

UNIT  
**10**



# Pack House Management



LEARNING / FACILITATING MATERIALS

CITRUS PRODUCTION  
NATIONAL CERTIFICATE I



implemented by  
**giz** Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH





## Introduction

Citrus fruits after harvest are conveyed from the farm site to either the pack house or processing unit. The pack house is a building with other facilities where fruits are packed prior to transportation or distribution to shops. This unit will help the learner to understand the entire activities that are carried out in the pack house in preparing citrus fruits for storage, transportation and distribution while maintaining the quality and value.

This learning material covers all the Learning Outcomes for pack house management in citrus for the Certificate I programme.



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## Demonstrate knowledge of a pack house

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In this LO, you will learn about the importance of pack house in citrus production, explain the importance of pack house layout, identify tools and equipment used in a pack house, apply pack house hygiene and apply safety measures in pack house.

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### PC (a) Explain the importance of pack house in citrus production

The citrus packing house is a combination of building and other facilities such as machinery, equipment, personnel and procedures which assist converting harvested fruits into acceptable market-ready packages. This process involves cleaning, waxing, grading, sizing, fungicidal treatment and final packing and also may include de-greening or colouring.

De-greening is the process of exposing citrus fruit to ethylene gas to accelerate peel colour.

Pack house can also be defined as a building or place where citrus fruits are packed and stored prior to transportation or distribution to shops. Citrus fruits after harvest need to be prepared for storage, sale or distribution. This can be undertaken on the farm. Activities in the pack house comprise the following basic operations:

- Removal of damaged fruits
- Washing
- Grading and sorting by maturity or size
- Waxing
- Refrigeration/ storage
- Packaging

### Importance of Pack House in Citrus Production

**At this level we will take you through few importance of pack house. The following are some importance of pack house, It**

- allows special operations to be performed on citrus fruits continuously for 24 hours regardless of the weather.
- is a facility for providing post-harvest protection. Waxing is done to protect the fruit against moisture loss on its journey to the market.
- allows external and internal quality inspections to be carried out.
- helps control citrus fruits decay.
- allows de-greening to take place

## PC (b) Explain the importance of pack house layout

### Importance of Pack House Layout

The size and degree of complexity of a pack house depends on the following factors:

- Quantity or volume of citrus fruits to be processed
- Capital to be invested

Pack house layout varies from a straw shelter to highly automated facilities. In some cases, storage rooms as well as offices for commercial sales are annexed to the pack house.

Pack houses are usually built with cheap but durable materials. However, it is important to create a comfortable environment both for produce and workers. This is because product exposed to unfavourable conditions can lead to rapid deterioration in quality.

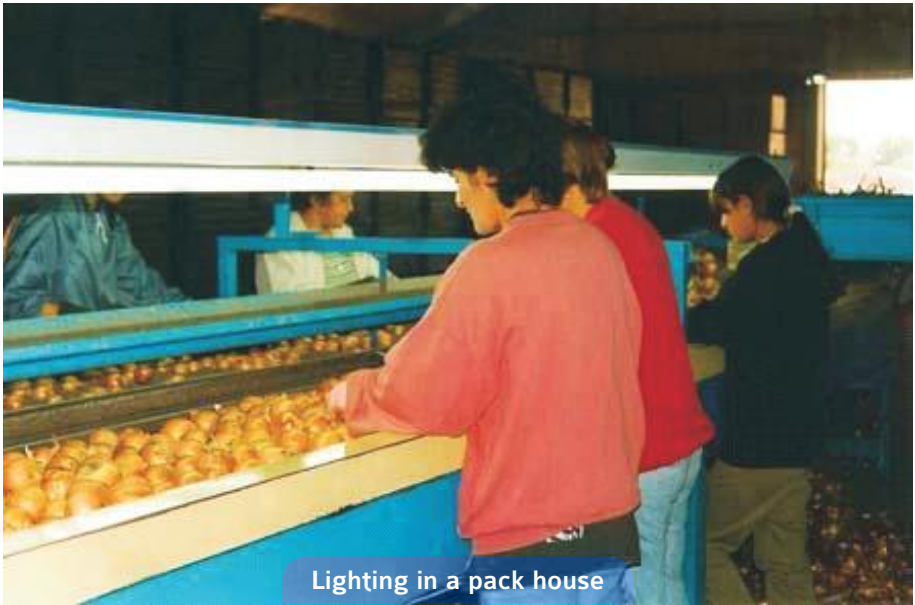
Also, uncomfortable working conditions for staff can lead to unnecessary rough handling. No two packinghouses are identical in size, layout or efficiency, but all are similar.

