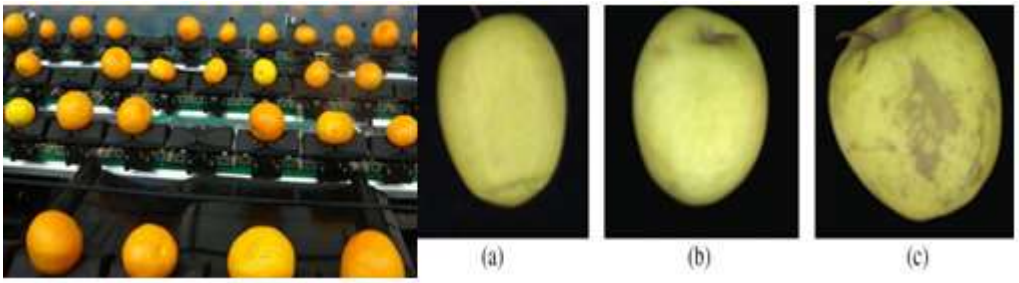



*Figure-4.1 grading*

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

1. Uniformity in size, shape, color and ripeness.
2. Uniformity in appearance.
3. Variety.
4. Seed content.
5. Moisture content.
6. Good visual appearance (absence of visual defects).

The importance of grading is:

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

✓ ***Sorting*** –

It is the process of separating moulded or infested or otherwise damaged ears or heads from the healthy ones before storage is started. It is removal of diseased, insect infested and mechanically damaged commodities and other unmarketable produce. Under this operation, injured, bruised, cut, over-sized, under-sized, decayed, shriveled products are sorted out. After sorting, healthy product is left free from any unwanted subject. Harvested products are subjected to sorting manually or mechanically placing them on running belt. Sorting is usually done manually. Sorting is often combined with grading, but in some applications both phases are separated from each other and the sorting phase is only for removing produce with surface deformities or blemishes and foreign / unwanted objects.

*Figure-4.2. sorting horticultural crop*

During this type of task, the worker usually stands in an upright position for long periods. The working height is fixed and unlikely to be adjustable to suit the particular height of the worker. This may cause continuous forward flexion and rotation of the neck and back. The alternative position is sitting on a chair, but then the upper body will probably be twisted. Continuous standing with bending of neck and/or twisting the back.

- **Advantages of sorting**
  - Remove unwanted items from the harvested products
  - Reduces chances of spoilage
  - Make work easy for grading or over-sized and under-sized items are removed
  - Improve the storage life of the products

| Self-Check 4 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. Discus about grading and sorting (10)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-5 | Storing crop |
|---|---|

## 5.1. Facilitating storage conditions to minimize post-harvest deterioration

Appropriate production practices, careful harvesting and proper packaging, storage and transport all contributes to the good produce quality. Once a crop is harvested it is impossible to improve its quality. The horticultural crops, because of their high moisture content are inherently more liable to deteriorate. Moreover, they are biological active and carryout transpiration, respiration, ripening and other biochemical activities, which deteriorate the quality of the produce. Poor handling, unsuitable containers, improper packaging, poor managements, and transportation can easily cause bruising, cutting, breaking, impact of wounding and other forms of injury. Therefore, special care and attention has to be given for safe handling of produces so as to reduce these losses.

◆ **Management of harvested products in storage**

High quality products will only come out of storage if it is high quality on entering storage and if the management of the storage facilities is of high standard. The success depends on:

- Pre-cooling of storage room before intake of the products.
- Control of temperature and a good air circulation within the storage for an even distribution of the temperature.
- Selection and grading of the products before storage.
- The best is pre-cooling of the products, but if not, avoid stacking warm products too tight. Don't let products touch the outer walls and the floor.
- Keep correct RH to avoid wilting.
- Don't store products too long.
- Sanitation is important. Keep storage areas clean and if necessary sterilize it to reduce risk of mould attacks.

◆ The reason/purpose for storage is to:

- Extend the marketing season or the life of products.
- Delay marketing of a crop until the prizes rise.
- Provide a reserve for more uniform distribution.

