Horticultural Crops Production

Level II

Learning Guide –76

Unit of Competence: Carry out Postharvest Handling Operations

Module Title: Carrying out Postharvest Handling Operations

LG Code: AGR HCP2 M19LO1- 76

TTLM Code: AGR HCP2 TTLM 1219V1

LO1:- Prepare for postharvest operations

Instruction sheet 1	Learning Guide 76

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

- Identifying post-harvest operations and client specifications
- Selecting materials, tools, equipment and machinery
- Carrying out pre-operational and safety checks on tools, equipment and machinery
- Compiling Hazard Analysis Critical Control Point (HACCP) and food safety
- Identifying Occupational Health and Safety (OHS) hazards
- Selecting suitable Personal Protective Equipment (PPE)
- Performing all work in an environmentally
- Applying and following site quarantine protocols, farm and personal hygiene

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

- Identify post-harvest operations and client specifications
- Select materials, tools, equipment and machinery
- Carry out pre-operational and safety checks on tools, equipment and machinery
- Compile Hazard Analysis Critical Control Point (HACCP) and food safety
- Identify Occupational Health and Safety (OHS) hazards
- Select suitable Personal Protective Equipment (PPE)
- Perform all work in an environmentally
- Apply and follow site quarantine protocols, farm and personal hygiene

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 “Sheets 1-8”.
4. Accomplish the “Self-checks 1-8” **in page -5, 9, 12, 15,17,19,22 and 25** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 ” **in page -26.**
6. Do the “LAP test” **in page – 26** (if you are ready).

Information Sheet-1	**Identifying post-harvest operations and client specifications**

1.1. Definition of post-harvest

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

1.2. Post-Harvest Goals

1. Harvest product at its optimum maturity
2. Maintain the product’s internal and external quality throughout packing, storage and distribution. It is Alive during this process.
3. Deliver the fruit to consumer at the time and in a form (e.g ripe, cut up, etc) that they will purchase it .

The major functions of food production can be seen as **pre** and **post-**harvest activities:

1.3. Post-Harvest Activities:

- Harvesting
- Pre-Storage treatments
- Grading/Selection
- Storage
- Packaging
- Transport
- Processing
- Marketing

1.4. Definition of post-harvest handling

In agriculture, postharvest handling is the stage of crop production immediately following harvest, including cooling, cleaning, sorting and packing. The instant a crop is removed from the ground, or separated from its parent plant, it begins to deteriorate. Post-harvest treatment largely determines final quality, whether a crop is sold for fresh consumption, or used as an ingredient in a processed food product. Effective handling decreases postharvest losses.

The most important goals of post-harvest handling are keeping the product cool, to avoid moisture loss and slow down undesirable chemical changes, and avoiding physical damage such as bruising, to delay spoilage.

Sanitation is also an important factor, to reduce the possibility of pathogens that could be carried by fresh produce, for example, as residue from contaminated washing water.

After the field, post-harvest processing is usually continued in a packing house. This can be a simple shed, providing shade and running water, or a large-scale, sophisticated, mechanized facility, with conveyor belts, automated sorting and packing stations, walk-in coolers and the like. In mechanized harvesting, processing may also begin as part of the actual harvest process, with initial cleaning and sorting performed by the harvesting machinery.

Initial post-harvest storage conditions are critical to maintaining quality. Each crop has an optimum range for storage temperature and humidity. Also, certain crops cannot be effectively stored together, as unwanted chemical interactions can result. Various methods of high-speed cooling, and sophisticated refrigerated and atmosphere-controlled environments, are employed to prolong freshness, particularly in large-scale operations.

Regardless of the scale of harvest, from home garden to industrialized farm, the basic principles of post-harvest handling for most crops are the same:

- handle with care to avoid damage (cutting, crushing, and bruising)
- cool immediately and maintain in cool conditions
- cull (remove damaged items)

Main elements of the post-harvest system

- Harvesting
- Handling
- Threshing
- Drying
- Transport and distribution
- Storing
- Processing
- Primary processing
- Cleaning, classification, dehulling, pounding, grinding, packaging, soaking,
- Winnowing, drying, sieving, whitening, milling
- Secondary processing
- Mixing, cooking, frying, moulding, cutting, extrusion
- Product evaluation
- Quality control: standard recipes
- Packaging
- Weighing, labeling, sealing
- Marketing
- Use

- Consumer preferences

According to me post-harvest system rolling a sequence of activities and operations that can be divided into three groups but according to document of FAO, it is mentioning the first two as follow as:

• Technical activities: harvesting, field drying, threshing, cleaning, additional drying, storage, processing;

• Economic activities: transporting, marketing, quality control, nutrition, extension, information and communication, administration and management.

• Consumption pattern: Preparing food, cooking,

1.5. Client specifications:

Process specifications such as: preferred packaging materials or containers and filling techniques, labeling and storage requirements from field to client, quality, and grading plant produce specifications.

• variables subject to seasonal and market forces such as: bud count and health, Variety, colour , maturity and ripeness, moisture content and texture, shape and size, skin condition and blemishes, weight and length.

Self-Check 1	Written Test

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

1. What is post-harvest? (2 point)
2. List post-harvest activities? (5 points)
3. List Main elements of the post-harvest system? (5 points)

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

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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

Selecting materials, tools, equipment and machinery

- ***Materials*** may include
  - Preservatives
  - Chemicals
  - Gases
  - Cleaning agents,
  - Packaging materials and containers
  - Labels
  - Adhesives and preforms.
- ***Tools, equipment and machinery*** may include

- ✓ Tractors
- ✓ Trailers
- ✓ Light trucks
- ✓ Forklifts
- ✓ Snips
- ✓ Knives
- ✓ Gloves
- ✓ Containers
- ✓ Grading
- ✓ Machinery
- ✓ Washers
- ✓ Brushes
- ✓ Dryers
- ✓ Chemical applicators
- ✓ Gassing chambers
- ✓ Labeling devices
- ✓ Packing tools
- ✓ Scales
- ✓ Pallets
- ✓ Hand trolleys and lifting aids

Self-Check 2	Written Test

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

1. List materials used for horticultural operation? (5 points)
2. List equipment and machinery used for horticultural operation? (5 points)

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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

Information Sheet-3	Carrying out pre-operational and safety checks on tools, equipment and machinery

3.1 pre-operational checks of facility, machinery and equipment's

Agricultural machinery and equipment is tangible personal property that is used directly in cultivating or harvesting a crop, collecting or processing of an agricultural product on the farm area.

What may be involved in routine pre-operational checks of tools or equipment's?

This may include routine *safety* and pre-start checks and preparatory procedures including *cleaning, lubricating, and hand sharpening, priming pumps, clearing filters, tightening, basic repairs* and adjustments.

Pre-operational checks: On machinery and equipment may include checking

- ***Fuels, fuel lines and oils:*** check the oil and the fuel line if it is not in good condition change or fill the oil and fuel respectively.

- ***Battery electrolyte levels, wheels and tires pressure***: when servicing the battery or checking the electrolyte level, wear rubber gloves, a rubber apron, and eye protection. Batteries contain sulfuric acid which is destructive. If it comes in contact with your skin, wash it off at once with water. Acid may splash on the skin or into the eyes inadvertently when removing electrolyte caps.

- ***Air filters:*** check the air filter if there is impurities on it, clean it with appropriate materials like air compressors.
- ***Safety guards:*** check the safety guards are located in the appropriate position.

Preparation on equipment may include:

- Cleaning, lubricating
- Identifying and segregating unsafe or faulty equipment for repair or replacement

Checks are conducted on all materials, tools and equipment with insufficient or faulty items reported to the supervisor. As the business grows and you get more clients and more assignment, you can get more tools and equipment and offer more services. Employers are also required to ensure that those using equipment have sufficient knowledge and training to use it safely.

A ***maintenance schedule should be in place*** before going to the work to ensure that your equipment is maintained at least at intervals indicated in the manufacturer's operating instructions or more frequently if indicated by the risk assessment. Any daily checks should be undertaken as recommended by the manufacturer. This will help prevent problems such as blockages, leaks or breakdowns, which can increase risks.

The need of pre operational check is: it minimizes the occurrence of hazards on the machine or on the operator.

Importance preoprational chekes

This minimizes risks and help to accomplish task without any difficulties. Safety checks must have done by skilled and knowledgeable person to minimize mistakes in operating tools and equipment**.**There are pre-operational and operational checks you can do

before and after starting the machines; that will only take a few minutes to ensure your safety, the safety of the people around you and the safety of your machines.

Pre oprational activity includes

Check all the tools and equipment before use.

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

Figure 1. Pre-operational activity

Self-Check -3	Written Test

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

1. Pre-operational checks focused on---------- (5 points)

A. Pre-start checks
B. Safety checks
C. Operational function checks
All

2. What are the things to be checked in pre-operational checks on machinery and equipment? (5 points)

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

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	Compiling Hazard Analysis Critical Control Point (HACCP) and food safety

4.1. Definition of hazard analysis

A hazard analysis is used as the first step in a process used to assess risk. The result of a hazard analysis is the identification of different type of hazards. A hazard is a potential condition and exists or not (probability is 1 or 0). It may in single existence or in combination with other hazards (sometimes called events) and conditions become an actual Functional Failure or Accident (Mishap). The way this exactly happens in one particular sequence is called a scenario. This scenario has a probability (between 1 and 0) of occurrence. Often a system has many potential failure scenarios. It also is assigned a classification, based on the worst case severity of the end condition. Risk is the combination of probability and severity. Preliminary risk levels can be provided in the hazard analysis. The validation, more precise prediction (verification) and acceptance of risk is determined in the Risk assessment (analysis). The main goal of both is to provide the best selection of means of controlling or eliminating the risk. The term is used in several engineering specialties, including avionics, chemical process safety, safety engineering, reliability engineering and food safety

4.2. Objectives of Compiling Hazard Analysis Critical Control Point (HACCP)

• To understand and address the hygienic insufficiencies existing at the plant level;

• To review the flow of materials within the production areas;

• To identify potential hazards to consumer safety;

• To manage major hazards and determine preventive and corrective actions and

• To reduce customer complaints and improve satisfaction.