The working area of the packinghouse is divided into three basic sections: pre-packing line (unloading, de-greening, temporary storage), packing line and post-packing line (assembly and loading of packed fruit).

A pack house should have adequate room for easy circulation with ramps to facilitate loading and unloading. Doors and spaces should be sufficiently large to allow the use of forklifts. The reception area should be large enough in order to keep the pack house in operation in the event of an interruption in the flow of products from the field such as rain, machine breakdown, etc.

A pack house needs to be located close to the production area and within easy access to main roads or highways. It also needs to have one entrance to facilitate and control supply and delivery. Moreover, it needs to be large enough for future expansion or additional new facilities. Sufficient space outside is also required to avoid congestion of vehicles entering and leaving. Buildings should be designed to ensure sufficient shade during most of the day in the loading and unloading areas.

Electricity is critical for equipment, refrigeration and particularly lighting. Because pack house usually work extended hours or even continuously during harvest time, lighting (both, intensity and quality) is critical in identifying defects on inspection tables. Lights should be below eye level to prevent glare and eyestrain.



Administration offices should be located on clean and quiet areas and if possible elevated. This is so that the entire operation is visible. Pack houses should have facilities or laboratories for quality analysis.

## **PC (c) Identify tools and equipment used in a pack house**

### **TOOLS and EQUIPMENT used in a PACK HOUSE**

Generally, pack house must have either or the following tools and equipment:

- Forklift
- Conveyors
- Refrigerators (cold room)
- Boxes





TAKE-OUT ELEVATOR IN DUMP TANK.



TAKE-OUT ELEVATOR & 24 BRUSH WASH DRIER.



PRESORT ROLLER CONVEYOR



FUNGICIDE BATH & PIPEWORK



TAKE-OUT ELEVATOR IN FUNG BATH & 16 BRUSH DRIER



8 BRUSH WAXER



8m x 2m DRY TUNNEL



10m or 12m DROP-BELT GRADING CONVEYOR



DROP-BELT GRADING CONVEYOR & TRANSFER CONVEYOR



7 or 10 BIN SECOND GRADE SIZER



20 BIN FIRST GRADE SIZER

## PC (d) Apply pack house hygiene

### Pack House Hygiene

Hygiene in the pack house must be observed by workers and also applied to tools and equipment. Some hygienic conditions that must be observed in the pack house are as follows:

- Inputs should not contain microbial or chemical contaminants.
- Hygienic and sanitary facilities should be available and must be located close to fields, indoor premises and in sufficient number.
- Citrus fruits unfit for human consumption should be segregated before storage
- Transport vehicles should not be used for the transport of hazardous substances unless they are adequately cleaned and where necessary disinfected to avoid cross- contamination.
- Cleaning procedures should include the removal of debris from equipment surfaces, application of a detergent solution, rinsing with water and where appropriate disinfection.
- Waste must not be allowed to accumulate in citrus fruit handling and storage areas or the adjoining environment.
- Storage areas for waste should be kept clean.
- Workers must have access to clean toilets and hand washing facilities in the vicinity of their work
- Eating areas should be clean and separated from packing facilities.

## PC (e) Apply safety measures in a pack house

### Safety measures to be observed in the pack house.

Personal	Tools	Others
<ul style="list-style-type: none"><li>• Wear protective clothing such as gloves, goggles, strong boots, trousers, long sleeves, and cap.</li></ul>	<ul style="list-style-type: none"><li>• Wash, clean, disinfect and oil tools and equipment used in the pack house.</li><li>• Repair any tools or equipment malfunctioning</li><li>• Use the right tool for the right work</li></ul>	<ul style="list-style-type: none"><li>• Use indications to direct or inform others.</li><li>• Train workers or people how to safely use tools, equipment found in the pack house.</li></ul>



## Self-assessment

### PC (a)

- 1a. Briefly explain the term pack house

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- 1b. Describe the activities that take place in the pack house.

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### PC (b)

- 1a. Your school organized a trip to a pack house and had interactions with the attendant. State four (4) importance of a pack house as discussed.

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- 1b. Describe three (3) qualities of the pack house

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- 1c. Explain why lighting system at the sorting table was below eye level of workers in the pack house.

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- 1d. Explain the purpose of a laboratory attached to the pack house.