◆ The marketable life of a commodity during storage is dependent on / affected by:

1. Initial quality of the product.
2. The storage stability (held at constant temperature etc).
3. The external conditions (temperature, RH etc).
4. The storage facilities and handling methods.

By improving the above factors the storage life of a product can be extended.

◆ **Conditions to be considered in storage**

a. Temperature

b. Relative humidity
c. Ethylene
d. Light
e. Controlled atmosphere
f. Insect/Rodents

| Self-Check 5 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. List the importance advantage of sorting (10)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-6 | Transporting crop |
|---|---|

### 6.1. Understanding transporting of horticultural crop

Transporting is also one of the practices of horticultural crop harvesting in which the harvested produces from the field are picked in to containers and transported to processing or storage area. When transporting harvested crops from the field to processing or storage area, care has to be given to reduce damages due to poor transporting and transporting facilities. Transporting is also one of the practices of horticultural crop harvesting in which the harvested produces from the field are picked in to containers and transported by tractor, trailer or forklift to processing or storage area.

Harvested vegetables must usually be moved from the point of production to the market for sale. Transport choice will be affected by distance, perishability of produce and availability and cost of transport. Very distant markets may require the use of aircraft. While trucks and vans may be suitable over shorter distances. In areas close to rivers or the seacoast, water transport may be the option. When transporting harvested crops from the field to processing or storage area, care has to be given to reduce damages due to poor transporting and transporting facilities.

The basic requirements for conditions during transportation are:

- ✓ Proper control of temperature,
- ✓ humidity
- ✓ Adequate ventilation.

Proper packaging and stacking to avoid excessive movement or vibration which may cause severe bruising or other types of mechanical injury.

### 6.2. Transport systems

i. **Short distance transport**

- Common at production site during production and packing
- The vehicles required to transport are:-
  - -Tractor trailers
  - - Wheel barrows
  - - Animal carts
  - - Push carts
  - - Cycle rickshaws

*Figure: 6.1. Harvested fruits ready to be transported to the packinghouse.*

ii. **Long distance transport**

- Commonly used to transport and distribute producese from production site to the market areas

**-**The transport types used in this system are**:**

1. Road transport
2. Railway transport
3. Air transport
4. Marine transport (shipment)

### 6.2.1. Characteristics of the main transport types:

♥ **ROAD TRANSPORT**

- Highest share of total transport
- Low fixed costs, but high variable costs
- A range of service from small parcels to large bulk products
- Wide range of transport types (also refrigeration transport)
- Can go to 'all' destinations / more flexible

♥ **RAILWAY TRANSPORT**

- Carries primary bulk product freight
- Fixed line systems
- High fixed cost and lower variable cost (per km)
- Speed rel. higher than road transport

♥ **WATER TRANSPORTATION SYSTEMS**

- Cargo carried by containers
- Speed varies
- Low cost over long distances (and low speed)
- Often temp controlling systems

- High fixed cost and low variable cost

♥ **AIR TRANSPORT**

- Domestic to international flight
- Often the quickest transport
- Some has temp controlled systems (ex. for flowers)
- The most expensive transportation

➢ **Factors to be considered in choice of transportation:-**

- **Distance of market**: - Use trucks and vans for short distance markets: whereas aircraft may require for long distance. In areas closer to river or seacoast. Water transport may be option.
- **Perishability of the produce**:- Leafy vegetables loss their turgidity quickly therefore they should be transported immediately after harvest.
- **Availability and cost of transport**:- Use cheap and transport for moving produce from production field to market for sale.
- **Good and established roads**:- If possible use good roads and produce should be transported in the cool of the evening through the night oar in the early morning depending on the distance.

### 6.3. Factors Affecting Transportation

- **Loss**

The damage and loss incurred during non-refrigerated transport are caused primarily by mechanical damage and by overheating.