4.2. Food safety is a significant quality aspect of any food product. A food safety management system using Hazard Analysis Critical Control Points (HACCP) is to identify 1) preventive steps to reduce hazards at each critical control point (CCP), 2) corrective responses if control limits are not met, and 3) documentation and verification requirements. The implementation has improved personal hygiene and sanitation practices, attained encouraging results of microbiological spot checks, and reduced customer complaints caused by internal infestation and extraneous matter by 71% and 83%, respectively. Improvements in good manufacturing practices were achieved in the areas of plant and equipment, operating procedures and policies. HACCP documents also assisted in training and contributed to the consistency of practices.

3. Results of HACCP Implementation Based on the results of the gap analysis, improvement was needed in several areas including the defining of responsibilities and training, condition of premises, improvement of supervision and improvement of storage facilities. Improving sanitation was the major area of concern.

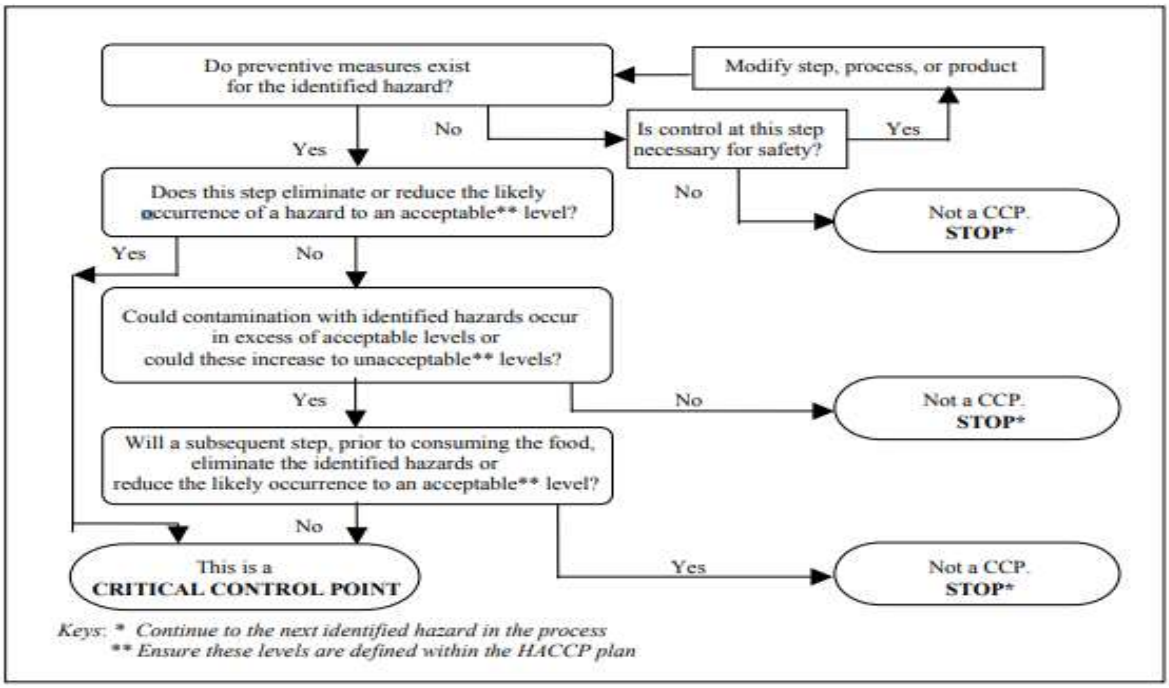

Fig. **Compiling Hazard Analysis Critical Control Point (HACCP) decision tree**

Self-Check- 4	Written Test

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

1. List Objectives of Compiling Hazard Analysis Critical Control Point? (5 points)
2. What is Food safety? **(5 points)**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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

Information Sheet-5	**Identifying Occupational Health and Safety (OHS) hazards**

Occupational safety and health (OSH), also commonly referred to as occupational health and safety (OHS), occupational health, or workplace health and safety (WHS), is a multidisciplinary field concerned with the safety, health, and welfare of people at work. These terms also refer to the goals of this field, so their use in the sense of this article was originally an abbreviation of occupational safety and health program/department etc.

The goal of occupational safety and health programs is to foster a safe and healthy work environment. OSH may also protect co-workers, family members, employers, customers, and many others who might be affected by the workplace environments. The term occupational health and safety is referred to as occupational health and

occupational and non-occupational safety and includes safety for activities outside of work.

In common-law jurisdictions, employers have a common law duty to take reasonable care of the safety of their employees. Statute law may in addition impose other general duties, introduce specific duties, and create government bodies with powers to regulate workplace safety issues: details of this vary from jurisdiction to jurisdiction.

5.1. Identifying OHS hazards,

5.1.1 **Types of hazards**

Physical hazards: These include noise, radiation

Chemical hazards:

Biological hazards

Psychological hazard

Ergonomic hazards:

Hazard control

The term ‘’hazardous’’ refers to any chemical which can affect an employee’s health. Effects can range from mildly irritating to potentially highly carcinogenic. The recommended hierarchies of control measures for managing hazards are:

1. Elimination

Whenever possible, remove the hazard completely through elimination.

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

2. Substitution

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

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

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

3. Engineering Controls

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

4. Administrative Controls

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

These measures may include changing work procedures, developing and implementing new policies and requiring personal protective equipment to be used. A typical example of an administrative control is the provision that suitable hearing protection be properly worn in areas where noise cannot be reduced to acceptable levels through elimination, substitution or by engineering controls.

Self-Check- 5	Written Test

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

1. . List types of hazard? (5 points)
2. What is the mechanism to prevent hazard? **(5 points)**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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

Information Sheet-6	**Selecting suitable Personal Protective Equipment (PPE)**

6.1 Selecting and checking personal protective equipment's

Selecting implies the process of ensuring that the personal protective equipment is directly related in protecting the person as related to the job performed. Select boot,

hats, lotions, googles, mask and gloves. In similar manner you need to identify the likely risks that might occur on your body or sense organs from specific agricultural crop works, then once you identify the risks it is necessary to select the necessary personal protective equipment that fit the body or the sense organ involved.

it is necessary to select the necessary personal protective equipment that fit the body or the sense organ involved.

Figure 1 Personal protective equipment

6.2 Checking suitability of personal protective equipment

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

Self-Check- 6	Written Test

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

1. What is the use of selecting and checking personal protective equipment's? (5 points)
2. List some of personal protective equipment's? **(5 points)**

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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

Information Sheet-7	**Performing all work in an environmentally**

7.1. Tips considering to perform works environmentally

To get the most out of your employees, you have to create a positive work environment for the entire team. When people feel encouraged, accepted and happy, they become more motivated and perform better. Isn't that a nice formula?

Yes, it takes time out of your day, but the process of creating a joyous workplace brings a sense of purpose to your work and results in dedicated performances. Plus, managers are responsible for nurturing their team, not just producing great project outcomes no matter the cost. All aboard?

Here are five tips to create a positive work environment:

1. **Engage in meaningful (in-person) dialog**

When you make the effort to connect with your team members in person—individually and as a group—you're establishing a position of caring that motivates individuals in all sorts of crazy-good ways. It's easy to send short messages in emails, and then rely on these small exchanges for most of your communication. Or, you can focus on what needs to get done next and forget to take a breath, look around, and get to know your employees. Don't fall into this rut. Instead, ask your team members about their immediate goals and project interests as well as their career objectives.

Also, remember: We're all human, and most humans respond well to the real thing—in-person communication that says "you matter."

2. Show your appreciation

One of the biggest complaints from employees is that they don't feel appreciated. The second someone gives us a "nice job" or "you made a difference on this project," we feel like we matter in a way that gives our work a sense of purpose. If you're not so inclined to give out verbal gold stars, an easy place to start is with a simple "thank you."

The next step is to give meaningful appreciation. Thread the high-fives and "nice jobs" with a more detailed picture behind your acknowledgment. This way, your employees can understand what they're doing well, and do more of it. Also, detailed praise shows you're paying attention and not throwing around empty phrases. When people feel like they're doing good work, they want to rise to the occasion even more.

3. Listen to everyone's ideas

Your entire team has great ideas. They're in the trenches all day, bringing their own experience and perspectives to the part of the project they're focused on. For example, if there's a way to make spreadsheets more efficient or cold-calls more productive, the team members know how. It's tempting to stick with protocol because you know that works well. But these days the world moves so fast nobody can afford to stay with a status quo for too long. So instead, make it a policy to listen to new ideas (you could structure appropriate time periods for this, too), and this will tell everyone they're a valuable part of the team. Give the good ideas a try; you never know what might happen—other than the team becomes more invested in their work and the project outcome, for starters.

4. Trust your team members

This is a harder rule to practice for some more than others. So try to default to the assumption that your team is made up of adult, responsibility-taking, competent workers that don't need to be treated like children. (In the end, people act the way they're treated.) In action terms, this means that when you delegate, really let go and let the individual own the task you gave them. You can also communicate trust by asking team members to make decisions for their part of the project, like:

Suggesting when and if meetings should happen

Anticipating roadblocks and communicate those to the group

Assuming that your team wants the best for the project. And if you sense the beginnings of some negative juju kicking up, invite discussions about office policy; see what the majority thinks.

