



Horticultural Crops Production

Level II

Learning Guide-72

Unit of Competence:- Harvest Horticultural crops

Module Title:- Harvesting Horticultural crops

LG Code: AGR HCP2 M18 LO1-LG-72

TTLM Code: AGR HCP2TTLM 0120v1

LO1: Perform routine assessment of plant products for harvest





Instruction Sheet

Learning Guide-72

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

- Determining Crop maturity
- Reporting Analysis
- Confirming the crop selected for harvesting

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 –

- Determin crop maturity.
- Report analysis .
- Select the crop for harvesting.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1 to Sheet 3”.
4. Accomplish the “Self-check 1, Self-check 2, and Self check 3” in **page -14, 17 and 19** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1 in page 20.
6. Do the “LAP test” in **page – 21** (if you are ready).





Information Sheet-1	Determining Crop maturity
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1.1. Introduction

Harvesting is the process of collect the product from field or from the mother tree when the crop is mature and ready for harvesting.

It is one of the major activities in horticultural crop production. 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 flavour 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.





Factors to be considered with regard timing of 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.

1.3 Harvesting operation

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.

1.4 Harvesting methods

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
2. Mechanical Harvesting





1.5 Crop maturity

❖ 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 metabolites into simple molecules.

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.

1.5.1 Types of maturity

The maturity has been divided into two categories i.e. Physiological maturity and Horticultural maturity

1. Physiological maturity: It is the stage when a fruit is capable of further development or ripening when it is harvested i.e. ready for eating or processing.



2. Horticultural maturity: It refers to the stage of development when plant and plant part possesses the pre-requisites for use by consumers for a particular purpose i.e. ready for harvest.

1.5.2 Importance of maturity indices:

- Ensure sensory quality (flavour, colour, aroma, texture) and nutritional quality.
- Ensure an adequate postharvest shelf life.
- Facilitate scheduling of harvest and packing operations.
- Facilitate marketing over the phone or through internet.

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.

Non-climacteric: Non-climacteric fruits, on the 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.

Table 1.1 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	
Sapota	

1.5.3 Types of indices and their components

1) Visual

a) **Size and shape:** Maturity of fruits can be assessed by their final shape and size at the time of harvest. Fruit shape may be used in some instances to decide maturity. For example, the fullness of cheeks adjacent to pedicel may be used as a guide to maturity of mango and some stone fruits.



Immature



Half mature



Mature

Fig1.1. mango harvest maturity by shape

Some cultivars of banana become less angular in cross section as development and maturation progress. Size is generally of limited value as a maturity index in fruit, though it is widely used for many vegetables, especially those marketed early in their development. With these produce, size is often specified as a quality standard, with large

size generally indicating commercial over-maturity and under-sized produce indicating an immature state

b) **Colour:** 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.

ii) **Physical indices**

a) **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, kinnow 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.



Fig 1.2 Penetrometer Plate

iii) **Chemical Measurement**

Measurement of chemical characteristics of produce is an obvious approach to the problem of maturity determination. The conversion of starch to sugars during maturation



is a simple test for the maturity of some apple cultivars. It is based on the reaction between starch and iodine to produce a blue or purple colour. The intensity of the colour indicates the amount of starch remaining in the fruit. The total soluble solids of the fruit can be measured with refractometer, which indicate the harvest maturity of fruits. Acidity is readily determined on a sample of extracted juice by titration with 0.1 N NaOH. The sugar acid or TSS acid ratio is often better related to palatability of fruit than either sugar or acid level alone.

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 °C or 10 °F), 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 °C or 68 °F).





Fig.1.3 Refractometer

Here are some examples of proposed minimum % SSC for selected commodities. 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 1.2 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

iv) Calculated indices:

- Calendar Date : 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-1.3 Index of selected Fruits

Maturity indicator	Crops
Elapsed days from full bloom to harvest	Apples, pears
Average heat levels during development	Peas, apples, sweet corn
Development of abscission layer	some melons, apples
surface shape and structure	Cuticle formation on grapes, tomatoes
Netting	some melons
Surface morphology and structure	Cuticle formation on grapes, tomatoes Netting of some melons Gloss of some fruits (development of wa
Size	All fruits and many vegetables
Specific gravity	Cherries, watermelons, potatoes
Shape	Angularity of banana fingers Full cheeks of mangos Compactness of broccoli and cauliflower



Compactness	broccoli and cauliflower
Solidity	Lettuce, cabbage, Brussels sprout

Table1.4 Textural properties of the crops

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

Table1.5 Compositional factors of the crops

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

Table1.6 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 longest
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 cavity
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)

**Self-Check 1****Written Test**

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

1. Define harvest? (5pt)
2. List climacteric and nonclimacteric fruits?(4pt)
3. What is maturity? (5 pt)
4. List & Explain the types of maturity? (3pt)

Note: Satisfactory rating - 17 points

Unsatisfactory - below 17points

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

Answer Sheet

Score =

Rating:

Name: _____

Date: _____

Short Answer Questions



Information Sheet-2	Reporting Analysis
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2.1 Sample taking

In order to conduct maturity indexing, the crops must be sampled and then a specific test is performed on the sample.

The first principle of sampling is that the sample must be representative of the bulk of the medium that is being sampled. A sample is not a piece or a section of a whole, but rather the whole reduced to a manageable volume. Although a fruit sample must be taken randomly, the focus should be on fruit that represent the development stage of the bulk of the crop. The focus should also be on the fruit that is likely to be harvested in the earlier part of the season, referred to as the first pick. Unusually large or small fruit would not be included in the sample. The sample is placed in a bag and the details of the field / orchard, the date of sampling is written on a label and sealed. Do not write on the outside of the bag, as the writing will wipe off.

2.2 Analysis of fruit Samples

The procedures set out in this section are applicable to citrus fruits. Similar tests are also conducted on tomatoes for the tomato processing industries where the brix, acidity and juice percentage is measured. Most other vegetable fruits and leafy vegetables will not be analysed chemically, while grain, oil etc. crops will only be monitored for moisture content. In the laboratory, details relating to the sample are noted, including the producer, orchard number, and fruit size and colour.

The fruit is then weighed, cut, its juice is extracted and the following parameters are measured:

- Juice percentage
- Brix, which relates to the total soluble solids or sugar content
- Acidity

The ratio of Brix to acidity is a further parameter used by the industry to determine acceptability of taste for different markets





The norms for different varieties are set at different levels. In the case of lemons, the only deciding factor for export is juice percentage, as neither Brix nor acidity levels are generally used for table fruit. In the case of niche cultivars, higher standards, meaning higher Brix and ratios, have been set to place the fruit in a particular marketing bracket. That standard has to be maintained to assure the producer of the potentially higher return from that market.

2.3 Recording and reporting maturity indexing

Information Once the internal quality results are received from the laboratory, the data is assessed relative to the management plan on the farm. The maturity indexing information is stored in a file and presented as a graph to develop a picture of how the fruit is maturing. If orchard practices need to be changed to manipulate fruit development, maturity indexing is a key factor in guiding this.

Finally once the maturity status of a given horticultural crop is determined depending on different crop maturity parameters, it should be analyzed and reported to the supervisor according to enterprise work procedures.