- **Mechanical damage**

Damage of this type occurs for many reasons, including:

- careless handling of packed produce during loading and unloading;
- vibration (shaking) of the vehicle, especially on bad roads;
- fast driving and poor condition of the vehicle;
- Poor stowage, which allows packages in transit to sway; the stow may collapse.
- Packages stacked too high; the movement of produce within a package increases in relation to its height in the stack.

- **Overheating**

This can occur not only from external sources but also from heat generated by the produce within the package itself. Overheating promotes natural breakdown and decay, and increases the rate of water loss from produce.

✖ **The causes of overheating include**:

- the use of closed vehicles without ventilation;
- close-stow stacking patterns blocking the movement of air between and through packages, thus hindering the dispersal of heat;
- the lack of adequate ventilation of the packages themselves;
- Exposure of the packages to the sun while awaiting transport or while trucks are queuing to unload at their destination.

*Figure-6.2. Compression injury in tomato*

*Figure6.3. Loss of scales in onion bulbs due to abrasions against rough surfaces*

*Figure: 6.4. Delays should be avoided either at reception or delivery, particularly when produce is exposed to the sun.*

♣ **Effects of unfavorable environment during transportation: -**

Effects of unfavorable environment during transportation results in:

-Poor quality of the produce:

**i.** Rapid decrease in valuable foods

ii. Inducing flavor

iii. Reducing palatability

i. **Rapid decrease in valuable foods**:- Under unfavorable environment respiration and transpiration are higher. Therefore leafy vegetables start wilting and loss of turgidity.

ii. **Inducing flavor**:-Due to inadequate ventilation and high temperature in transport vehicles vegetables like potato, onion, cabbage, etc develop off flavor and start rotting.

iii. **Reducing palatability**: - Edible quality and freshness is reduced if vegetables are transported under unfavorable environment.

◆ **Adequate facilities and proper handling**

Safe handling of harvested products and transporting materials plays very important role in shelf life of harvested products and remunerative market income. Since most the harvested horticultural products are perishable, careful handling and transporting of these products and storage or transporting containers have a central role in reducing the post-harvest losses which are caused by poor handling and transporting of the harvested products.

As soon as products are harvested with whole plant or part(s), they immediately undergo certain physiological and biochemical changes and certain losses with respect to loss in weight, appearance, color, texture, nutritive value and etc. Therefore, to avoid these extent losses, there is the need to handle the storage/transporting materials and the products as a whole in well-organized manner.

Importance of safe handling and transporting of harvested products:

- To reduce physical damage of the product
- To remove rotten, unhealthy, or immature products
- To minimize contamination with diseases and pests
- To increase the shelf-life of harvested products
- To meet consumers need and attract market value.

- **The most important considerations to consider in the transportation operation of horticultural products are**:
    - Mechanical damage: impact, compression, vibration, puncturing etc. Especially while loading and unloading stacking, rough packing material, overstocked products and on bumpy roads during transport.
    - Maintaining proper temp and RH. Refrigerated transportation, Controlled RH or transportation during the night.
    - Ensuring product compatibility. Ex. Climacteric fruits (Avocado, apples...) can produce large amounts of ethylene, which will affect other products.
    - Minimizing the cost of transport. Affected by: distance of transport, mode of transport, condition of road (asphalt vs. dirtroad),
    - Nature of the product: perishable/durable, size and weight, value etc.
    - Proper control of temperature, humidity and adequate ventilation.
    - Proper packaging and stacking to avoid excessive movement or vibration which may cause severe bruising or other types of mechanical injury.
    - Adequate facilities and proper handling

Safe handling of harvested products and transporting materials plays very important role in shelf life of harvested products and remunerative market income. Since most the harvested horticultural products are perishable, careful handling and transporting of these products and storage or transporting containers have a central role in reducing the post- harvest losses which are caused by poor handling and transporting of the harvested products.