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**PC (c)**

1. Explain the uses of the following equipment in the pack house.

i. Forklift

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ii. Conveyors

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iii. Refrigerators (cold room)

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iv. Boxes

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**PC (d) (e)**

1. Complete the table below:

<b>Two hygienic methods in the pack house</b>	<b>Two safety measures in the pack house</b>
1.	1.
2.	2.

## Demonstrate knowledge of washing and disinfecting harvested fruits

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In this LO, the learner will learn about the importance of washing and disinfecting, describe methods of washing and disinfecting, identify types of chemical for washing and disinfecting and demonstrate the procedure for drying.

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### PC (a) Explain the importance of washing and disinfecting harvested fruits

Most citrus fruits receive various chemical treatments such as spraying of insecticides and pesticides in the field. Most of these chemicals are poisonous to humans, even in small concentrations; therefore all traces of chemicals must be removed from produce before packing.

After washing fruits, disinfectant agents are used to avoid propagation of diseases among consecutive batches of fruits. In a soaking tank, a typical solution for citrus fruit includes a mixture of various chemicals at specific concentration, pH, and temperature, as well as detergents and water softeners.

Sodium-ortho-phenyl-phenate (SOPP) is an effective citrus disinfectant but requires precise control of conditions in the tank. Concentrations must be kept between 0.05 and 0.15% with pH at 11.8 and temperature in the range of 43-48°C. Recommended soaking time is 3-5 minutes. Deviation from these recommendations may have disastrous effects on the fruit since the solution will be ineffective if the temperature or concentration is too low.

### PC (b) Methods of washing and disinfecting harvested citrus fruits.

Citrus fruit after harvesting must be treated before packing. There are several methods of treating harvested citrus fruits; an example is the hot water treatment.

Hot water treatment of fruits is carried out in hot water treatment tanks fitted with thermostatic controls to maintain a constant temperature of 52°C. The hot water is treated with fungicide such as sodium hypo chloride at 200 ppm concentration for 2-3 minutes.

There are two main methods of washing and disinfecting harvested fruits using the hot water treatment in the pack house. These are automated and un-automated (manual)

### **Automated method of washing and disinfecting harvested citrus fruits**

The cleaning and washing of fruits is done at the pack house facility through automated washing system fitted with overhead sprayers and smooth rotating brushes to clean and wash the fruits. Washing, brushing, disinfecting and straining can be done using specially made PVC brushes.

Note that machines can do a combination or/and a part of mentioned activities.

### **Un-automated (manual) method of washing and disinfecting harvested citrus fruits**

This method does not involve the use of machines rather manual way of cleaning and disinfecting. With this method citrus fruits are dipped into a tank containing water and disinfectant for a few minutes and then removed and cleaned by hand.



## PC (c) Demonstrate the procedure for drying

### Procedure for Drying

After treatment, the fruits are passed through drying process till the moisture on the surface of fruits gets evaporated and thereafter wiped with a soft muslin cloth. Drying of fruit is done by removing excess water in preparation for the wax application.

Wax adheres best to fruits that pass through a drying system after cooling in either the washing or chemical applications units. During drying, warm air circulates and dries the fruit thereby increasing the skin temperature of the fruits.



## Self-assessment

### PC (a)

1. Explain three (3) reasons for washing and disinfecting citrus fruits

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### PC (b)

2. State the main differences between the automated and manual method of washing and disinfecting citrus fruits.

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### PC (c)

3. Visit a recognized pack house and demonstrate the procedure for drying citrus fruits.

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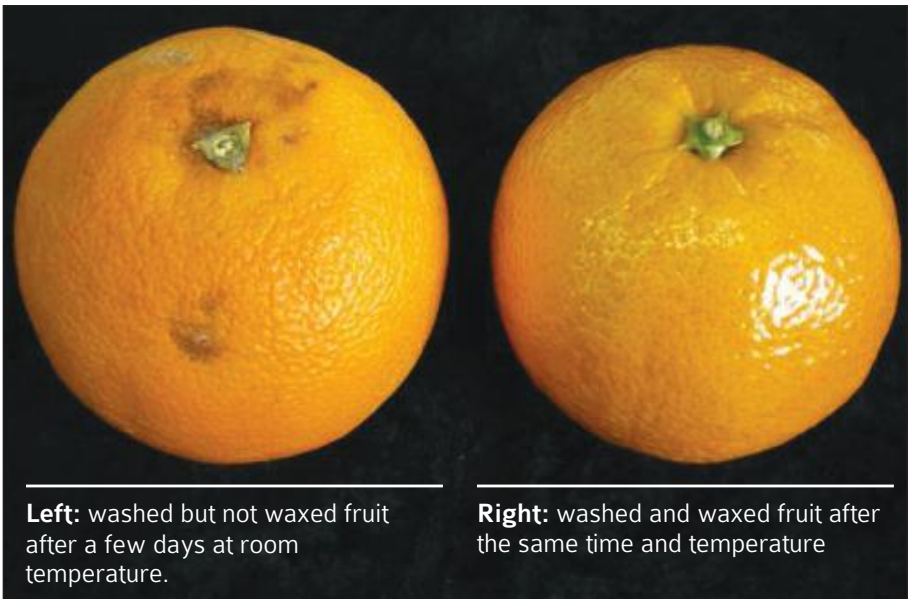
## Demonstrate knowledge of waxing, treatment of peduncle and drying