Self-Check- 2	Written Test
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Name: _____

Date: _____

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

1. What is Brix? (4 pt)
2. Unusually large or small fruit would not be included in the sample? (3 pt)
 - a. True b. False
3. What is the first principle of sampling? (5 pt)

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

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

Answer

Score =

Rating:

Name: _____

Date: _____

Short Answer Questions





Information Sheet-3	Crop Selection for harvesting
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3.1. Crop Selection for harvesting

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. In this case some of the crops to be selected for harvest may include Fruit, vegetable, flower, foliage and bulb crops.

When selecting crops for harvest depending on their maturity status, careful attention has to be given for:

- Types of crops to be harvested
- Nature of crop to be harvested
- 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
- way of harvesting





Self-Check- 3	Written Test
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Name: _____

Date: _____

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

1. What is the advantage of crop selection for harvesting? (10 pt)
2. List market requirements criteria? (10pt)

Note: Satisfactory rating - 20 points

Unsatisfactory - below 20points

Answer

Score =

Rating:

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

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 equipments or observation
5. Interpret and analyze the results by comparison with specification charts.
6. Finally, report to your supervisor.





LAP Test	Practical demonstration
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Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions:

Task 1. Determining crop maturity





Reference

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->





Horticultural Crops Production

Level II

Learning Guide-73

Unit of Competence:-Harvest Horticultural crops

Module Title:- Harvesting Horticultural crops

LG Code: AGR HCP2 M18 LO2-LG-73

TTLM Code: AGR HCP2 TTLM 0120v1

**LO2:-Prepare equipment for
harvesting**





Instruction Sheet	Learning Guide-73
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This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Selecting Tools, equipment and machinery
- Carrying out pre-operational and safety checks on tools, equipment and machinery
- Identifying OHS hazards ,assessing and reporting risks
- Selecting and maintaining suitable personal protective equipment (PP)

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 –

- Select tools, equipment and machinery .
- Carry out pre-operational and safety checks on tools, equipment and machinery.
- Identify risks, assess and report OHS hazards to the supervisor.
- Select suitable personal protective equipment (PPE).

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1 to Sheet 4”.
4. Accomplish the “Self-check 1, Self-check 2, Self-check 3 , and Self check 4” **in page 34, 37, 44 and 48** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1 in page 49.
6. Do the “LAP test” **in page – 50** (if you are ready).





Information Sheet-1	Selecting Tools, equipment and machinery
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1.1 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. 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 sanitising 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 for 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 1.1 Pruning shear

In some crops, specialised 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 1.2 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 1.3 harvesting by using ladder

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.

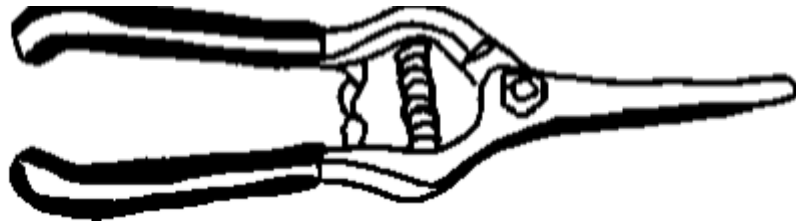


Fig 1.4 Thin curved blade for grapes and fruits:



Fig 1.5 Straight bladed hand shears for fruits and flowers

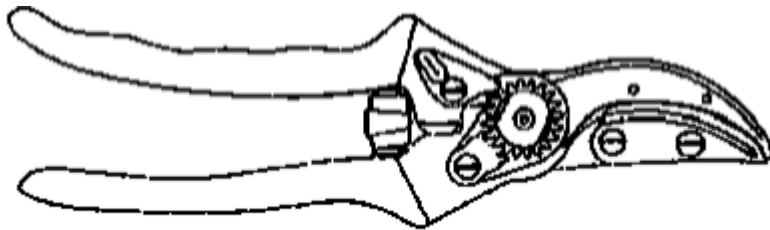


Fig 1.6 Cut and hold hand shears

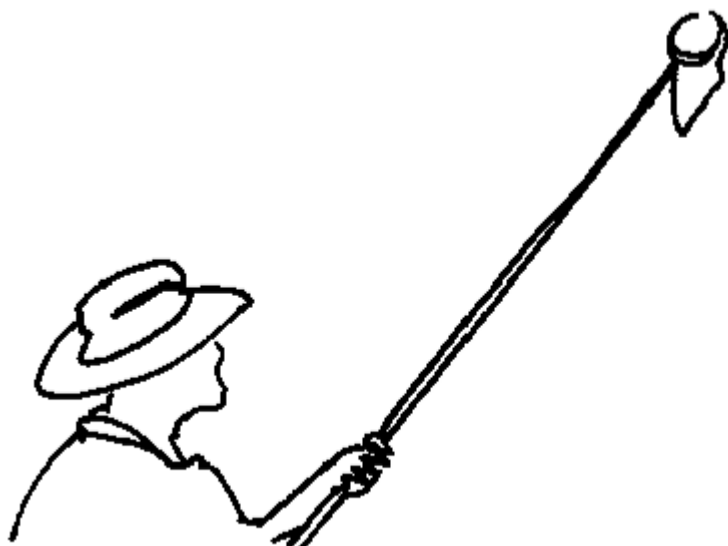


Fig 1.9 Using a picking pole

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 1.10 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 1.11 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 packhouses. 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 1.12 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 1	Written Test
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Name: _____

Date: _____

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

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 points

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

Answer

Score =

Rating:

Name: _____

Date: _____

Short Answer Questions



Information Sheet-2	Carrying out pre-operational and safety checks on tools, equipments and machinery
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2.1 pre-operational and safety checks on tools, equipments 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



Self -Check 2	Written Test
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Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. Write the preoperational check of tractors and forklifts (5 points)
2. Why needs preoperational checks? (5 points)

Note: Satisfactory rating - 10 points

Unsatisfactory - below 10 points

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

Answer

Score =

Rating:

Name: _____

Date: _____

Short Answer Questions

Information Sheet-3	Identifying OHS hazards, assessing and reporting risks
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3.1 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. Poor handling of different harvested products and equipments will leads to:

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

3.2 Safety wear appropriate to harvest the crops and/or handling the harvested crops

❖ Working with machinery

Operators should not touch any machine unless he/she is trained to conduct maintenance on the machinery. When machinery is involved, it is best to wear overalls, protective gloves and closed end shoes (not barefoot or sandals). All parts of the body, except the face is covered, reducing the risk of injury due to stray rocks or even plant debris during the harvest process. Wear protective eyewear. Fine dust, soil and plant particles are always present during mechanical harvesting of dry products such as soybean, and can cause severe eye damage. Due to the dust and fine particles surrounding the harvester at work, dust masks should be used to prevent these from being inhaled. Do not wear loose clothes that may be caught in moving parts of machinery.

❖ Safety during hand harvesting

Wear overalls and closed shoes. Although no machinery is involved, grass leaf blades can cut exposed skin. Some crops such as tomato contain chemicals that may irritate the skin. Unprotected feet may be injured if harvesting bins are dropped on the foot. If pruning shears, knives or other tools with blades are used during the harvesting process, wear protective gloves.

3.3 Food Safety Practices

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

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

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

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

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

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

- soil associated pathogenic bacteria (Clostridium botulinum, Listeria monocytogenes)
- feces associated pathogenic bacteria (Salmonella spp)
- pathogenic parasites (Cryptosporidium, Cyclospora)
- pathogenic viruses (Hepatitis, Enterovirus).