- **Importance of safe handling and transporting of harvested products**:
    - To reduce physical damage of the product
    - To remove rotten, unhealthy, or immature products
    - To minimize contamination with diseases and pests
    - To increase the shelf-life of harvested products
    - To meet consumers need and attract market value.

| Self-Check 6 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. List the basic requirements for conditions during transportation (10)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-7 | Calculating and recording harvest yields |
|---|---|

### 7.1. Requirement of calculating and recording harvest yields

Total harvest of the plot is obtained by multiplying total number of units harvested by the average unit weight. Crop productivity can then be calculated by dividing total production by the area from where the production came from. Yield. It refers to the percentage of non-defective items of all produced items, and is usually indicated by the ratio of the number of non-defective items against the number of manufactured items. Total harvest of the plot is obtained by multiplying total number of units harvested by the average unit weight. Crop productivity can then be calculated by dividing total production by the area from where the production came from. Multiply the average number of rows per ear by kernels per row by the number of ears in a thousandth of an acre and divide by 90 to estimate yield in bushels per acre. For example: 16 rows x 40 kernels x 32 ears = 21,504 kernels in a thousandth of an acre / 90 = 240 bushels per acre. Percent yield is the percent ratio of actual yield to the theoretical yield. It is calculated to be the experimental yield divided by theoretical yield multiplied by 100%. If the actual and theoretical yield is the same, the percent yield is 100%.

The basic goal of all agricultural activities (both pre-harvest and post-harvest) is to get remarkable, marketable, quantitable and quality final yield. It is the final operation that a famer or a producer analyses the production cost that was consumed during all production activities and the profit he/she gets from the produced crop. Basically, calculating and recording picking tallies or harvest yields is important to:-

- ✪ Know the amount of yield obtained from a given area of land.
- ✪ Compare the amount yield obtained from the previous season yield
- ✪ Analyze the production cost and total profit gained during the growing season.
- ✪ Record data and information for the future season.

The harvested yield could be expressed in Kg/ha, Quintal/ha, tone/ha…etc. Harvest records may include:-harvest workers tallies or working hours, written harvest instructions, dates of harvest, withholding periods (time since last chemical spray), crop yield from each section, weather conditions during harvest, percentage crop deterioration, maturity measurements taken, storage conditions, machinery settings or adjustments, machinery repairs and Maintenance, dispatch details and delivery dockets.

| Self-Check 7 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. List the importance of calculating and recording harvest yields (10)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

| Operation sheet -1 | Carrying out basic sorting and grading of the crop |
|---|---|

- ✖ Grading fruits
- ✓ Procedures

Step1. Identify fruit to be grading.

Step2. Transport harvested fruit

Step3. Setting quality criteria for grading

Step3. Separate fruits based on maturity, colour, size, quality,

Step4. Grading selected fruit based on criteria

| LAP Test | Practical Demonstration |
|---|---|

Name_____ Date_____

Time started_____ Time finished_____

Instructions:

Task-1 showing the way of grading fruit crop

## References

Thompson, J.F. et al. 2001. Effect of cooling delays on fruit and vegetable quality. Perishables Handling Quarterly Issue No. 105: 2-5.

Kitinoja, L and Gorny, J. (1998) Post-harvest technology for fruits and vegetables Produce marketers: Economic opportunities. Quality and Food Safety by, Department of Pomology, University of California, Davis. A joint publication of UC Post harvest Outreach Program and Punjab Horticultural Post harvest technology Centre, USAID/ACE.

# HORTICULTURAL CROP PRODUCTION

## Level -III

# Learning Guide -71

**Unit of Competence**: - Co-ordinate Horticultural Crop Harvesting

**Module Title: -** Co-ordinating Horticultural Crop Harvesting

**LG Code:** **AGR HCP3 M16 LO4-LG-71**

**TTLM Code:** **AGR HCP3TTLM 0120v1**

**LO 4:** Deliver crop to specified destination

| Instruction Sheet | Learning Guide #-71 |
|---|---|

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

- Confirming delivery details
- Delivering crop
- Completing delivery documentation

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

Specifically, upon completion of this Learning Guide, **you will be able to –**

- Confirm delivery details
- Deliver crop
- Complete delivery documentation

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 5.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1,2 and 3” **in page –** 107,112 and 115
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).

| Information Sheet-1 | Confirming delivery details |
|---|---|

### 1.1. Delivery details including quantity, timing and destination

After finishing the transportation and storage tasks, it is utmost important to include some confirming delivery details including quantity, dates of harvest, withholding periods (time since last chemical spray), crop yield from each section, weather conditions during harvest, percentage crop deterioration, maturity measurements taken, storage conditions, machinery settings or adjustments, machinery repairs and maintenance, dispatch details and delivery dockets.