5**. be spontaneous and have a little fun**

Everyone wants to have fun at work—even though everyone defines "fun" a little differently. Still, if you can keep the previous four tips in action, then fun—or a sense of enjoyment and being able to be yourself at work—becomes a more natural part of everyone's job. Fun happens when people feel well-connected with a team where

there's mutual respect, open communication, acceptance of who people are and everyone's collaborating and working toward the same goal. When teams are working well together, it makes it easier to be spontaneous and have some fun – whether it's a last-minute Football Friday party after a project launch, or a brief pause in the afternoon to tell stories and have a few laughs over topics that have nothing to do about work.

Sometimes we all need a break from the seriousness of business.

And remember—whether you're a team leader or team member, everyone plays a role in contributing to your work environment.

The best project managers know how to motivate, inspire and nurture a positive work environment that brings out the best in individuals and the team.

Self-Check- 6	Written Test

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

1. List Tips considering to perform works environmentally? (5 points)

Note: Satisfactory rating - 5 points and above Unsatisfactory - below 5 points

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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

Information Sheet-8	**Applying and following site quarantine protocols, farm and personal hygiene**

Applying and following site quarantine protocols, farm and personal hygiene

In the contest of international law, Quarantine is the regulations of a country imposing a period of time during which vehicles arriving in port is forbidden to land freight or passengers, because it is suspected of being infected with contagious diseases/crop pests.

After the liberalization of regulations for import of plants and plant materials that followed General Agreement on Tariffs and Trade (GATT) ratification by participating countries, there is a potential risk of introducing several destructive pathogens and pests, especially viruses, viroid's, and physoplasmas. Implementation of adequate quarantine safeguards has become imperative to prevent the introduction of new pathogens. Establishment of a post-entry quarantine facility along with expertise in propagation of plants by tissue culture techniques will lead to large-scale production of pathogen-free plants within short periods. Various methods are used for the detection of viruses, viroid's, and phyto plasmas in vegetative propagated planting materials. The grow-out test, indicator- inoculation test, indexing method, histopathological test, electron microscopy, and serological tests are employed for the early detection of infection and elimination of infected materials or plants. Effective functioning of post-entry quarantines will greatly help to prevent the introduction and subsequent spread of plant pathogens.

Quarantine defines the scope of quarantine as follows: In this Act, quarantine includes, but is not limited to, measures:

(A) for or in relation to, the examination, exclusion, detention, observation, segregation, isolation, protection, treatment and regulation of vessels, installations, human beings, animals, plants or other goods or things; and

(B) Having as their object the prevention or control of the introduction, establishment or spread of diseases or pests that will or could cause significant damage to human beings, animals, plants, and other aspects of the environment or economic activities.

1.1. The Plant Quarantine System

The plant quarantine system is regulatory and operational activities that together are designed to prevent the entry establishment and spread of regulated pests in Ethiopia.

Inspection is conducted to check for pest infestation prior to import /export at the Plant Protection Station (which is located at seaports/airports), markets or production sites. Furthermore, laboratory tests may be conducted for nematodes and plant diseases.

1.2. Inspection of container vessels of personal and/or work vehicles

Most of the cargo transported in the country is by container. Hence, inspection procedures must be adapted to this means of conveyance. The Inspector should be aware of the following:

• A high level of risk occurs when the container is opened since pests that may have been shipped with the produce can escape at the time of opening.

• A pest could multiply rapidly during the period of confinement in the container (for example, dependent on the life-stage of the pest in/on the produce when the container is loaded, as well as on its rate of development).

• There may also be some risk of contaminating pests both on the outside of the container and inside empty containers, especially those that may have previously held regulated cargo.

The import inspections performed by the PQ Unit are designed to verify the conformity of imported consignments with the phyto sanitary requirements in order to prevent the entry and spread of regulated pests or to ensure decontaminating. General inspection procedures include document verification, identity checking and phyto sanitary verification. Specific inspection procedures for phyto sanitary verification of consignments of different classes of commodities are also given.

1.3. Ensuring the decontaminating personal and/or work vehicles

Decontamination involves a combination of physical and chemical procedures that are used to remove soiling and inactivate the target disease organism. An effective decontamination program is vital during all stages of any emergency disease response. The decontamination process comprises a number of stages. These are:

- Planning identification and assessment of risks, design of efficient and effective procedures, and training of personnel;
- Implementation cleaning, disinfection, and waste treatment and disposal; and
- Pasting for effectiveness.

Ineffective decontamination usually

- Fails to include adequate cleaning as part of the process;
- Uses inappropriate disinfecting agents; or
- Does not allow adequate contact time with the disinfecting agent.

Self-Check 8	Written Test

Name: _____ Date: _____

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

1. What is personal hygiene? (3)
2. What quarantine? (3 points)

Answer

Score = _____

Rating: _____

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

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

Operation sheet	Identifying post-harvest operations

Objectives to Identifying post-harvest operations

Procedures

1. Prepare harvested products
2. Prepare transportation and storage facilities

3 Maintain the temperature of the product immediately after harvesting

8. Sort the harvested fruits
9. Transport the product in a safe way to processing or storage area
10. Storage properly if stored and deliver as quickly as possible for processing industry if processed.

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LAP Test	Practical Demonstration

Name: _____ Date:_____

Time started: _____ Time finished: _____

Instruction:

1. Prepare harvested products
2. Prepare transportation and storage facilities
3. Sort the harvested fruits
4. Store the product properly in storage container

List of Reference Materials

- WILLS, R .B.H. Post-harvest and handling and storage of fruits and vegetables FAO/GCP/CPR/008/BEL, Beijing, China, 1988.
-
- 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
- HANDLING OF FRESH FRUITS, VEGETABLES AND ROOT CROPS TRAINING MANUAL

Horticultural Crops Production

Level II

Learning Guide –77

Unit of Competence: Carry out Postharvest Handling Operations

Module Title: Carrying out Postharvest Handling Operations

LG Code: AGR HCP2 M19LO2- 77

TTLM Code: AGR HCP2 TTLM 1219V1

LO2:- Transport harvested produce

Instruction sheet 1	Learning Guide 77

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

- Employing safe manual handling techniques
- Conducting field handling practices
- Maintaining temperature of harvested produce
- Transporting produce
- 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:

- Employ safe manual handling techniques
- Conduct field handling practices
- Maintain temperature of harvested produce
- Transport produce
- Maintain containers

Learning Instructions

7. Read the specific objectives of this Learning Guide.
8. Follow the instructions described below 3 to 6.

9. Read the information written in the information “Sheet 1- Sheet 5”.
10. Accomplish the “Self-check 1 Self- check 5,” **in page -33, 36, 38, 40 and 42** respectively.
11. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 ” **in page -43.**
12. Do the “LAP test” **in page – 43** (if you are ready).

Information Sheet-1	**Employing safe manual handling techniques**

1.1 manual handling techniques

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.

1.2. Different types harvesting bags are available:

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

Figure 1.1 harvesting bag handling

Plastic buckets or other containers are suitable for harvesting fruits that are more easily crushed, such as tomatoes. The containers should be smooth, with no sharp edges or projections to damage the produce

Figure1.2 plastic bucket

Baskets as long as they do not have sharp edges or splinters that can injure produce. If they are not sturdy, they may bend out of shape when lifted or tipped especially if they are large and crush or otherwise damage the contents

Figure1.3. basket splinter

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 piking 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

1.3. 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.

 Post Harvest losses are of two types:

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

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

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

Self-Check 1	**Written Test**

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

1. What is the Importance of safe handling? (5 point)
2. Write different factors that affecting handling of horticultural crops? (5 points)

Score = _____

Rating: _____

Answer

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

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

Name: _____ Date: _____

Information Sheet-2	**Conducting field handling practices**

2.1. Field handling practices:

Correctly stacking containers on transport to reduce the risk of bruising, squashing or damaging produce, lifting rather than dragging containers to avoid contact with dirt, observing fill level of containers, smoothly transporting harvested produce to post-harvest processing or storage facility.

Transport planning

Transport planning allows for high utilization and less impact regarding new infrastructure. Using models of transport forecasting, planners are able to predict future transport patterns. On the operative level, logistics allows owners of cargo to plan transport as part of the supply chain. Transport as a field is studied through transport economics, the backbone for the creation of regulation policy by authorities. Transport engineering, a sub-discipline of civil engineering, and must take into account trip generation, trip distribution, mode choice and route assignment, while the operative level is handles through traffic engineering

Infrastructure

Infrastructure is the fixed installations that allow a vehicle to operate. It consists of both a way, terminal and facilities for parking and maintenance. For rail, pipeline, road and cable transport, the entire way the vehicle travels must be built up. Air and water craft are able to avoid this, since the airway and seaway do not need to be built up. However, they require fixed infrastructure at terminals.

Terminals such as airports, ports and stations, are locations where passengers and freight can be transferred from one vehicle or mode to another. For passenger transport, terminals are integrating different modes to allow riders to interchange to take advantage of each mode's advantages. For instance, airport rail links connect airports to the city centers and suburbs. The terminals for automobiles are parking lots, while buses and coaches can operates from simple stops.[13] For freight, terminals act as transshipment points, though some cargo is transported directly from the point of production to the point of use.

The financing of infrastructure can either be public or private. Transport is often a natural monopoly and a necessity for the public; roads, and in some countries railways and airports are funded through taxation. New infrastructure projects can involve large spending, and are often financed through debt. Many infrastructure owners therefore impose usage fees, such as landing fees at airports, or toll plazas on roads. Independent of this, authorities may impose taxes on the purchase or use of vehicles.