Many of these pathogens are spread via a human (or domestic animal) to food to human transmission route.

- Handling of fruits and vegetables by infected fieldworkers or consumers, cross contamination,
- use of contaminated irrigation water,
- use of inadequately composted manure or contact with contaminated soil are just a few of the ways that transmission of human pathogens to food can occur.

While produce quality can be judged by outward appearance on such criteria as color, turgidity and aroma; food safety can not. Casual inspection of produce cannot determine if it is in fact safe and wholesome to consume. Management of growing and postharvest

handling conditions are paramount in preventing the contamination of fresh produce by physical hazards, harmful chemicals and human pathogens.

3.3.1 Food Safety on the Farm

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

Clean soil

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

Clean water

- Test surface water that is used for irrigation for fecal pathogens on a regular basis, especially if water passes close to a sewage treatment or livestock area.
- Keep livestock away from the active recharge area for well-water that will be used for irrigation.
- Keep chemicals away from the active recharge area for well-water that will be used for irrigation.
- Filter or use settling ponds to improve water quality.
- Where feasible, use drip irrigation to reduce crop wetting and minimize risk. □ Use potable water for making up chemical pest management sprays.

Clean surfaces

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

Clean hands

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

3.4 Minimizing pathogen contamination during harvest

During harvesting operations field personnel may contaminate fresh fruits and vegetables by simply touching them with an unclean hand or knife blade. Portable field latrines as well as hand wash stations must be available and used by all harvest crew members. Monitoring and enforcement of field worker personnel hygiene practices such as washing hands after using the latrine are a must, to reduce the risk of human pathogen contamination. Workers who are ill with hepatitis A or who have symptoms of nausea, vomiting or diarrhea should not be assigned to harvest fresh produce.

Produce once harvested should not be placed upon bare soils before being placed in clean and sanitary field containers. Field harvesting tools and gloves should be clean, sanitary and not be placed directly in contact with soil. Field containers should be cleaned and sanitized on a regular basis as well as being free of contaminants such as mud, industrial lubricants, metal fasteners or splinters. Do not allow workers to stand in field bins during harvest to reduce pathogen spread by shoes.

Plastic field bins and totes are preferred to wooden containers since plastic surfaces are easier to clean and sanitize, which should be done after every use. If containers are not cleaned and sanitized after every use, they may become contaminated and then contaminate the next products which are placed in the container. Wooden containers or field totes are almost impossible to sanitize since they have a porous surface and wooden or metals fasteners such as nails from wooden containers may accidentally be introduced into produce. Cardboard field bins if reused should be visually inspected for cleanliness and lined with a polymeric plastic bag before reuse to prevent the risk of cross contamination.

Depending upon the commodity, produce may be field packaged in containers that will go all the way to the destination market or be temporarily placed in bulk bins, baskets or bags which will be transported to a packing shed. Employees, equipment, cold storage facilities, packaging materials and any water which will be contacting the harvested produce must be kept clean and sanitary to prevent contamination.

3.4.1 Personal hygiene and health

To prevent contamination of produce with human related diseases, all labourers should practice strict personal hygiene and should know that their health may affect the safety of the end user. Important rules to adhere to are listed below: •

- Wash hands under running water and with soap after each visit to the bathroom.
- Wear a hair net if you are involved in packing and further processing of the produce.
- Wear a mask over the mouth and nose if you have to handle fruits and vegetables.
- In the case of a severe cold or other disease, inform your employer or group leader so that the correct health procedures can be followed. •
- If you have or if you suspect you have some other contagious disease, inform your employer or group leader so that the appropriate measures can be followed. This may involve you being used in aspects of the harvest process which will not place you in direct contact of the produce etc. Remember your problem might be curable, but if you do not inform or trust your employer or group leader with this information, you could suffer unnecessarily. •
- When you have open wounds on your body, cover it with clothes or bandages. Replace bandages at least once a day and make sure you are treating the condition correctly. If the wound is on the hands, use gloves when the produce has to be handled. Also inform your employer or group leader of this situation, to ensure the right health procedures are followed. •
- In case of an accident during the harvesting or post harvesting of the crop, call the person(s) responsible for first aid to the scene of the accident, and then inform the group leader and employer immediately. •
- If a fellow worker is not adhering to the rules set out by the employer, report it to the group leader or employer promptly. Rules are usually set to protect all role players in the harvesting process, this includes you, and a person not following these rules are not only endangering him/herself, but you also. Therefore, love yourself and report any potential problems promptly.

Use of identify and assess hazards, employers and workers:

- Collect and review information about the hazards present or likely to be present in the workplace.
- Conduct initial and periodic workplace inspections of the workplace to identify new or recurring hazards.
- Investigate injuries, illnesses, incidents, and close calls/near misses to determine the underlying hazards, their causes, and safety and health program shortcomings.
- Group similar incidents and identify trends in injuries, illnesses, and hazards reported.



- Consider hazards associated with emergency or non-routine situations.
- Determine the severity and likelihood of incidents that could result for each hazard identified, and use this information to prioritize corrective action

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.
- Noise, dust.
- Pollen.
- Pests.
- Sharp hand tools and equipment.
- Manual handling.
- Ladders.
- Slippery or uneven surfaces.
- Holes and moving machinery and vehicles.





Self- Check -3	Written Test
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Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. What type of hazard that happens in harvesting? (5 points)
2. What is the role of hazard identification? (7 points)

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

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

Answer

Score = _____ Rating:

Name: _____

Date: _____

Short Answer Questions



Information Sheet-4	Selecting and maintaining suitable personal protective equipment (PPE)
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4.1 Selecting and maintaining suitable personal protective equipment (PPE)

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.

4.2 Types of PPE

Personal protective clothing and equipment may include:

- Boots
- Hat/hard hat
- Overalls
- Gloves
- Protective eyewear
- Hearing protection]
- Respirator or face mask
- Sun protection, e.g., sun hat, sunscreen



fig4.1 Respiratory

Different types of PPE are described below

Foot protection

Workers must wear closed-toe shoes at all times to protect feet from chemical spills and sharp objects.



Fig4.2 boot

Eye protection: Use safety glasses for minor splash hazards, goggles for moderate hazards, and **goggles** combined with a **face shield** for severe hazards.



Fig 4.3 Eye glasses



Fig.4.4 Goggle

Hand protection: Hand protection is indicated for the possibility of severe cuts, lacerations, or abrasions, punctures, temperature extremes, and chemical hazards.



Fig.4.5 Glove

Body protection: Protective clothing includes lab coats, smocks, scrub suits, gowns, rubber or coated aprons, coveralls, uniforms, and pierce-resistant jackets and vests.



Fig.4.6 overall

Head protection: Hard hats must be worn by electricians, construction workers, and any other workers when there is a danger of objects falling from above.



Fig.4.7 Helmet

Hear Protectors

Hearing protectors come in two forms: plugs and muffs. Hearing protectors should always be considered “personal” equipment and should not be used by other individuals, except for



muffs that are adequately cleaned and sanitize

Fig .4.8 Ear protections

Protective clothing is close fitting, with low resistance to tearing, with narrow sleeves and without protruding parts. It mainly provides protection against being entangled by moving machine parts.