### 1.2. Importance to marketing

Transportation is a big and often the most important factor in the marketing of fresh produce. Ideally, transport would take produce from the grower directly to the consumer, as in many developing countries. In more complex marketing systems (those serving towns, cities or distant countries)' the cost of transport contributes significantly to the price paid by the consumer, and sometimes exceeds the value of the raw product.

Losses directly attributed to transport conditions can be high. The goal of every person concerned with transport should be that the produce be kept in the best possible condition during transport and that the haulage of produce be quick and efficient. To this end, produce should be properly packaged and properly loaded on a suitable vehicle.

| Self-Check 1 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. List the activities included in Confirming delivery details(10)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

### 2.1. delivering crops with damage levels

During harvesting and post-harvest handling of harvested horticultural crops product, there may exist crop damages. Those damages must be recorded depending on their damage levels. The damage that may be caused in harvested crops may be biological (due to different pathogens), mechanical (due to poor handling), and environmental (due to different weather conditions).

### 2.2. Causes of loss during transport

The damage and loss incurred during non-refrigerated transport are caused primarily by mechanical damage and by overheating.

- **Mechanical damage**
- **Overheating**

#### 2.2.1. Methods of transport

☞ **Trucks used to transport fresh produce**.

Most fresh produce is now moved in road vehicles, with lesser amounts by sea, air or inland waterways. The vehicles in most common use are open pick-ups or bigger trucks, either open or enclosed. The use of road vehicles is likely to increase, so users should give attention to the following:

- closed vehicles without refrigeration should not be used to carry fresh produce except on very short journeys, such as local deliveries from farmers or wholesalers to nearby retailers;
- open-sided or half-boarded trucks can be fitted with a roof on a frame. The open sides can be fitted with canvas curtains which can be rolled up or moved aside in sections to allow loading or unloading at any point around the vehicle. Such curtains can protect the produce from the elements but still allow for ventilation. Where pilfering is a problem, the sides and rear of the truck must be enclosed in wire mesh;
- a second, white-painted roof can be fixed as a radiation shield 8 or 10 cm above the main roof; this will reflect the sun's heat and help to keep produce cool;
- for the ventilation of long-distance vehicles, more elaborate air intakes can be fitted in conjunction with louvres, to ensure a positive air flow through the load;

- Refrigerated trucks or road, rail or sea containers may be used for long journeys, but the cost of such transport makes it uneconomical for small-scale operations.

☞ **Handling and stowage practices**.

Although the shape and condition of trucks are important factors in fresh produce transportation, the loading and stowing methods in vehicles are pertinent to damage and loss:

- the best loading factor must be achieved, that is the maximum load that can be carried economically under satisfactory technical conditions: a stable and well-ventilated load;
- the size and design of packages should give adequate levels of ventilation of contents with the minimum of wasted space, and the packages should be strong enough to protect the contents
- loading and unloading of vehicles should be properly supervised to prevent careless handling of packages; loading aids such as trolleys, roller conveyors, pallet or forklift trucks should be used where possible to reduce the handling of individual packages;
- stowage should be carefully done to avoid collapse of the stow during transport; packages should not be stacked higher than the maximum recommended by the maker, otherwise the bottom layers may collapse under the weight of those above
- packed produce should be protected from sun and rain at all times including during loading and unloading
- packages should be loaded on dunnage (pieces of lumber or slatted racks) on the beds of vehicles, or on pallets in order to allow the circulation of air around stacks during transport;
- If the load is to be distributed to several locations, packages should be loaded in reverse order to that in which they will be unloaded, i.e. last on, first off; at the same time the load should be distributed evenly on the vehicle.