Transport or transportation is the movement of people and goods from one location to another. Modes of transport include air, rail, road, water, cable, pipeline, and space. The field can be divided into infrastructure, vehicles, and operations. Transport is important since it enables trade between peoples, which in turn establishes civilizations.

Transport infrastructure consists of the fixed installations necessary for transport, and may be roads, railways, airways, waterways, canals and pipelines, and terminals such as airports, railway stations, bus stations, warehouses, trucking terminals, refueling depots (including fueling docks and fuel stations), and seaports. Terminals may be used both for interchange of passengers and cargo and for maintenance.

Vehicles traveling on these networks may include automobiles, bicycles, buses, trains, trucks, people, helicopters, and aircraft. Operations deal with the way the vehicles are operated, and the procedures set for this purpose including financing, legalities and policies. In the transport industry, operations and ownership of infrastructure can be either public or private, depending on the country and mode.

Passenger transport may be public, where operators provide scheduled services, or private. Freight transport has become focused on containerization, although bulk transport is used for large volumes of durable items. Transport plays an important part in economic growth and globalization, but most types cause air pollution and use large amounts of land. While it is heavily subsidized by governments, good planning of transport is essential to make traffic flow, and restrain urban sprawl.

Self-Check 2	Written Test

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

1. What is the Importance Field handling practices:? (5 point)
2. What is Transport or transportation of horticultural crops? (5 points)

Score = _____

Rating: _____

Answer

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

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

Name: _____ Date: _____

Information Sheet-3	Maintaining temperature of harvested produce

3.1. Maintenance of temperature of the harvested crops

All type of physiological and biochemical process related to plant growth and yield are influenced by the temperature. The higher temperature during field conditions decreases life and quality of the produce. At high temperature, stored carbohydrates of fruits, vegetables and flowers are quickly depleted during respiration and plant respires at the faster rate. The produce which is having higher amount of stored carbohydrates show longer storage/vase life. For example- high temperature during fruiting season of tomato leads to quick ripening of fruits on and off the plant.

Orange grown in the tropics tend to have higher sugars and TSS than those grown sub tropics. However, tropical grown oranges tend to be green in colour and peel less easily and it is due to the lower diurnal temperature that occurs in the tropics.

3.2. 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.

Self-Check 3	**Written Test**

Name: _____ Date: _____

Directions: Answer the following questions carefully.

1. Why maintain temperature of the crop? 5pts
2. How to monitor storage facilities? 5pts
3. Explain the effect of temperature for storing? 5 points

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

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

Information Sheet-4	Transporting produce

4.1 Transporting the crop

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

The basic requirements for conditions during transportation are:

- Proper control of temperature, humidity and adequate ventilation.
- Proper packaging and stacking to avoid excessive movement or vibration which may cause severe bruising or other types of mechanical injury.
- Adequate facilities and proper handling

Safe handling of harvested products and transporting materials plays very important role in shelf life of harvested products and remunerative market income. Since most the harvested horticultural products are perishable, careful handling and transporting of these products and storage or transporting containers have a central role in reducing the post- harvest losses which are caused by poor handling and transporting of the harvested products. 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 agricultural 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. dirt road),
- Nature of the product: perishable/durable, size and weight, value etc

Self-Check 4	Written Test

Name: _____ Date: _____

Directions: Answer the following questions carefully.

1. What are basic requirements for conditions during transportation? (5pts)
2. Lists the most important considerations to consider in the transportation operation of agricultural products? (5pts)

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

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

Information Sheet-5	Maintaining containers

5.1 Facilitating storage conditions to minimize post-harvest deterioration

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

- **Management of harvested products in storage**

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

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

The reason/purpose for storage is to:

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

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

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

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

◆ **Conditions to be considered in storage**

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

Fig 1.1. Management of harvested products in storage

Self-Check 5	**Written Test**

Name: _____ Date: _____

Directions: Answer the following questions carefully.

1. What are The reason/purpose for storage? 5pts
2. Lists the Conditions to be considered in storage? 5pts

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

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

Operation sheet	perform fruit handling

Objectives to perform fruit handling activities

Procedure

Step 1-identify fruit types

Step 2-Select eliminate and separate products: with damage,

Step 3 -keep products in shade after harvest.

Step 4-Protect from high temp. And sunlight throughout the post-harvest chain.

Step 5-Handle products with care to avoid mechanical injuries.

Step 6-Keep good sanitation procedures. Clean harvest containers, display and storage facilities etc.

List of Reference Materials

- **WILLS, R .B.H.** Post-harvest and handling and storage of fruits and vegetables FAO/GCP/CPR/008/BEL, Beijing, China, 1988.
-
- 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
- HANDLING OF FRESH FRUITS, VEGETABLES AND ROOT CROPS TRAINING MANUAL-

Horticultural Crops Production

Level II

Learning Guide –78

Unit of Competence: Carry out Postharvest Handling Operations

Module Title: Carrying out Postharvest Handling Operations

LG Code: AGR HCP2 M19LO3- 78

TTLM Code: AGR HCP2 TTLM 1219V1

LO3:- Grade, label, treat, weigh and pack produce

Instruction sheet 1	Learning Guide 78

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

- Grading and labeling harvested produce
- Applying post-harvest treatments
- Working Post-harvest practices economical and methodical
- Undertaking post-harvest operations

- Cleaning and Maintaining tools, equipment and machinery
- Identifying and confirming quality parameters of produce and specifications
- Selecting correct packaging materials and containers
- Weighing, recording and repacking filled containers
- Using correct filling techniques for specific containers and produce
- Applying container Label where required, wraps and lids

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:

- Grade and label harvested produce
- . Apply post-harvest treatments
- . Work Post-harvest practices economical and methodical
- . Undertake post-harvest operations
- . Clean and Maintain tools, equipment and machinery
- . Identify and confirm quality parameters of produce and specifications
- . Select correct packaging materials and containers
- .Weigh, record and repack filled containers
- . Use correct filling techniques for specific containers and produce
- Apply container Label where required, wraps and lids

Learning Instructions

13. Read the specific objectives of this Learning Guide.
14. Follow the instructions described below 3 to 6.
15. Read the information written in the information “Sheet 1- Sheet 9 ”.
16. Accomplish the “Self-check 1- Self-check 9” **in page -46, 48, 51,58,59,61,65,67,69 and 71** respectively.
17. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, Operation Sheet 2 ” **in page -72&73**
18. Do the “LAP test” **in page – 72&73** (if you are ready).

Information Sheet-1	Grading and labeling harvested produce

1.1 **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 of Grading may be:

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

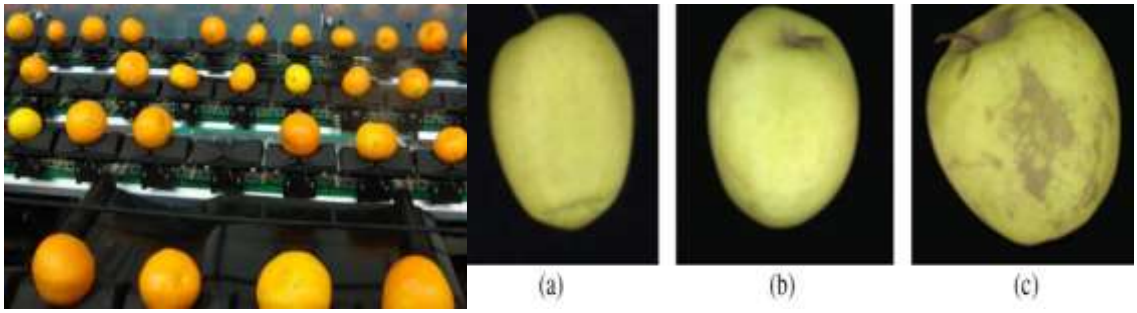

Fig 1.1. Grading of fruit

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 1	Written Test

Name: _____ Date: _____

Directions: Answer the following questions carefully.

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

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

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

Information Sheet-2	Applying post-harvest treatments

2.1. Definition of treatment

Treatment is the method of applying chemicals to harvest products in order to reduce perishability of fruits and increase shelf life.

Fresh fruits are living tissues subject to continuous change after harvest. Some changes are desirable from consumer point of view but most are not. Post-harvest changes in fresh fruit cannot be stopped, but these can be slowed down within certain limits to enhance the shelf life of fruits.

The post-harvest treatments play an important role in extending the storage and marketable life of horticultural perishables.

i) Washing with chlorine solution: Chlorine treatment (100-150 ppm available chlorine) can be used in wash water to help control inoculums build up during packing operations. Maintain pH of wash water between 6.5 and 7.5 for best results.

ii) Ethylene inhibitors/Growth regulator/ fungicide treatments: 1-MCP (1-methyl cyclopropene), AVG (Amenoethoxyvinyl gycine), silver nitrate, silver thiosulfate, cycloheximide, benzothiadiazole etc. are some of the chemicals which inhibit ethylene production and / or action during ripening and storage of fruits. The growth regulators or fungicidal application such as GA_3 or cytokinius, bavistin, procloraj, imazalil etc. can be effectively used to extend/ enhance the shelf life of fruits.

iii) Calcium application: The post-harvest application of Ca Cl_2 or Ca $(NO_3)_2$ play an important role in enhancing the storage and marketable life of fruits by maintaining their firmness and quality. Calcium application delays aging or ripening, reduces postharvest decay, controls the development of many physiological disorders and increases the calcium content, thus improving their nutritional value.

iv), Thermal treatments:

a) **Hot water treatment:** Fruits may be dipped in hot water before marketing or storage to control various post-harvest diseases and improving peel colour of the fruit (Table 2). In mangoes, the hot water treatment is recommended at 50-52^{O}C for 5 minutes to reduce the fungal infection during ripening or storage. This treatment helps in attaining uniform ripening within 5-7 days. Fruit should not be handled immediately after heat treatment. Cooling of fruit with water showers or forced air should be provided to help return the fruit to their optimum temperature as soon as possible after completion of the treatment.

b), Vapour heat treatment (VHT): This treatment proved very effective in controlling infection of fruit flies in fruits after harvest. The boxes are stacked in a room, which are heated and humidified by injection of steam. The temperature and exposure time are adjusted to kill all stages of insects (egg, larva, pupa and adult), but fruit should not be damaged.

v) Fumigation: The fumigation of SO_2 is successfully used for controlling post-harvest diseases of grapes. This is achieved by placing the boxes of fruit in a gas tight room and introducing the gas from a cylinder to the appropriate concentration.