Do not wear any rings and other jewelers.

Safety boots to protect against heavy parts falling down or slipping on slippery ground.

Personal protective equipment for special tasks

When performing special tasks it is necessary to wear personal protective equipment. This special protective equipment is explained below. Ear defenders to protect against hearing damage Hard hat to protect against parts and materials falling down and flying around Protective gloves to protect the hand against friction scratch punctures or deep cuts as well as contact with hot surfaces. Safety goggles to protect the eyes against parts flying around or squirts of fluids.



Self-Check 4	Written Test
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Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. Mention types of PPE using for harvesting. (5 points)
2. Why needs PPE? (5 points)

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

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

Answer Sheet

Score = _____ Rating: _____

Name: _____

Date: _____

Short Answer Questions





Operation sheet -1	Selecting Tools, equipment and machinery for horticultural crop harvesting
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Selecting Tools, equipment and machinery for horticultural crop harvesting

Procedure

Step1-select the horticultural crop

Step2-prepare the materials tools and equipment

Step3-Asses the hazard relates to tools

Step4-prepare PPE

Step5- use PPE





LAP Test 1	Practical Demonstration
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Name: _____

Date: _____

Time started: _____

Time finished: _____

Instruction:

Task. 1. Selecting Tools, equipment and machinery for horticultural crop harvesting





Reference

1. Source: Gorny, J.R. 1999. Chapter 10: Food Safety for fresh horticultural produce. In : Kitinoja, L. and Gorny, J.R. Small-Scale Postharvest Technology: Economic Opportunities, Quality and Food Safety. Postharvest Horticulture Series No.21, Department of Pomology, University of California, Davis.
2. For information on obtaining portable toilet facilities, contact the Portable Sanitation Association International at (800) 822-3020.)





Horticultural Crops Production

Level I

Learning Guide-74

Unit of Competence:-Harvest Horticultural crops

Module Title: - Harvesting Horticultural crops

LG Code: AGR HCP2 M18 LO3-LG-74

TTLM Code: AGR HCP2 TTLM 0120v1





5.If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1,2,and 3 in page 84, 84 and 85 respectively.

6. Do the “LAP test” in page – 86 (if you are ready).

Information Sheet-1	Working Harvesting practices
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1.1 Factors to be considered in harvesting

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.

The method of harvesting is determined by:

- Nature of the crop, delicacy of crop.
- The importance of speed during and directly after the harvesting.
- The cost of labour/machinery.
- The quality requirements of the market.
- If it is for fresh consume or for processing.

In general there are two types Harvesting methods:

- a. Manual Harvesting
 - b. Mechanical harvesting
- a. 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 farmers 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

Manual harvesting is done by the the help of tools and equipments:



Fig.1.2 Pole fruit piker

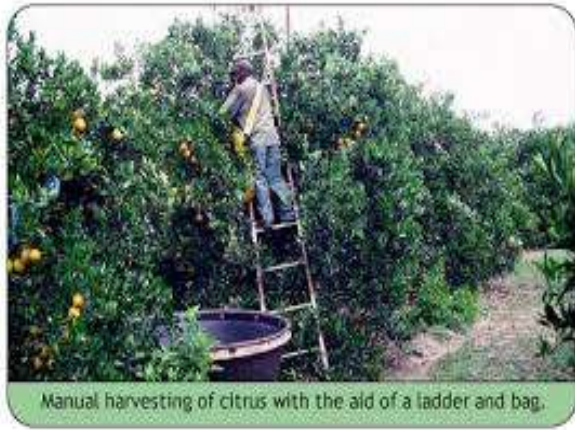


Fig 1.3 Ladder / bag picking method



Fig1.4 Fig potato harvesting



Fig 1.5 berry piker

a. Mechanical Harvesting

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

Primary 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.



Fig 1.6 Mechanical Harvesting

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

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

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

1. Write the methods of harvesting? (5pts)
2. List the effects of early and late harvesting? (5pts)
3. Write the care during harvesting? (5 points)

Note: Satisfactory rating - 15points

Unsatisfactory - below 15 points

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

Answer Sheet

Score =

Rating:

Name: _____

Date: _____





Short Answer Questions

Information Sheet-2	Undertaking Harvesting the crop
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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, egg plant 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

2.2 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 flavour 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. •
- **Lettuce** - 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 see below fig 2.5 .
- Use ladders where possible see below fig 2.6

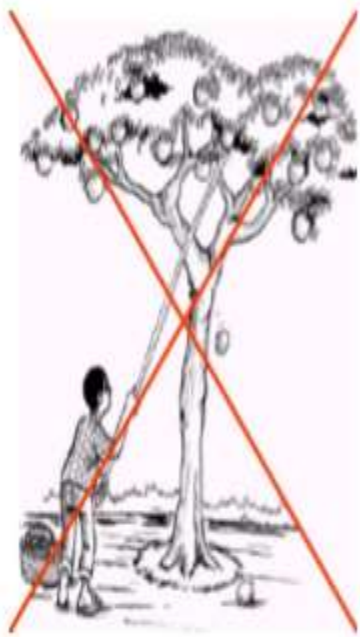


Fig 2.5 Shake the branches



Fig 2.6 Ladder / bag picking method

- When harvesting for processing, a harvesting stick can be used where fruit are too high to reach but allow the fruits to drop onto a soft surface, such as a net see below the fig.2.7

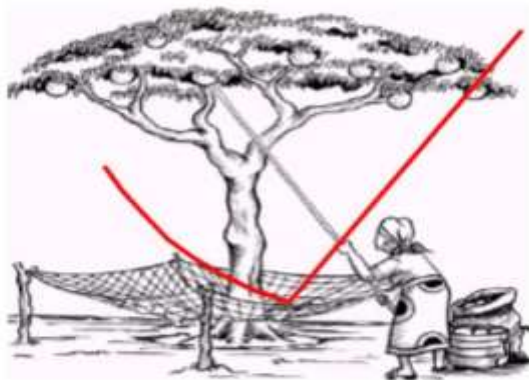


Fig 2.7 harvesting by using stick and net

- 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 harvest

- 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 principals 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 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 sweetpotatoes, potatoes, cassava and yams 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
Sweetpotato	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.

2.3.1 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.

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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.

A small cart can help reduce the amount of bending and lifting the picker has to do during harvest. The carts shown below have a single wheel in front, and can be pushed along the row ahead of the picker.

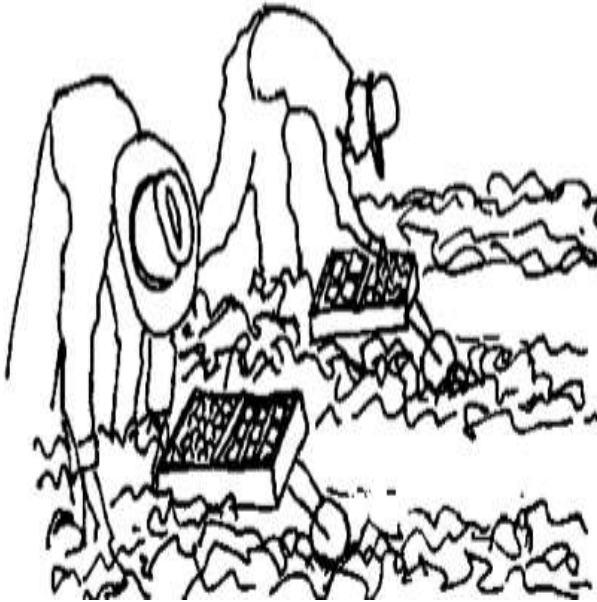


Fig 2.8 Field packing strawberries



Fig 2.9 Field packing lettuce:

2.5 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.