Although every care may be taken to observe all the above precautions, the standards of driving remain a difficult problem to overcome. In many cases, drivers are induced to speed in order to make more money for themselves or their employers. Whenever possible, only experienced and responsible drivers should be employed.

♣ **Other modes of transport.**

Fresh produce is transported by many other means, from head-loads to air-freighting. In all cases, the same conditions should be observed. Produce must be:

- kept as cool as possible;
- kept dry;
- Moved to market as quickly as possible.

✖ **Rail transport**. In some countries a large amount of produce is carried by rail.

The advantages are:

- transport damage to produce while moving is slight as compared with that from haulage over rough roads;
- Costs are lower than transport by road.

Rail transport, however, requires extra handling since road transport is needed to and from the rail journey; transport by road alone usually is a door-to-door service.

✖ **Water transport**

- ***Inland***. Waterway transport is used in some countries to move produce to markets. Much of the produce carried in this way is packed in locally made crates or sacks. The vessels employed are often mixed passenger-cargo craft, and no special handling is provided for fresh produce.
- ***Sea*****.** Short-distance transport of fresh produce in small ships without refrigeration is common in countries of island communities (e.g. the Philippines). Ships often accommodate passengers and general cargo, and no special provision is made for fresh produce, which may be stowed in unventilated holds. Losses are high, owing to rough handling by porters, inadequate packaging and overheating in unventilated holds or near engine rooms.

There is much room for improvement in this mode of transport. A model for organized and efficient sea transport is the refrigerated shipment of commercial crops such as bananas, although a modest investment by the small-scale shipper could greatly improve performance.

- **Air freight.** As with shipping, the international trade in the air-freighting of high-value exotic crops is generally well organized. In some countries where road links are poor (e.g. Papua New Guinea), produce is carried by air from production areas to urban markets. Costs are high and losses often heavy because of:

    - poor, non-standard packages;
    - careless handling and exposure to the elements at airports;
    - consignments left behind in favour of passengers;
    - flight delays owing to bad weather or breakdowns;
    - intermittent refrigeration followed by exposure to high temperatures;
    - Relatively small produce shipments.

Even though changes are made in packaging and handling, it is unlikely that the overall situation will improve much until road links are established between producers and consumers.

### ♣ Transport to the packinghouse

When crops are harvested at some distance from the packinghouse, the produce must be transported before packing. The gravity driven conveyor system for bananas illustrated below provides an example of how handling can be minimized during preparation for market. Harvested bananas are carried to the platforms set up along the conveyor route, then lifted and hung from hooks attached to the wire. Transport speed is controlled by workers who lead the produce to the packinghouse at the bottom of the hill.

| Self-Check 2 | Written Test |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. Discus the transporting methods briefly(5)
2. List the Causes of loss during transport(5)

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

| Information Sheet-3 | Completing delivery documentation |
|---|---|

### 3.1. completing accurately delivery documentation

A delivery order (abbreviated D/O) is a document from a consignee, or an owner or his agent of freight carrier which orders the release of the transportation of cargo to another party. ... A delivery order which is used for the import of cargo should not to be confused with delivery instructions. Delivery documents generally provide the delivery instructions for an order or trip and specify the products and quantities to deliver. They serve to transfer ownership of the products to the customer. Some types might also specify the product price and additional charges.