Figure 2.1. Chemical treatment

vi), Irradiation: Ionizing radiation can be applied to fresh fruits and vegetables to control micro-organisms and inhibit or prevent cell reproduction and some chemical changes. It can be applied by exposing the crop to radiations from radioisotopes (normally in the form of gamma-rays measured in Grays (Gy), where 1 Gray = 100 rads.

vii) Waxing: Waxing of fruits or vegetables is a common post-harvest practice. Food grade waxes are used to replace some of the natural waxes removed during harvesting and sorting operations and can help reduce water loss during handling and marketing.

Self-Check 2	**Written Test**

Name: _____ Date: _____

Directions: Answer the following questions carefully.

1. What is post-harvest treatment? 5pts
2. Mention and explain post-harvest treatments? 5points
3. Explain importance of treatments? 5pts

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

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

Information Sheet-3	. Working Post-harvest practices economical and methodical

3.1. ECONOMIC ASPECTS OF POST-HARVEST LOSSES

Food losses occurs when no consideration between perishable and non-perishable or preferable foodstuffs. In one of its studies assessing losses of perishable products through handling or post-harvest operations, the special FAO loss-prevention programme presents the following conclusions: if harvest operations, storing (stacking and/or packaging in warehouse), storage and transport are defective, losses are separated as follows:

Harvesting	5-8 percent
Storing operation	15-20 percent
Storage	5-10 percent
Transport	10-12 percent

Fig. 3.1 use local available storage structure other than high cost storage

3.2. 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.

Field curing

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. Dried onions should never be allowed to come into con

Self-Check 3	**Written Test**

Name: _____ Date: _____

Directions: Answer the following questions carefully.

4. Describe post harvesting techniques of vegetables? 5pts
5. Mention advantage and disadvantages of mechanization? 5pts
6. What is curing? 5 points
7. Explain the importance of curing? 5pts

Note: Satisfactory rating – 20 points and Unsatisfactory - below 20points

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

Information Sheet-4	**Undertaking post-harvest operations**

4.1. Handling and Transporting

Losses occur primarily during transportation from the farm gate to collection centers, village fairs, wholesale markets and retail outlets. During transportation, sitting and

sheeping on the poly-sacks in which fruits and vegetables are tightly packed is a common practice. Packaging used by traders, does not accommodate or compensate for bad road surfaces and high temperature and humidity conditions that prevail during extended periods of transportation, resulting in a rapid deterioration of quality. Thus produce is often bruised, infested by postharvest pathogens and is not of optimum quality on reaching distribution points.

Marketing

Marketing is "the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large. Marketing is a product or service selling related overall activities.

Marketing is used to identify the customer, satisfy the customer, and keep the customer.

4.2. . Maintaining a clean, safe and hyiegienic work area

Tasks may include disabling unused tools, equipment and machinery and storing neatly out of the way of post-harvest activities, safely storing materials including chemicals on-site, using signage and safety barriers during and removing after post-harvest activities are completed, cleaning, fumigating or sterilizing post-harvest equipment and storage facilities.

4.3. General operations in post-harvest practices

- Dumping
- Washing
- Waxing
- Sorting
- Sizing
- Fruit packing line
- Processing

Operations in a packinghouse are.

Dumping can be done using either dry or water-assisted methods, depending upon the sort of produce being handled.

Cleaning, as well, can be by washing with chlorinated water or dry brushing alone. **Waxing**, if practiced, occurs after washing and removal of surface moisture.

Grading, as illustrated, separates the product into processing and fresh market categories. Sizing further separates the product, with the smallest size going to the local market or to processing. Typically, the best quality produce is packaged and marketed at the regional or national level.

4.4. Processing of horticultural crops

When conditions are not suitable for storage or immediate marketing of fresh produce, many horticultural crops can be processed using simple technologies. There are some processing methods that can be used by small-scale handlers, including drying, fermenting, canning, freezing, preserving and juicing. Fruits, vegetables and flowers can all be dried and stored for use or sale in the future. Fermentation is popular throughout the world as a food preservation method, and over 3,500 individual fermented foods have been described by Campbell-Platt (1987). Fruits and vegetables can be canned or frozen, and fruits are often preserved in sugar or juiced.

Processing equipment

A catalog of postharvest processing equipment is available from Intermediate Technology Publications. Included are driers, storage containers, cleaners, hand mills, power mills, shellers, decorticators (seed removers), oil processing equipment, fruit presses, and root crop cutters/graters. Some examples are shown below.

Two-man cassava grater:

Self-Check 4	Written Test

Name: _____ Date: _____

Directions: Answer the following questions carefully.

1. Write the post-harvest operations in horticulture? (5 points)
2. Write some processing equipment's? (5 points)

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

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

Information Sheet-5	Cleaning and Maintaining tools, equipment and machinery

5.1. **Cleaning and maintaining materials**

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.

5.2. Reporting problems to the supervisor

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

Problems during post-harvest handling may include:

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

Self-Check 5	Written Test

Name: _____ Date: _____

Directions: Answer the following questions carefully.

1. What is the purpose of cleaning? 5pts
2. Mention some problems occur during harvesting? 5pts
3. List down reporting problems? 5pts

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

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

Information Sheet-6	Identifying and confirming quality parameters of produce and specifications

6.1**. Quality parameters of produce**

Quality of fresh-cut fruit and vegetable products is a combination of attributes, properties, or characteristics that determine their value to the consumer. Quality parameters include appearance, texture, flavor, and nutritive value. The relative importance of each quality parameter depends upon the commodity or the product and whether it is eaten fresh (with or without flavor modifiers, such as dressings and dips) or cooked. Consumers judge quality of fresh-cut fruits and vegetables on the basis of appearance and freshness (“best if used by” date) at the time of purchase. However, subsequent purchases depend upon the consumer’s satisfaction in terms of textural and flavor (eating) quality of the product. Consumers are also interested in the nutritional quality and safety of fresh-cut products.

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.

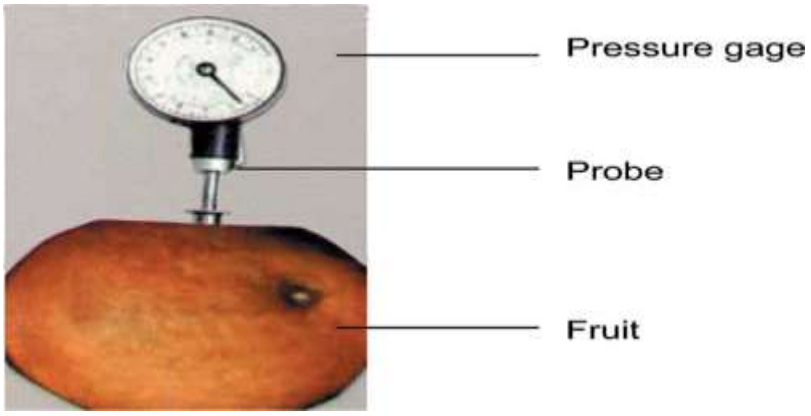

Figure 6.1. Pressure tester used to measure firmness of fruits and vegetables

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

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

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

6.2. Interpreting harvest specifications and schedules

Timing of harvest is complicated because there are often great differences in the rate of development and maturation of individual plants in the field or even between fruits on the same tree. The harvesting methods used are also important here, because if you use mechanical harvesting methods you usually harvest all the plants at the same time, by hand-harvesting you can distinguish and pick only those with the right maturity level.

The proper time of harvesting is ascertained from the type of crop (i.e. maturity, size, texture, color, sweetness, flavor etc), the weather condition when harvesting and the purpose of production. Different crops have different criteria for maturity and quality. Harvesting too early or delayed too late may cause some problems, harvesting too early result in low yields for tubers are not in full size, while harvesting too late may cause the tubers to become fibrous or woody, and increase the risk of tuber loss due to rotting and pests in vegetables. Harvesting under a good weather condition are necessary, because it is desirable from the standpoint of disease and keeping quality that the tubers go into storage in a clean and dry condition

Self-Check 6	Written Test

Name: _____Date: _____

Directions: Answer all the questions listed below.

1. What are the major Quality parameters of produce?(4 pts)
2. Why Interpreting harvest specifications and schedules?(4 pts)

Note: Satisfactory rating – 8 points and Unsatisfactory - below 8 points

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

Information Sheet-7	**. Selecting correct packaging materials and containers**

7.1. Packaging in horticulture

Packaging, refers to all those activities related to designing, evaluating and producing the container for a product.

Packaging technologies found in retail stores relevant to most horticulture include modified atmosphere packaging, active and intelligent packaging, edible coatings and tamper evidence devices.