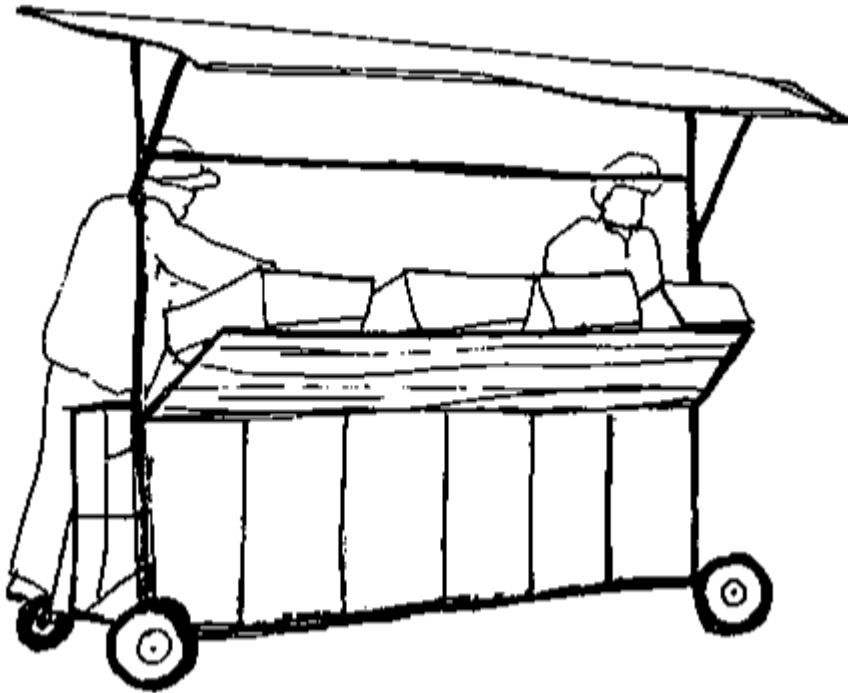


Fig. 2.10. movable cart

This larger cart for field packing is designed to be pulled by a small tractor into the field when the crop is harvested. This type of cart can be used for field packing many types of crops. The roof folds down for easy transport, and opens up to provide a wide area of shade for the packers and the commodity. The cart design can be modified as needed to suit various products and different operations.

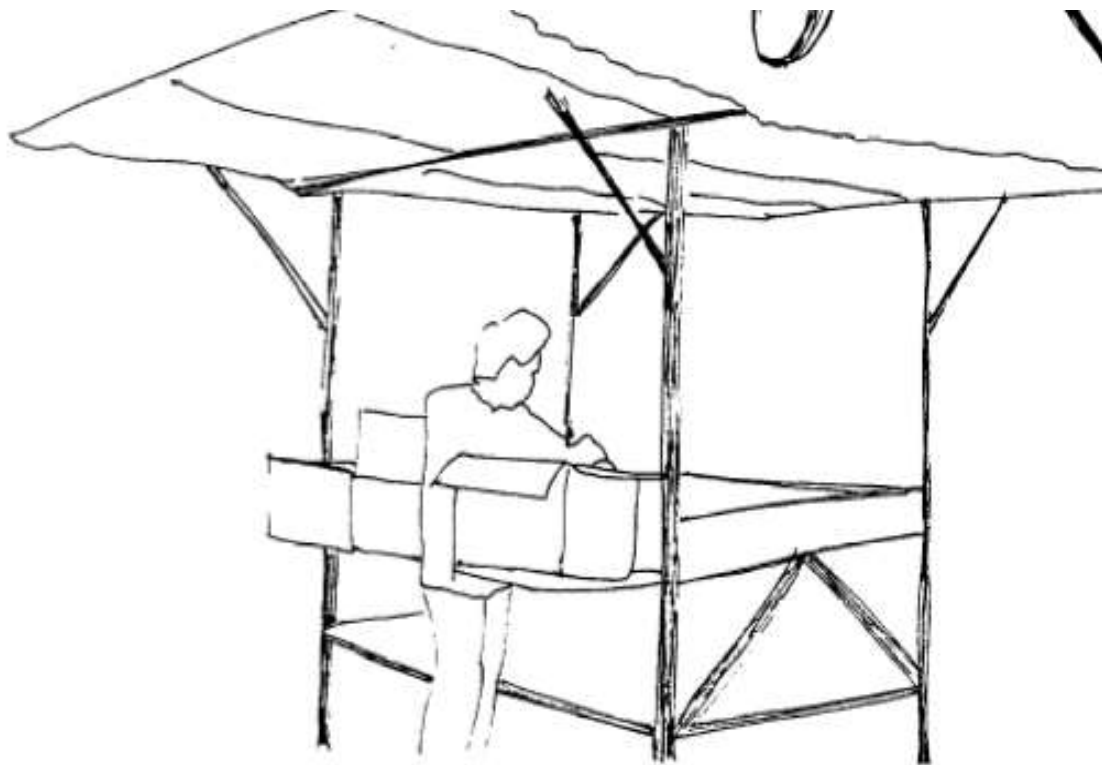


Fig. 2.11. Larger cart

❖ **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

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

1. How to minimize plant and crop damage? (5pts)
2. Write the basic principals or orchard hygiene? (5pts)
3. List the advantafges of plant residue left on the field? (5 points)

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

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

Answer Sheet

Score = _____ Rating:

Name: _____

Date: _____

Short Answer Questions



Information Sheet-3 Carrying out basic sorting and grading of the crop

3.1 Sorting

The removal of diseased, insect infested and mechanically damaged commodities and other unmarketable produce.



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.

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.

3.2 Grading

Grading and packing 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.

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.

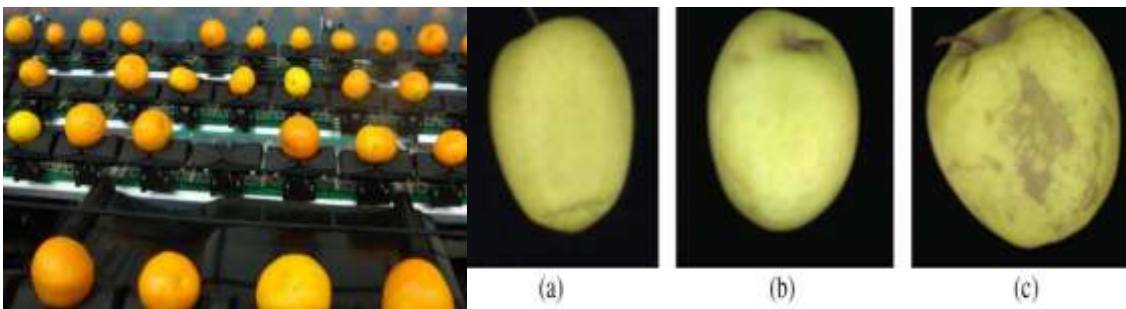


Fig 5.1 grading

Grading 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.