In this LO, you will learn about the importance of waxing, treatment of peduncle and drying, describe methods of waxing, identify and select the appropriate type of wax and fungicide and demonstrate the procedure of applying wax and fungicide.

### PC (a) Explain the importance of waxing, treatment of peduncle and drying.

During growing, a citrus fruit segregates a natural wax layer. In many instances this wax layer softens as a consequence of heat and direct sunlight. Because of this softening the wax layer becomes a reservoir for dust, dirt, mould, fungal and bacterial spores and pre-harvest spray residues that have adhered. That is why one of the first steps in a citrus pack house is to wash the fruits. Besides improving fruit appearance, a great part of fungal and bacterial spores are removed as well as any spray residue that may be in this layer. But the thorough washing of fruit removes the natural wax layer.

Artificial wax is applied to replace the natural wax lost during washing of fruits. This adds a bright sheen to the fruit. The function of artificial waxing is summarized below:





- Provides a protective coating over entire surface.
- Seals small cracks and dents in the rind or skin.
- Seals off stem scars or base of petiole.
- Reduces moisture loss.
- Permits natural respiration.
- Extends shelf life.
- Enhances sales appeal.



Note: Waxing reduces dehydration and ageing symptoms while appearance is improved.

## PC (b) Describe methods of waxing

### Methods of Waxing

Wax can be applied as sprays or foams by immersion and dripping or in other ways. Uniform distribution is important. Soft brushes, rollers or other methods are used to ensure that application on the surface of fruit is thorough and texture is even. Wax is best applied from the brush itself.



This method can be grouped into two categories;

- Automated
- Un-automated (manual)

Heavy application can block fruit gas exchange and produce tissue asphyxia. Internal darkening and development of off-flavours and off-odours are some of the characteristics. It is very important that waxes are approved for human consumption.

## PC (c) Select the appropriate type of wax and fungicide

### Type of wax and fungicide

Waxing materials may be either natural or man-made. The waxing materials used depend to some extent on regulations in the country of production and/or export; both natural waxes (sugar-cane, carnauba, shellac, or resin) and petroleum-based waxes (contain polyethylene) are used. Examples of wax are

- Citrosol A S (petroleum-based wax for citrus)
- StaFresh 705 (water-based coating for lemons)
- Citrashine (natural water-based wax for citrus)
- Citrus Lustr 402 (citrus wax, shellac-based.)

Waxing is performed with water waxes or emulsions made up mainly of shellac, carnauba wax and polyethylene. Wax may be applied in a volatile petroleum-based solvent but is now more commonly applied via water-based emulsion. Most of the waxes contain fungicides (example is the StaFresh 451 which is a high gloss aqueous wax containing a fungicide 2-4 thiazolyl benzimidazole TBZ 0.1 %

### PC (d) Demonstrate the procedure of applying wax and fungicide

Various waxes and fungicide are available on the market. Each wax or fungicide has a recommended rate and timing. It is relevant that users of these products read product labels and adhere to all recommendations and rates in applying wax or fungicide to citrus.

**Activity:** Learner should be given a recommended wax and fungicide to apply to citrus.



## Self-assessment

### PC (a)

- 1a. State two (2) reasons for applying wax on citrus fruits.
- 1b. Research and find out more about peduncle treatment and share your findings with your classmates.

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### PC (b)

1. In groups of three, demonstrate the methods of waxing harvested fruits.

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### PC (c)

- 1a. Visit a recognized citrus pack house to find out some examples of fungicides used in waxing citrus fruits.

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1b. Write a report and discuss in class.