Modified atmosphere packaging (MAP)

Classification of packaging:

Packages can be classified as follows:

- Flexible sacks; made of plastic jute, such as bags (small sacks) and nets (made of open mesh)
- Wooden crates
- Cartons (fiber board boxes)

- Plastic crates
- Pallet boxes and shipping containers
- Baskets made of woven strips of leaves, bamboo, plastic, etc.

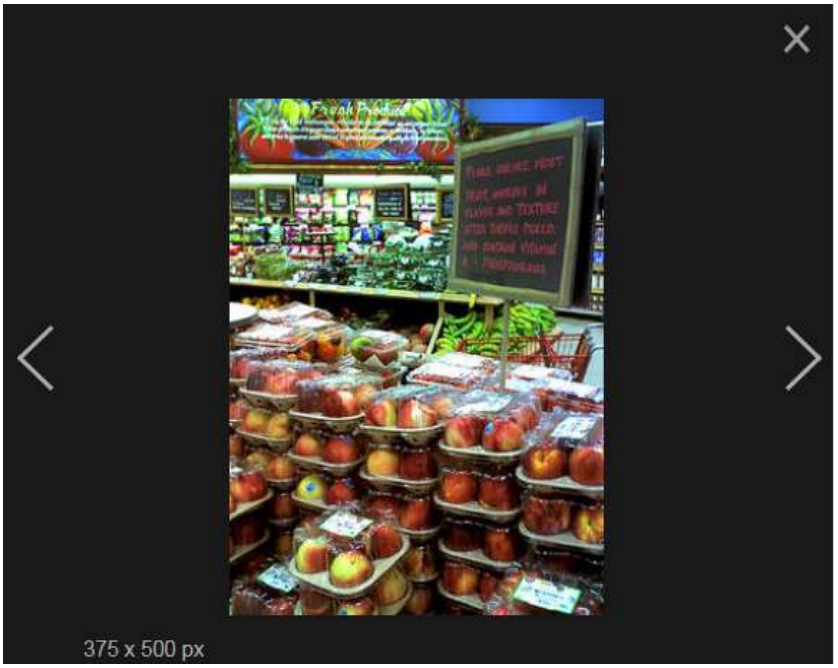

Fig. 6.2. Fruit packaging material

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

MAP for the packaging of fresh fruit and vegetables differs markedly from that designed for meat, fish, poultry and bakery goods in that produce is still "alive" and respiring. Has a large application in fresh and cooked chilled foods.

- Is a very effective preservation technique, especially for chilled perishable foods
- Extends shelf life from 25 – 400%
- Uses common gases of oxygen (O2), carbon dioxide (CO2) and nitrogen (N2). Other gases include carbon monoxide (CO), nitrous oxide (N2O), ozone (O3) and hydrogen (H2).

- Utilizes carbon monoxide for reducing the discoloration of fresh cut produces (highly toxic gas.).

Active and Intelligent packaging

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

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

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

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

Refresh (convex plastics)

Refresh modified atmosphere packaging is especially ideal for ready-made retail bags for minimally-processed produce such as mixed salads, peeled carrots and stir fry mixes. Custom designed to exactly match the handling conditions and respiration rate of the specific packaged produce, refresh films extend the life of fresh produce by manipulating the amount of O2 and CO2 contained within the packaging. Refresh Lidding offers anti-fog, high clarity, and the ability for the film's permeability to be custom-designed to match the respiration and extend the shelf-life of specific packaged fresh produce.

Edible films and coatings

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

Horticultural uses include:

- Inhibition of browning on whole lettuce, shredded lettuce, baby lettuce leaves and broccoli

- Inhibition of browning on fresh whole peeled and sliced potatoes
- Inhibition of processing related color changes
- Inhibition of dehydration of fresh orange segments
- Control of chilling injury and texture degradation

Self-Check 7	Written Test

Name: _____Date: _____

Directions: Answer all the questions listed below.

1. Define fruit packaging ?(5 pts)
2. What is Active and Intelligent packaging?(5 pts)

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

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

Information Sheet-8	Weighing, recording and repacking filled containers

8.1. Weighing equipment

Marely offers a range of electric weighing units / scales specifically designed for the food processing industry. Characterized by robust and compact design, Marely food scales are proven to perform extremely fast, accurately and reliably in the harsh conditions of wash down environments. They require minimal maintenance and are capable of enduring decades of daily use.

Both our bench scales and floor scales can be combined with a comprehensive range of Marel weighing indicators and HMIS, printers, software and accessories to suit individual processing needs. Marel scales are suitable as stand-alone installations or part of a complete production management system.

Fast, accurate and flexible weighing
Water-resistant to IP67 & IP69K standards
Hygienic and robust design and construction

8.2. Recording and packaging

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

Uses of record

Records assist a farmer to improve his business, b/c such records will enable him to establish whether or not the business being run profitably & whether or not his resource are being put to the best use. Records also help the farmer when he is preparing his budgets, which are estimates of his annual expenditure & income. From the past data available to him, he is in a position to predict probable income for the present & for the future years with some accuracy.

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

Fig.1 weighing fruits

A. **B.**

Fig. 2 weighing fruits

Self-Check 8	Written Test

Name: _____Date: _____

Directions: Answer all the questions listed below.

1. Define fruit weighing ?(5 pts)
2. What is recording ?(5 pts)

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

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

Information Sheet-9	Using correct filling techniques for specific containers and produce

Correct filling techniques for specific containers and produce are used to fill and arrange produce within containers according to client specifications and industry best practice.

Containers may be made of wood, Styrofoam, and plastic, but corrugated fiberboard is the most popular rigid container. Each material has advantages and disadvantages. Stacking strength, length of storage, storage treatment, precooling method and cost influence the choice of material. If the container has contact with water or ice, it should be made of water-resistant material. Nailed wooden boxes and wire bound wooden crates provide rigidity under moist conditions and have excellent stacking strength. Due to costs, though, they are being replace

Fig.1 Correct filling container

Pallet boxes are very efficient for transporting produce from the field to the packinghouse or for handling produce in the packinghouse. Pallet boxes have a standard floor size (1200 × 1000 mm) and depending on the commodity have standard heights. Advantages of the pallet box are that it reduces the labour and cost of loading, filling, and unloading; reduces space for storage; and increases speed of mechanical harvest. The major disadvantage is that the return volume of most pallet boxes is the same as the full load. Higher investment is also

required for the forklift truck, trailer, and handling systems to empty the boxes. They are not affordable to small producers because of high, initial capital investment.

Figure 2. Typical plastic crate holding fresh oranges.

Self-Check 9	Written Test

Name: _____Date: _____

Directions: Answer all the questions listed below.

1. List some of Containers used to fill fruits ?(5 pts)
2. What is recording ?(5 pts)

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

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

Information Sheet-10	Applying container Label where required, wraps and lids

10.1. Labeling:

Package labelling or labeling is any written, electronic, or graphic communications on the packaging or on a separate but associated label

Container number, packing date, produce details such as grade, number, origin, variety, weight, producer details, quality assurance and handling instructions.

Objectives of labeling

Physical protection – The objects enclosed in the package may require protection from, among other things, mechanical shock, vibration, electrostatic discharge, compression, temperature etc.

Barrier protection – A barrier from oxygen, water vapor, dust, etc., is often required. Permeation is a critical factor in design. Some packages contain desiccants or Oxygen absorbers to help extend shelf life. Modified atmospheres [7] or controlled atmospheres are also maintained in some food packages. Keeping the contents clean, fresh, sterile[8] and safe for the intended shelf life is a primary function.

Containment or agglomeration – Small objects are typically grouped together in one package for reasons of efficiency. For example, a single box of 1000 pencils requires less physical handling than 1000 single pencils. Liquids, powders, and granular materials need containment.

Information transmission – Packages and labels communicate how to use, transport, recycle, or dispose of the package or product. With pharmaceuticals, food, medical, and chemical products, some types of information are required by governments. Some packages and labels also are used for track and trace purposes.

Labeling Produce containers should be labeled at each end and on the top with the following information:

1. Commodity (potatoes, apples, etc.)
2. Size, count and/or net weight (50 count, 32 pounds, etc.)
3. Grade (U.S. Fancy, U.S. #1, etc.)
4. Packer/grower/shipper (name and address)

5. Packing date (1-23-91, etc.)

6. Quality assurance or control code (harvest date information, bin number, packing time, packer number, inspector number, gassing room number for tomatoes or honeydew melons, etc.) It is most important to label the end of the container; this part of the box will be most visible when containers are stacked. The first four items let the buyer know who, what and how much. The last two items help with quality assurance or control of the produce. If there are problems, a quality assurance code system will help find the source of the problem.

Self-Check 10	Written Test

Name: _____Date: _____

Directions: Answer all the questions listed below.

1. Define Labeling ?(5 pts)
2. Write Objectives of labeling ?(5 pts)
3. Write Labeling information on containers? (5 points)

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

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

Operation sheet 1	Grading and labeling harvested produce

Objectives to applying grading and labeling harvested produce

Procedure

Step 1-identify type of fruit used for grading

Step 2-Select the product based on size

Step 3-select necessary materials

Step 4- identify ripen and non-ripen fruits

Step 5 –put separately

Step 6-lable the products.

LAP Test 1	Practical Demonstration

Name: _____ Date:_____

Time started: _____ Time finished: _____

Instruction:

1) Apply fruit grading activities
2) Sorting fruits
3) Labeling containers

Operation sheet 2	Applying post-harvest treatments

Objectives to applying post-harvest treatments

Procedure

Step1-identify type of fruit used to treat

Step2-Select necessary chemicals used to apply

Step3-select necessary materials

Step 4- use PPE

Step5 -apply treatments

Step6-Handle products with care to avoid mechanical injuries.