*Table 3.1 document type*

| Document Type | Description | Remark |
|---|---|---|
| Bulk Delivery Ticket | This document provides the delivery instructions for the sales order or trip and specifies the bulk products and quantities to be delivered to the customer. It can be used to record additional information about what was actually delivered. This document might also serve to transfer the ownership of the product to the customer. Although the bulk delivery ticket is not intended to be an invoice, you can include price information. | |
| Bulk Invoice | This document provides the delivery instructions for the sales order or trip and specifies the bulk products and quantities to be delivered to the customer. It can be used to record additional information about what was actually delivered. This document also shows the product price, tax, and other additional charges that might apply. It serves to transfer the ownership of the product to the customer. | |
| Packaged Delivery Ticket | This document provides the delivery instructions for the sales order or trip and specifies the packaged products and quantities to be delivered to the customer. It can be used to record additional information about what was actually delivered. This document also serves to transfer the ownership of the product to the customer. Although the packaged delivery ticket is not intended to be an invoice, you can include price information. | |

| | | |
|---|---|---|
| Packaged Invoice | This document provides the delivery instructions for the sales order or trip and specifies the packaged products and quantities to be delivered to the customer. It can be used to record additional information about what was actually delivered. This document also shows the product price, tax, and other additional charges that might apply. This document serves to transfer the ownership of the product to the customer. | |

| **Self-Check 3** | **Written Test** |
|---|---|

Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

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

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

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

**Short Answer Questions**

## Reference


Wills, r .b.h. Post-harvest and handling and storage of fruits and vegetables fao/gcp/cpr/008/bel, beijing, china, 1988.

Fao “prevention of post-harvest food losses: fruits, vegetables and root crops”, fao training series n.17/2, rome, 1989.available also at: http/www.fao.org/inpho/en/resources/library/index.asp Www.anilrana13014.webbly.com google search = anilrana13014.

Handling of fresh fruits, vegetables and root crops training manual-Arias, c.j. And toledo j., “manual de manejo poscosecha de frutas tropicales”.fao,tcp/per/6713,lima, peru, 2000.

Watkins, c. B., and j. Nock. 2012. “Production guide for storage of organic fruits and vegetables.” *New York state department of agriculture & markets, publ. #10.* Http:// nysipm.cornell.edu/organic_guide/stored_fruit_veg.pdf

| NO | TTLM developer Name | Back ground Qualification | College Address | College Name | Cell Phone | E-mail |
|---|---|---|---|---|---|---|
| 1 | Deribow Gonfa | Plant science(Bsc) | Oromiya | Fitche PollyTVET | 0912774688 | gonfad24@gmail.com |
| 2 | Tesfaye Tekola | Agronomy (Msc) | Benishangul Gumuz | Assosa ATVET | 0910550651 | tttekola@gmail.com |
| 3 | Berhanu Mammo | Horticulture (BSc) | Mizan ATVET | Federal | 0912676883 | birehanmammo@gmail.com |
| 4 | Haftu Mehari | Plant science(BSc) | Tigray | Maichew ATVET | 0914312311 | Kalabkalab61@gmail.com |
| 5 | Melaku Bawoke | Agronomy (Msc) | Federal | Gewane | 0920258287 | Melakubawoke10@gmail.com |
| 6 | Tadesse Yasin | Horticulture (BSc) | Amhara | Kombolcha PollyTVET | 0921626541 | tadaseyasin2019@gmaio.com |
| 7 | Zewde Paulos | Agronomy(Msc) | SNNPR | Sodo ATVET | 0921004814 | Zedpa2013@gmail.com |
| 8 | Bekele Belete | Agronomy (Msc) | SNNPR | Sodo ATVET | 0916379025 | Bekelebelete6@gmail.com |
| 9 | Fetene Muluken | Agronomy (Msc) | Amhara | Woreta ATVET | 0986911690 | Fetenemuluken9@gmail.com |
| 10 | Misgana Belay | Agronomy (Msc) | Oromia | Nedjo ATVET | 0911983854 | Misbel2000@gmail.com |
| 11 | Sadik Ebrahim | Agronomy (Msc) | Federal | Agarfa ATVET | 0920617776 | sadikebra@gmail.com |
| 12 | Birhanu reda | Horticulture(BSc) | Tigray | Maichew ATVET | 0923452395 | birhanureda@gmail.com |

Profile of trainers participate on special Horticultural Crop Production TTLM development

for level III at Adama 2020