❖ The following are the advantages of grading fruit:



- The buyer can purchase based on grade
- The buyer is assured of consistency in quality at every purchase
- The seller is able to meet consumer requirements
- Price differentials can be established between grades.

Quality criteria used for the grading of fruits

- Varietals characteristics
- Level of maturity
- Cleanliness of fruit – i.e. freedom from adhering soil, chemical residues and other foreign matter
- Freedom from mechanical injury – bruises and cuts
- Freedom from disease
- Shape/form
- Uniformity in size





Self-Check 3	Written Test
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Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. What is sorting and grading? 5pts
2. Explain importance of sorting and grading? 5pts
3. List down quality criteria used to grade horticultural crops? 5pts

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

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

Answer Sheet

Score = _____
Rating:

Name: _____

Date: _____

Short Answer Questions



Information Sheet-4	Cleaning and maintaining Harvesting tools, equipment and machinery
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4.1 Cleaning, sterilizing and maintaining harvest tools, equipment and machinery

Cleaning of harvesting tools refers to both removal of dirt and plant material becomes adhered as well as to the removal of microscopic particles including disease organisms. The harvested produce must not come into contact with post-harvest decaying organisms, as it will reduce the shelf life and quality of produce

Removal of dirt, plant material etc. from tools and equipment prolongs the lifespan of the tools. High pressure wash, rinse, and sanitize all crop containers and bins, equipment, storage facilities, and food contact surfaces prior to harvest.

- Use approved sanitizer at proper concentration
- Cover clean bins when not in use.
- Avoid standing in bins, or putting personal items, such as coats or gloves, in bins during harvest.
- Clean produce with potable water and acceptable sanitizer.
- Use and maintain proper sanitizer concentrations to wash produce.



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

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

1. What is cleaning mean? 5pts
2. Write the advantages of removal of dirt, plant material etc. from tools and equipments? (5points)

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

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

Answer Sheet

Score =

Rating:

Name: _____

Date: _____

Short Answer Questions



Information Sheet-5**Reporting problems to the supervisor.**

There may be different problems while conducting harvesting activities. Identifying and reporting problems to supervisor is important to solve the problems on time as much as possible.

Problems when harvesting a crop may include:

- Hazards.
- Pests.
- Tools, equipment and machinery
- Crop quality.
- Other team members.
- Climate or plant health.



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

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

1. Write the problems occurred during harvesting? 5pts
2. What is the function reporting problems? 4pts

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

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

Answer Sheet

Score = _____ Rating:

Name: _____

Date: _____

Short Answer Questions



Operation sheet -1	Undertaking Harvesting the crop
---------------------------	---------------------------------

1.1 Harvesting vegetables

Procedures

- Step.1 Identify vegetable crops to be harvested.
- Step.2 Determine maturity based on maturity indexes.
- Step.3 Prepare containers and labor used for harvesting
- Step.4 Prepare transportation and storage facilities
- Step.5 Prepare harvesting schedule which is used as guideline for harvesting activities
- Step.6 Undertake harvesting activities
- Step.7 Maintain the temperature of the product immediately after harvesting
- Step.8 Sort the harvested fruits
- Step.9 Transport the product in a safe way to processing or storage area
- Step.10 Storage properly if stored and deliver as quickly as possible for processing industry if processed

Operation sheet -2	Undertaking Harvesting the crop
---------------------------	---------------------------------

2.1 Harvesting fruits

Procedures

- Step1. Identify fruit 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.



Operation sheet -3	Carrying out basic sorting and grading of the crop
---------------------------	--

3.1 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 1	Practical Demonstration
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Name: _____

Date: _____

Time started: _____

Time finished: _____

Instruction:

Task1. Harvesting vegetables

Task2. Harvesting fruits

Task3. Grading fruits





Horticultural Crops Production

Level II

Learning Guide-75

Unit of Competence:-Harvest Horticultural crops

Module Title: - Harvesting Horticultural crops

LG Code: AGR HCP2M18 LO4-LG-75

TTLM Code: AGR HCP2 TTLM 0120v1

LO4: Transport the crop





Instruction Sheet	Learning Guide -75
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This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Working Safe manual handling techniques
- . Moving and stacking containers
- . Maintaining temperature of the crop
- . Transporting the crop
- Maintaining 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 –

- work safe manual handling techniques.
- Move and stack containers .
- Maintain temperature of the crop.
- Transport the crop.
- Maintain containers in good working order

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1 to Sheet 5”.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 ,Self-check 4 and Self check 5” in **page -93, 96, 103, 106 and 108** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1 in page 109.
6. Do the “LAP test” in **page – 110** (if you are ready).



Information sheet-1

Working Safe manual handling techniques

1.1 Proper handling

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. They should be designed for opening at the base to allow produce to be emptied through the bottom into a field container without tipping the bag



Fig 1.1 harvesting bag

Picking baskets, bags and buckets come in many sizes and shapes. Buckets are better at baskets in protecting produce, since they do not collapse and squeeze produce.

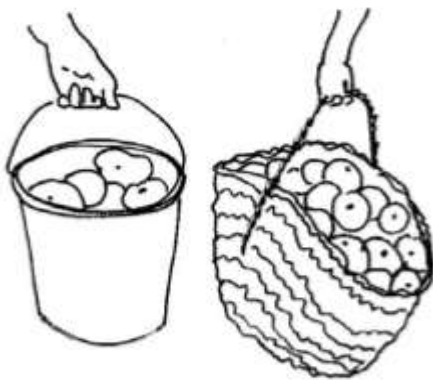


Fig 1.2 Harvesting containers

Bulk bins, usually of 250 to 500 kg capacity and mostly used by large growers, where crops such as apples or cabbages are sent to houses for selection, grading and packing or for canning/freezing or processing. Bins can be carried by a forklift attachment on a tractor that moves produce from harvesting points to assembly areas.

When unventilated bulk bins are used in the field, produce should only be left in them briefly and protected from sun or rain. Produce held in bulk for long will overheat and be more subject to decay. Bulk bins transported over long distances must be perforated to minimize heat build-up in the contents.



Figure1.4 bulk bins

Picking baskets, bags and buckets come in many shapes and sizes. Harvesting containers can be made by sewing bags with openings on both ends, fitting fabric over the open bottom of ready-made baskets, fitting bags with adjustable harnesses or by simply adding some carrying straps to a small basket.



Figure1.5 picking basket

Plastic crates are relatively expensive but are durable, reusable and easy to clean. When empty, they can be nested to save space in storage or transport. When filled they can be stacked if every other crate is turned in the direction opposite to the one below.



Figure 1.6 Plastic create

Handling the crop carefully to prevent damage

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.

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





Self-Check -1	Written Test
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Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. Write the factors affecting harvesting of horticultural crops? (5pts)
2. List the importance of safe handling? (10pts)

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

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

Answer Sheet

Score =

Rating: _____

Name: _____

Date: _____

Short Answer Questions



Information sheet-2	Moving and stacking containers
----------------------------	---------------------------------------

2.1 Removing or loading full containers after harvesting to minimize deterioration of the crop

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.