Step6-Keep good sanitation procedures.

LAP Test 2	Practical Demonstration

Name: _____ Date:_____

Time started: _____ Time finished: _____

Instruction:

1) Select necessary chemicals used to treat fruits
2) Perform chemical treatments to stored products
3) Store avoid mechanical injury with good sanitation

List of Reference Materials

- WILLS, R .B.H. Post-harvest and handling and storage of fruits and vegetables FAO/GCP/CPR/008/BEL, Beijing, China, 1988.
-
- 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
- HANDLING OF FRESH FRUITS, VEGETABLES AND ROOT CROPS TRAINING MANUAL

Horticultural Crops Production

Level II

Learning Guide –79

Unit of Competence: Carry out Postharvest Handling Operations

Module Title: Carrying out Postharvest Handling Operations

LG Code: AGR HCP2 M19LO3- 79

TTLM Code: AGR HCP2 TTLM 1219V1

LO4:- Store produce in a facility

Instruction sheet 1	Learning Guide 79

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

- Placing Containers
- Transporting and arranging pallets or racks
- Reading and reporting storage facility monitoring gauges
- Checking and removing condition of stored produce
- Cleaning storage facility and packing 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:

- Place Containers
- Transport and arrange pallets or racks
- Read and report storage facility monitoring gauges
- Check and remove condition of stored produce
- Clean storage facility and packing containers

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-Sheet 5”.
4. Accomplish the “Self-check 1- Self-check 5” **in page -79, 81, 83, 87 and 90** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1,” **in page -91.**
6. Do the “LAP test” **in page – 91**(if you are ready).

Information Sheet-1	Placing Containers to ensure stability and optimum airflow.

1.1 Aeration System Management

The primary objectives of aeration are to keep the grain at a seasonally cool temperature and to maintain uniform grain temperatures - preferably no more than a 10o F difference in temperature from one part of the bin to another. These objectives can be achieved by keeping grain temperatures within 10 to 15o F of the average ambient air temperature. Thus, seasonal temperature changes require changes in aeration fan operation.

There are a number of fan operation schedules that can be used to maintain the quality of stored grain. Following the management procedure outlined below will help assure that basic aeration requirements are met. Adapt it as necessary to meet individual needs and conditions.

Move at least one (preferably two) cooling zone(s) through the grain to remove field or dryer heat and help equalize moisture contents.

Thereafter, move one cooling zone per month through the grain until it is cooled to between 35o and 40o F and to equalize grain mass temperatures.

Check the grain temperature and condition every two weeks and as needed to monitor cooling zone progress

Aeration is needed, even if grain is dry and cool when placed in storage, to keep the grain mass at the desired temperature and to keep temperatures equalized. Differences in grain temperatures create convection currents which can move and concentrate moisture in the top center of the bin. Problems caused by this moisture movement, or moisture migration, often become obvious in the spring when outside air temperatures begin to warm. The first indication of trouble is usually damp or tacky feeling kernels at the grain surface, followed by the formation of a crust. Moisture migration is more of a problem in a peaked storage because the moisture is concentrated in a smaller volume of grain.

1.2. Storage facilities:

Cool rooms of various sorts depending on type and suitability of produce being stored, storage sheds, cool room environmental conditions including humidity, light, and temperature.

Routine measures

Grain insects will hide in dark crevices, under grass and leaves surrounding storage areas, between steel sheeting joints in silos and sheds, around inlets and outlets, inside conveyors and headers or wherever grain is stored. Sheds and bulk stores usually have areas which retain significant amounts of grain and dust and require careful cleaning. Older silos too often have poor 'grain shedding joins and ledges.

Bags should also be kept clean of grain residues or else thrown out. Grain spilt during loading and unloading should be cleaned up and destroyed straight away.

Areas around storage structures and equipment should be kept clean and weed free, to assist in removing grain spills. It is essential to plan a cleaning program and to have specific cleaning equipment. Equipment, which need not be expensive, would include an air compressor and fittings, air guns, vacuum cleaner, firefighting pump and hose and brooms.

Routine measures include:

_ cleaning machinery

_ cleaning storages

_ Surface treatment

Grain aeration provides growers with a powerful tool to maintain grain quality during harvest and storage. Aeration cooling may not eliminate the need for chemical insect control, but it will dramatically slow insect development.

Key Points

- Grain temperatures below 20°C significantly reduce mould and insect development.
- Reducing grain temperature with aeration cooling protects seed viability.
- Controlling aeration cooling is a three-stage process — continual, rapid and then maintenance.
- Stop aeration if ambient, relative humidity exceeds 85 per cent.

- Automatic grain aeration controllers that select optimum fan run times provide the most reliable results.

Fig .1.1 Aeration cooling for pest control

Fig 1.2 Typical bag stack with covers drawn back to allow airing

Self-Check 1	Written Test

Name: _____Date: _____

Directions: Answer all the questions listed below.

1. What is the primary objectives of aeration ?(5 pts)
2. What are the Key Points of grain storage ?(5 pts)

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

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

Information Sheet-2	**Transporting and arranging pallets or racks**

Pallets are a portable platform device used for storing or removing goods that are stacked on it.

Rack Storage:

Transportation is not just about moving an object from point A to point B, it's a process of value delivery: sending things all over the country, carrying customers to upper floors or building a warehouse for cargos, all of which require products in transportation, factories and it's easy to find suitable products whether for construction fields, daily use, or entertainment. Looking for cheap Rack Storage products, warehouse rack manufacturers and Rack Storage factory directory.

Wire mesh pallet cage for transportation, used in warehouses and workshops for goods containing and carrying, is highly recommended for use in manufacturing industries. Semi-

open construction for easy storage and drawing. With the features of universal size, reliability, space saving and security.

1. The storage cage is made of high quality iron material and formed by cold harder welding.
2. Folded structure makes loading .Revolving and storing much convenient. It's easy to manage. Meanwhile, it could save space when not using with it folded structure.
3. The surface treatment is zine-plated, so it is beautiful and durable and there is no pollution in every process.
4. It is proper for moving work of workman, crane, trolley, pallet truck. The goods can be easily accessed because the gate can open.
5. It is in accordance with international standards, and can be used with containers. It is also the replacement of wooden cases.
6. The cage can be used in workshops and supermarkets for sales promotion and storage.

Wire mesh pallet cage for transportation Wire mesh pallet cage for transportation

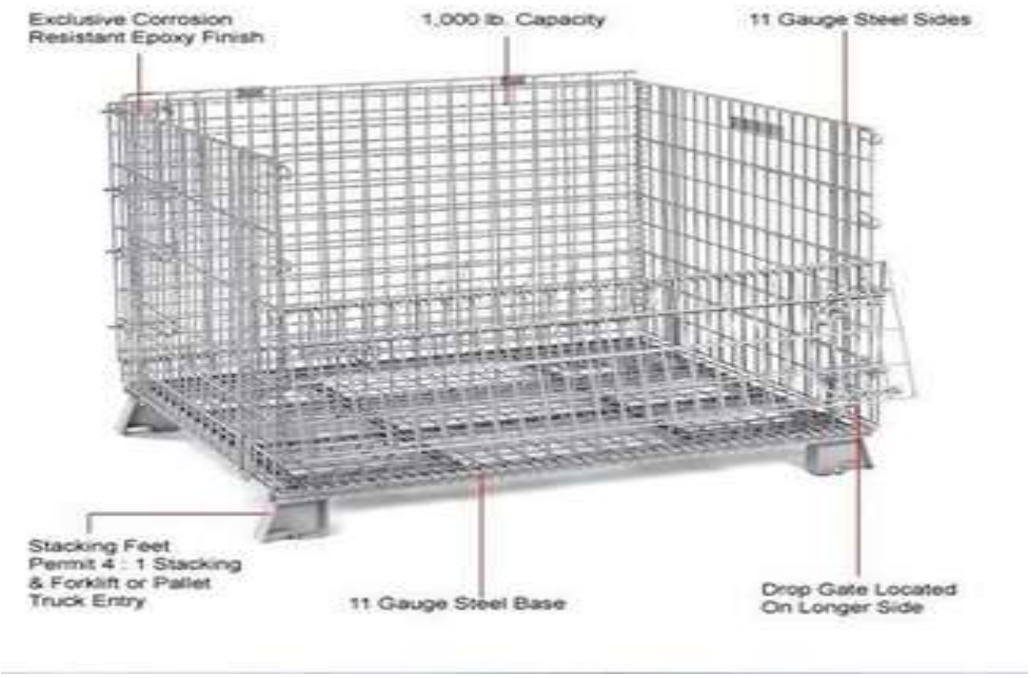

Fig.2. 1 **Wire mesh pallet cage**

Fig.2.2 pallets used to transport grains

Self-Check 2	Written Test

Name: _____Date: _____

Directions: Answer all the questions listed below.

1. Define the term Pallets ?(5 pts)
2. What is Transportation ?(5 pts)

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

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

Information Sheet-3	Reading and reporting storage facility monitoring gauges

3.1. Monitor grain Gauge Bin Level

Grain Gauge level monitor is a proven and cost effective method to accurately monitor the levels of material in your bin. A perfect complement to your grain moisture tester equipment.

You can install multiple Grain Gauge devices along the bin wall at key levels. Simply let the gauge do the work for you. No more climbing and risking your safety. Simple, dependable grain bin level monitoring!