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PC (d)

1. State the procedure of applying wax and fungicide. With the named wax and fungicide give the procedure for their application to citrus.

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## Demonstrate knowledge of Sorting and grading of citrus fruits

In this LO, you will learn about the importance of sorting and grading, identify the factors to consider, use the appropriate factors, identify factors that lead to rejection of citrus fruits and reject citrus fruits based on these factors.

### PC (a) Explain the importance of sorting and grading.

Citrus fruits inspected and sorted help to remove fruits which do not meet the requirements for the grade, quality, pricing, easy packing and to satisfy various market needs. At the sorting table, the trained workers wearing gloves sort out the oversized and undersized fruits (immature/scarred/blemished fruits, diseased/insect damaged).

The amount of blemish (external marks) on a fruit or colour will determine which grade the fruit should be sorted to. Commonly citrus fruits are sorted into the following grades;

- Top quality
- Average
- Low quality



The sorting and grading process consists of sorting product in grades or categories of quality. This can be done both manually and mechanically (automated).



Manual sorting



Automated sorting

## **PC (b) Identify the factors to consider when sorting and grading citrus fruits**

Factors to consider when sorting and grading citrus fruits

Certain parameters are used to sort and grade citrus fruits in the pack house. Factors that influence sorting and grading citrus fruits are;

- Colour
- Size
- Quality

These parameters affect the grade in which a fruit can find itself after it has been sorted. Bruised, rotten, off-shaped fruits are usually removed.

Rejects mainly on aesthetic (colour) grounds provide a second or even third quality grade. These can be marketed in less demanding outlets or used as raw material for processing.

Sizing is another basic operation undertaken in a pack house and can be carried out before or after sorting by colour. Both operations should always be carried out before grading. This is because it is easier to identify fruits with defects on a uniform product, either in terms of size or colour.

According to weight or dimensions (diameter, length or both). Spherical or almost spherical products like grapefruits, oranges are easy to sort by size. Sizing can be performed manually using rings of known diameter. Quality therefore combines the parameters of colour and size. Sorting by weight is carried out in many crops with weight sensitive trays.

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## **PC (c) Use the appropriate factors in sorting and grading**

Commercial citrus fruits are graded primarily on their surface appearance. Discolourisation, scanning, texture of skin, freedom from scale insects and algae are key factors that are considered in grading and sorting.

Grading the fruits is the only manual operation between harvesting and packing.

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## **PC (d) Identify factors that lead to rejection of citrus fruits.**

Factors used to reject citrus fruits are as follows:

- size
- shape

- colour
- the presence of blemishes
- the presence of foreign materials

## PC (e) Reject citrus fruits based on factors in PC(d)

**Activity:** Learners will be given an amount of citrus fruits and asked to reject citrus fruits based on the factors in PC (d)



### Self-assessment

#### PC (a)

1. Apart from the importance stated in the learning materials, state other importance of sorting citrus fruits.

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#### PC(c)

2. State the factors used in sorting and grading.

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#### PC (d)

3. Identify three (3) factors that can lead to rejection of citrus fruits.

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## Demonstrate knowledge of packaging materials

In this LO, you will learn about the importance of packaging, identify the types of packaging materials and arrange boxes in stacks.

### PC (a) Explain the importance of packaging

The main purpose of packaging is to ensure that the product is inside a container along with packing materials to prevent movement and to cushion the produce (plastic or moulded pulp trays, inserts, cushioning pads, etc.) and for protection (plastic films, waxed liners, etc.). It needs to satisfy three basic objectives namely:

- contain product and facilitate handling and marketing by standardizing the number of units or weight inside the package.
- protect product from injuries (impact, compression, abrasion and wounds) and adverse environmental conditions (temperature, relative humidity) during transport, storage and marketing.
- provide information to buyers, such as variety, weight, number of units, selection or quality grade, producer's name, country, area of origin, etc. Additional information are frequently included such as nutritional value, bar codes or any other relevant information on traceability.
- All the above objectives ensure proper storage and distribution



## PC (b) Identify the type of packaging materials

### Types of packaging material

Citrus fruits can be packaged into the following:

- Flexible sacks; made of plastic jute and nets (made of open mesh)
- Wooden crates
- Cartons
- Plastic crates
- Pallet boxes and shipping containers
- Baskets made of woven strips of leaves, bamboo, plastic, etc.