2.1.1 Stacking patterns/hand-stacked

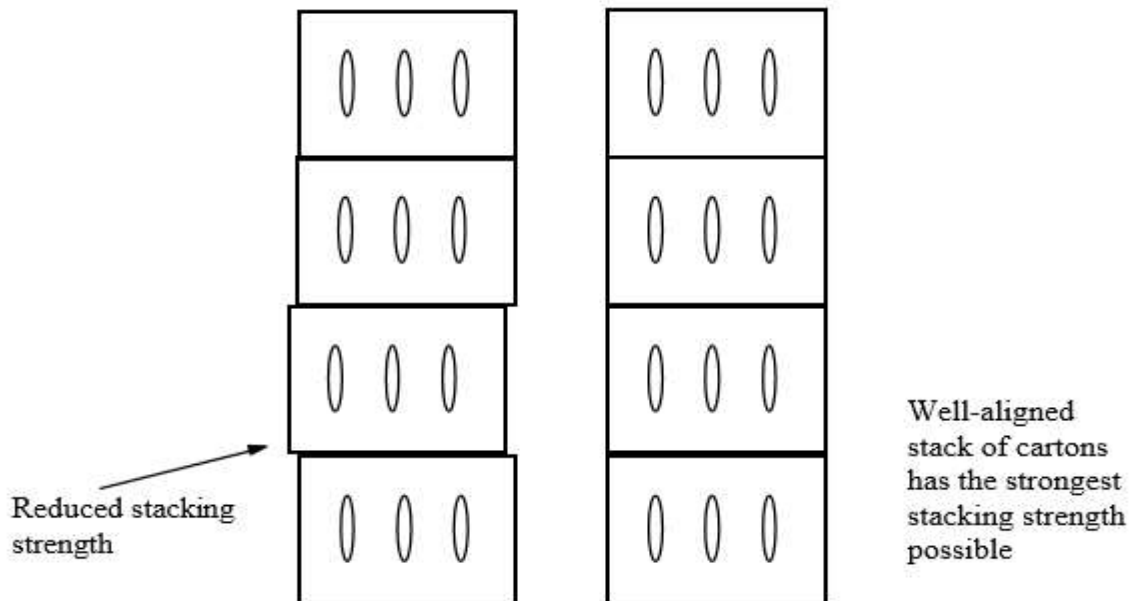
Produce transported in cartons should also be stacked so as to allow adequate air circulation throughout the load. On the floor of the truck, pallets or other supports should be used to keep the cartons out of direct contact with the floor. When cartons of various sizes must be loaded together, the larger, heavier containers should be placed on the bottom of the load. Parallel channels should be left for air to move through the length of the load.

2.1.2 Stacking patterns/pallet and slip sheet loads

Containers should be loaded so that they are away from the side walls and the floor of the transport vehicle in order to minimize the conduction of heat from the outside environment. The use of pallets keeps the cartons off the floor, while center-loading leaves an insulating air space between the pallet loads and the outside walls.

2.1.3 Stacking strength

When stacking containers, be sure to align them properly. Whenever possible, stack them so that corner matches corner on both the cartons and the pallet. Most of the strength of corrugated fiberboard containers is in their corners, so an over-hang of only 1 inch will decrease stacking strength by 15 to 34%.



2.1.4 Bracing the load

There should always be a void between the last stack of produce and the back of the transport vehicle. The load should be braced to prevent shifting against the rear door during transit. If the load shifts, it can block air circulation, and fallen cartons can present great danger to workers who open the door at a destination market. A simple wooden brace can be constructed and installed to prevent damage during transport.

Bracing the load can be accomplished using wooden braces, load rails, air pillows or Styrofoam blocks. The key is to immobilize stacked produce to reduce damage during transport.



Self-Check -2	Written Test
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Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. When cartons of various sizes must be loaded together, the larger, heavier containers should be placed on the bottom of the load? (5pts)

a/ True b/ false

2. Containers should be loaded so that they are on the side walls and the floor of the transport vehicle? (4pts)

a/True b/ false

3. Write the cause of poor handling of horticultural crops? (5pts)

Note: Satisfactory rating - 14 points

Unsatisfactory - below 14 points

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

Answer Sheet

Score =

Rating:

Name: _____

Date: _____

Short Answer Questions



Information sheet-3	Maintaining temperature of the crop
----------------------------	-------------------------------------

3.1 Temperature and relative humidity control

Throughout the period between harvest and consumption, temperature control has been found to be the most important factor in maintaining product quality. Fruits, vegetables and cut flowers are living, respiring tissues separated from their parent plant. Reducing the rate of water loss slows the rate of shriveling and wilting, causes of serious postharvest losses.

Keeping products too cool can also be a serious problem. It is important to avoid chilling injury, since symptoms include failure to ripen (bananas and tomatoes), development of pits or sunken areas (oranges, melons and cucumbers), brown discoloration (avocado and eggplant), increased susceptibility to decay (cucumbers and beans), and development of off-flavors (tomatoes).

Cooling involves heat transfer from produce to a cooling medium such as a source of refrigeration. Heat transfer processes include conduction, convection, radiation and evaporation.

If a ready supply of electricity is available, mechanical refrigeration systems provide the most reliable source of cold.

2.2 Temperature of a crop at the processing or storage area

A) Packing operations: The packing operations include the following steps:-

- Dumping / collection
- Pre-sorting
- Washing / Cleaning
- Sizing / Grading
- Bunching / Wrapping
- Postharvest Treatments
- Packing
- Cooling

It is important to minimize mechanical damage by avoiding drops, rough handling and bruising during the different steps of packing operations. Secondly the pack operations should be carried out in shaded area. Shade can be created using locally available materials like, shade cloth, woven mats, plastic tarps or a canvas sheet hung from temporary poles. Shade alone can reduce air temperatures surrounding the produce by 8-17°C.

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

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

iii) Washing and Cleaning: Washing with clean water.

- Mangoes, bananas should be washed to remove latex. - Kiwifruit should be dry cleaned or brushed after curing or storage

iv) Sizing / Grading: Grading can be done manually or by automatic grading lines. Size grading can be done subjectively (visually) with the use of standard size gauges. Round produce units can be easily graded by using sizing rings.

long slanted tray with a series of opening which coverage (largest at the top, smallest at the bottom). This type of sizes works best with round commodities.

The grading of fruits plays an important role in domestic and export marketing of fruits. Different fruits have different grades on the basis of their size and weight.

Grade designation and quality of fruits: Fruits should be

- clean, round, free from any visible foreign matter
- fresh in appearance, free of pests
- free from damage caused by pests or diseases
- free of any foreign smell and/or taste

B) Precooling of Horticulture Produce

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

The shed storage may occur in a temperature-controlled environment such as a cool room. These may include forced air cool rooms, hydro cool rooms and vacuum cool rooms.

Method of pre-cooling :

- Room cooling
- Forced air cooling
- Hydrocooling
- Vacuum cooling
- Package icing

i) Room cooling : It is low cost and slow method of cooling. In this method, produce is simply loaded into a cool room and cool air is allowed to circulate among the cartons, sacks, bins or bulk load.

Advantages: - Produce can be cooled and stored at the same room thus saves on handling costs. - No extra cost for pre-cooling equipment. - Suits for crops, which are marketed soon after harvest.

Disadvantages:

It is too slow method of cooling - Space requirements for room cooling are more as compared to storage, thus loss of storage capacity. - Unsuitable for packed produce. - Excessive water is lost from the produce due to slow cooling. Horticulture crops suitable for rooms cooling are: Potato, onion, apple and citrus

ii) Forced-air cooling: Forced air-cooling is mostly used for wide range of horticultural produce. This is the fastest method of pre-cooling. Forced air-cooling pulls or pushes air through the vents/holes in storage containers. In this method uniform cooling of the produce can be achieved if the stacks of pallet bins are properly aligned. Cooling time depends on (i) the airflow (ii) the temperature difference between the produce and the cold air (iii) produce diameter.

Advantages:

- Fast method of pre cooling
- Suitable for wide range of highly perishable commodities.
- Uniform cooling, if palletized containers or bins are properly aligned.

- Cooling times can be controlled for different types of produce by controlling the air flow rate.

Horticultural produce suitable for forced air cooling are: Grapes, Berries, Pears, Peach, Oranges, Strawberries tomato, and other tropical and subtropical fruits.

iii) Hydrocooling : The use of cold water is an old and effective cooling method used for quickly cooling a wide range of fruits and vegetables before packaging. For the packed commodities it is less used because of difficulty in the movement of water through the containers and because of high cost involved in water tolerant containers. This method of cooling not only avoids water loss but may even add water to the commodity. The hydrocooler normally used are of two types :

a) Shower type : In this type of hydrocooler, cold water is pumped to an overhead perforated pan which produces a shower over the produce which may be in bins or boxes or loose on a conveyor belt passing beneath. The water leaving the produce may be filtered to remove debris, then passed over refrigeration coil where it is recooled.

b) Immersion type: In this type of hydrocooler, the produce is brought in contact with cold water by using a conveyor (flume type) or by lowering bins / boxes in tank of water which is continuously cooled by mechanical refrigeration system. Poor cooling would result if the product simply moved with the water. Flume hydrocoolers convey the product either against (counter flow) or across (cross flow) the flow.

Efficient cooling depends upon adequate water flow over the product surface. Immersion type hydrocoolers usually take longer time to cool produce than shower type cooler. Generally the small quantity chlorine or other chemicals are added in the water to sanitize it.

Advantages :

- Less energy is used as compared to forced air cooling.
- Hydrocooler can be easily integrated into a packing operation and become a step within a simple packing line.
- Moisture loss does not take place. Disadvantages :
- Most of the packages don't tolerate wetting.
- Wax layer of some fruits like pear, plum, apple are removed by using spray type of hydrocooler :

Horticultural produce suitable for hydrocooling are: Mango, peach, cherry, spargus etc.

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

Advantages :

- Packed produce can be cooled if the pack allows moisture transfer.
- Fast and uniform cooling takes place.
- Most energy efficient method. Disadvantages :
- High capital cost
- Produce loses more moisture

Horticultural produce suitable for hydrocooling are: mushrooms

Table 3.1. recommended storage temperature of fruits and vegetables

Name of commodity	Temp(°C)	RH (%)	Approximate Shelf-Life
Apple	-1-4	90-95	1-12 months
Apricot	0-1	90-95	1-3 weeks
Banana	13-15	90-95	1-4 weeks
Grape	-0.5-0	90-95	2-8 weeks
Guava	6-8	90-95	2-3 weeks
Lemon	10-13	85-90	1-6 months
Mandarin	4-5	90-95	2 months
Mango	13	85-90	2-4 weeks
Mushrooms	0	90	7-14 days
Papaya	7-13	90-95	1-3 weeks
Peach	0-1	90-95	2-4 weeks
Pear	-1.5-0.5	90-95	2-7 months
Pineapple	7-13	85-90	2-4 weeks
Plum and prunes	0-1	90-95	2-5 weeks
Pomegranate	5	90-95	2-3 months

Strawberry	0	90-95	7-10 weeks
Sweet cherries	-1-0.5	90-95	2-3 weeks
Asparagus, green	1-2	95-100	2-3 weeks
Beans	4-7	90-95	7-10 days
Avocado	7	85-90	2 weeks
Broccoli	0	95-100	10-14 days
Cabbage	0	90-95	3-6 weeks
Carrots	0	90-95	6-8 months
Cauliflower	0	90-95	3-4 weeks
Eggplant	10-12	90-95	1-2 weeks
Garlic	0	65-70	6-7 months
Ginger	13	65-70	6 months
Lettuces	0	90-95	2-3 weeks
Okra	7-10	90-95	7-10 days
Onion	0	65-70	1-8 months
Peas	0	90-95	1-2 weeks
Bell Pepper	7-10	90-95	2-3 weeks
Radish	0	90-95	1-2 months
Tomato	10-13	90-95	1-3 weeks
Watermelon	10-15	90-95	2-3 weeks
Lettuce	0	98-100	2-3 weeks
Garlic	0	65-70	6-7 month
Orange	8-10	85-90	8-12 week



Self-Check -3	Written Test
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Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. Write the recommended storage temperature of mango, avocado and carrot? 5pts
2. Write the method of pre-cooling? 10pts

Note: Satisfactory rating - 15 points

Unsatisfactory - below 15 points

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

Answer Sheet

Score =

Rating:

Name: _____

Date: _____

Short Answer Questions



Information sheet-4	Transporting the crop
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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. 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.

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.





Self-Check -4	Written Test
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Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. Explain the Importance of safe handling and transporting of harvested products? 5pts
2. Write the basic requirements for conditions during transportation? 10pts

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

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

Answer Sheet

Score =

Rating:

Name: _____

Date: _____

Short Answer Questions





Information sheet-5	Maintaining Containers
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Maintaining containers in effective working order

All containers required for the different operations under taken under harvesting operation should be maintained and prepared in advance manner required by the enterprise work procedure. The container may includes: boxes, trays, crates, bulk bins or net bags

Some of the major importance's of maintaining containers in effective working order is to:-

- Minimize the buying cost of new containers
- 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 containers during harvesting.

Providing harvest workers with sufficient containers to match harvest output and to prevent unnecessary interruptions

Depending on the type of horticultural crop to be transporting and number of workers required for the work, it is the most important to provide harvest workers with sufficient containers to match harvest output and to prevent unnecessary interruptions.





Self-Check -5	Written Test
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Instructions: Perform the following tasks. Write your answers in the answer sheet provided:

1. Write the major importance of maintaining containers? (10pts)
2. List the container that required maintenance? (4pts)

Note: Satisfactory rating - 14 points

Unsatisfactory - below 14 points

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

Answer Sheet

Score =

Rating:

Name: _____

Date: _____

Short Answer Questions





Operation sheet-1	Working Safe manual handling techniques
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Working Safe manual handling techniques

Procedure

Step1-keep products in shade after harvest.

Step2-Protect from high temp. And sunlight throughout the post-harvest chain.

Step3-Handle products with care to avoid mechanical injuries.

Step4-Keep good sanitation procedures.

Step5-Clean harvest containers, display and storage facilities.





LAP Test 1	Practical Demonstration
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Name: _____

Date: _____

Time started: _____

Time finished: _____

Instruction:

Task1. Working Safe manual handling techniques



List of Reference Materials

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2. **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
3. HANDLING OF FRESH FRUITS, VEGETABLES AND ROOT CROPS TRAINING
MANUAL-



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Profile of trainers participate on special Horticultural Crop Production TTLM development for level I at Adama 2019