Manual sorting



Automated sorting

## PC (c) Arrange boxes in stacks

### Arrangement of boxes in stack

Arrangement of boxes in stack is very important since the safety and long shelf life of the boxed citrus depends on it. Wrong arrangement will lead to pressure being exerted on boxes beneath which might collapse or damage the fruits in them.

The most common size used internationally is 120 x 100 cm. It is sometimes made of plastic materials. Depending on the packaging dimensions, a pallet may hold from 20 to 100 units.



Correct arrangements of boxes



Wrong arrangement of boxes





## Self-assessment

### PC (a)

1. State three (3) reasons for packing citrus fruits.

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### PC (b)

2. State and explain two (2) advantages of wooden crates over the plastic crates used in packaging citrus fruits.

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### PC (c)

3. Visit a pack house and demonstrate how to arrange at least 10 boxes in stacks

## Demonstrate knowledge of pre-cooling and cooling

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In this LO, the learner will explain the importance of pre-cooling and cooling, identify and explain the methods of pre-cooling and cooling, determine the pre-cooling and cooling temperatures and the duration of cooling and pre-cooling.

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### PC (a) Explain the importance of pre-cooling and cooling citrus in a pack house

Pre-cooling and cooling of citrus is the process of applying coldness

Several methods of cooling are applied to fruits after harvesting to extend shelf life and maintain a fresh-like quality.

#### Pre-cooling and cooling

Fruit is pre-cooled when its temperature is reduced from 3 to 6°C (5 to 10°F) and is cool enough for safe transport. Pre-cooling may be done with cold air, cold water (hydro-cooling), direct contact with ice, or by evaporation of water from the product under a partial vacuum (vacuum cooling).

### PC (b) Explain the method of pre-cooling and cooling

#### Methods of pre-cooling and cooling

##### Air pre-cooling

Pre-cooling of citrus fruits with cold air is the most common practice. It can be done in refrigerator cars, storage rooms, tunnels, or forced air-coolers (air is forced to pass through the container via baffles and pressure differences).

##### Icing

Ice is commonly added to boxes containing citrus fruits by placing a layer of crushed ice directly on the top of the fruit. Ice slurry can be applied in the following proportion: 60% finely crushed ice, 40% water, and 0.1% sodium chloride to lower the melting point. The water to ice ratio may vary from 1:1 to 1:4.

## Room cooling

This method involves placing the citrus fruits in cold storage. The type of room used may vary but generally consists of a refrigeration unit in which cold air is passed through a fan. The circulation may be such that air is blown across the top of the room and falls through the fruit by convection. The main advantage is that it is cost effective because no specific facility is required.

## Forced air-cooling

The principle behind this type of pre-cooling is to place the fruit into a room where cold air is directed through the fruit after flowing over various refrigerated metal coils or pipes.

Forced air-cooling systems blow air at a high velocity leading to dehydration of citrus fruits. To minimize this effect, various methods of humidifying the cooling air have been designed such as blowing the air through cold water sprays.



The importance of factors such as mould growth and chilling injuries must be taken into account as well as the required length of storage.

## PC (c) Determine the pre-cooling and cooling temperature.

Temperature management in pre-cooling and cooling is important because it maintains quality of citrus fruits. Citrus fruits can be stored at 5-9°C.

## PC (d) Determine the duration of cooling and pre-cooling

Temperature management is important throughout the period between harvest and consumption in order to maintain good produce quality. Cooling practices provide marketing flexibility by making it possible to market produce at the optimum time and over longer distances.

The duration of cooling and pre-cooling depends on the temperature. The storage life of citrus fruits is highly variable and related to the respiration rate; there is an inverse relation between respiration rate and storage life in citrus fruits. Fruits with low respiration generally keeps longer.



## Self-assessment

### PC (a)

1. State two (2) reasons for pre-cooling and cooling citrus fruits.

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### PC (b)

1. Explain the following methods of cooling citrus fruits

- i. Forced air-cooling

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- ii. Room cooling

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2. State the main reason why you will choose the room cooling method instead of the force air cooling method.

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### PC (c)

1. Explain why temperature management is important in pre-cooling and cooling of citrus fruits.

### PC (d)

2. Explain the relationship between storage life and duration of cooling and pre-cooling of citrus fruits

### Activity

- i. Organize a field trip to a recognized pack house facility. During the visit, observe and write on the following:

- a. Waxing
    - b. Packing in stacks
    - c. Materials for packing citrus
    - d. Pre-cooling and cooling
    - e. Duration for pre-cooling and cooling