Standard Features & Benefits:

- Easy installation
- Clear visibility: glows-in-the-dark
- No electricity required
- Maintenance free
- Cost effective

How It Works:

Once the material reaches the desired level of the installed Grain Gauge on your bin, the roller portion of the gauge will turn from black to a bright green. The bright green will also glow in the dark at night time. As the material is emptied from your bin and recedes below the Grain Gauge, the roller will automatically change to black.

Simple Installation:

The Grain Gauge is installed from the outside of the bin. No bin entry. Simply drill a 1¼ inch hole and insert two screws. It's that simple.

Accurate Temperature & Humidity Indoor Monitor

- Measures humidity and temperature
- Magnetic backing for convenient placement

- Displays in Celsius or Fahrenheit
- Records levels to display highs and lows
- Easy-to-read display

Ensuring proper indoor humidity has important skin, allergen and other health benefits by inhibiting the growth of mold, bacteria, viruses, fungi, mites and other asthma inducing agents. The Accurate Digital Temperature & Humidity Monitor allows you to check comfort conditions at a glance with this indoor humidity gauge and thermometer combination.

Fig. 1 Accurate Temperature & Humidity Indoor Monitor gauge

Self-Check 3	Written Test

Name: _____Date: _____

Directions: Answer all the questions listed below.

1. What is standard features & benefits ?(5 pts)
2. What is Grain Gauge ?(5 pts)

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

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

Information Sheet-4	Checking and removing condition of stored produce

4.1. **Initial Grain Condition**

Grain quality will not improve during storage. At best, initial quality can only be maintained. To help assure that only high quality grain goes into storage, the following is recommended:
Clean around the bin site. Remove any old grain, grass, weeds, and other debris.

Remove all traces of old grain from the bin and harvesting and handling equipment.
Properly adjust the combine to minimize grain damage.
Clean the grain as it is put into the bin, preferably using a rotating grain cleaner.
Cool the grain to the prevailing outside air temperature as soon as it is put into the bin.

4.2 Insect and Mold Control

Insects are generally not a problem in grain stored for less than 10 months or a year. However, if grain is to be stored for longer than this, or if a bin has had an insect problem in the past, special precautions should be taken. These include:
Spray the inside of the bin with protective insecticides 2 to 3 weeks before new grain is added.
Treat the grain with an approved insecticide as the bin is filled.
Top-dress the grain with an approved insecticide after the bin has been filled and the grain surface has been leveled.
Left untreated, an insect infestation will eventually lead to other storage problems. Insects give off moisture which can cause grain moisture contents to increase enough to create a mold problem. Mold activity will in turn raise temperatures and result in an increased rate of insect reproduction. Greater numbers of insects create more moisture, and the cycle is repeated at an ever increasing rate.
The initial cooling is important, so do not skimp on fan operation. Turn the fans on as soon as grain covers the perforated floor or aeration ducts, and operate continuously until the grain has been cooled to the prevailing outside temperature. Since cooling is the primary concern, especially if the grain has come from a dryer, do not turn the fans off during rainy or humid

weather. Failing to properly cool the grain can cause more problems than the small amount of rewetting that occurs from running the fan on a humid day.

4.3 Monitoring Grain Condition

Following the above aeration schedule will help maintain grain quality. However, grain condition needs to be monitored to verify that the desired temperature control is being achieved. Further, a regular checking schedule is essential if mold and insect activity are to be detected and controlled in a timely fashion. The method and frequency of checking will vary with time of year, initial condition of the grain, and aeration procedure. Generally grain should be inspected at least once a month during the winter and every two weeks over the spring, summer, and fall.

Grain checking is extremely important during the summer because grain is being held at higher temperatures and aeration conditions are less favorable than during the rest of the year. Grain temperatures need to be checked and recorded on a regular basis. Without temperature records, it is difficult to tell whether elevated grain temperatures are caused by normally occurring outside temperatures or by heating due to mold activity. The grain needs to be probed to locate any moisture pockets where molds will develop rapidly as temperatures warm. Insect activity is also at a peak during the summer, and frequent checking is required if infestations are to be controlled before they develop into major problems.

Failure to monitor grain condition throughout the entire storage period is a frequent mistake. A small area which starts to heat or otherwise "go out of condition" can quickly get out of control and spread within the bin. Think of the grain as being cash in the bin, and consider how frequently it would get checked if that were the case.

Some areas and conditions to check when monitoring grain quality include:

Grain surface for condensation, crusting, wet areas, molds, and insects.

Bin roof for condensation and leaks.

Grain mass for non-uniform temperatures, high moisture pockets or layers, molds, and insects.

4.4 Exhaust air for any off-odors.

If problems are detected, they need to be evaluated and corrected as soon as possible. This may include cooling with aeration, further drying, or fumigation for insect control.
Once the last grain has been augured into the bin and the hatches closed, there is often a tendency to forget about what is needed to maintain the grain at a high level of quality. However, without proper management, that grain can rapidly deteriorate, becoming a worthless mass.

Grain spoilage is usually the cumulative result of several different handling and management operations and decisions. Thus, the better the overall management program, the better the chance for maintaining grain quality. Four factors which greatly affect grain storability are (1) grain moisture content; (2) grain temperature; (3) initial condition of the grain; and (4) insects and molds. These factors are all interrelated.

Moisture Content

If grain moisture content is too high, even the best aeration equipment and monitoring management will not keep the grain from spoiling - it only delays the inevitable. Recommended moisture contents are given in Table 1. These recommendations assume the grain is high quality and aerated to control temperatures and moisture migration. Reduce the recommended moisture contents by 1 percentage point when storing low quality grain. This includes immature grain, severely cracked and damaged grain, and grain subject to previous insect or mold activity. Also reduce the recommended moisture contents by at least 1 percentage point for grain in temporary or emergency storage.
Moisture also moves by vapor diffusion from warmer to cooler areas in the bin. If grain is not properly cooled for winter storage, there is a tendency for moisture to move to the cool grain along the bin sidewall, causing spoilage. Moisture movement problems can be prevented or minimized by keeping grain mass temperatures equalized and within 10 to 15o F of the average outside air temperature.

Grain Temperature

Whether holding wet grain for a short period of time or storing dry grain for longer periods, it is important that grain temperatures be controlled by moving air through the grain mass. Because both wet grain and molds respire and give off heat, aeration is needed to keep the grain cool and to slow mold growth. Properly aerated grain can generally be safely held about four times longer than non-aerated grain.

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It is critical to carefully manage stored grain to prevent grain deterioration and possible serious economic loss. This management should include:

A well-designed and properly-operated storage system with adequate aeration capacity.

Storing only clean grain at the proper moisture content and temperature.

Checking the grain condition regularly and correcting problems before they get out of hand.

Self-Check 4	Written Test

Name: _____ Date: _____

Directions: Answer the following questions carefully.

1. What are conditions to be considered for storage? 5pts
2. How to monitor storage facilities? 5pts
3. Explain the effect of temperature for storing? 5 points

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

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

Information Sheet-5	Cleaning storage facility and packing containers

5.1**. Cleaning**

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

Washing and sanitation

Sanitation is of great concern to produce handlers, not only to protect produce against postharvest diseases, but also to protect consumers from food borne illnesses. E. coli 0157:H7, Salmonella, Chryptosporidium, Hepatitis, and Cyclospera are among the disease-causing organisms that have been transferred via fresh fruits and vegetables. Use of a disinfectant in wash water can help to prevent both postharvest diseases and food borne illnesses.

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

Storage crops

What about the crops that will not be transported and marketed fresh after harvest? Growers can extend their selling season into the winter months by growing root crops and other vegetables and fruits suited for long-term storage. The challenge is in keeping quality high by creating and maintaining the correct storage environment. As Growing for Market editor Lynn Byczynski notes,

Most storage crops require low temperatures and high humidity, two factors that don't come together easily. Several others require low humidity and low temperatures. And then there

are a few that fall in between. Root crops such as beets, carrots, turnips, rutabagas, and leeks store best at 32º F and 90 percent humidity. Potatoes prefer temperatures of 40-60º F and 90 percent humidity. Onions and garlic like it cool—32º—but require less humidity—about 65-75 percent. Winter squash prefer temperatures of 50-60º F, but dry. That's four different types of storage for vegetables that will hold a month or more: cold and humid; cold and dry; cool and humid; cool and dry. (10)

The two structural options for storage of these crops are coolers and root cellars. By providing an example of a farm using both: "The Sealy's have a bank barn, which has the bottom floor built into a hillside…They have built both coolers and a dry storage room into the lower floor to provide different combinations of temperature and humidity for the vegetables they store." Coolers used for root crop storage will require water added to the air and regular monitoring of the humidity level (see discussion under preventing moisture loss above.) Some growers have used concrete basements of houses, closed off from heat and with ventilation to let in cold winter air, as root cellars. Another idea is to bury a big piece of culvert under a hillside. (10)

Whatever the method, only "perfect" produce is suitable for long-term storage, so careful inspection is critical. Any damaged produce is going to spoil and induce spoilage in the rest of the crop. Byczynski advises growers to "either rub off soil and leave the crops somewhat dirty, or wash them and let them dry thoroughly before putting them in storage. With onions, garlic, winter squash, pumpkins and sweet potatoes, it's important that they be cured thoroughly before storage" (10).

Fig 1. Different cleaning tools

Fig.2 Clean and maintain the storage structure:

Self-Check 5	Written Test

Name: _____ Date: _____

Directions: Answer the following questions carefully.

1. What is cleaning ? 5pts
2. What is the importance of sanitation? 5pts

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

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

Operation sheet	**perform Cleaning of storage facility**

Objectives to perform Cleaning of storage facility

Procedure

Step 1-wear PPE

Step 2-identify materials for cleaning

Step3-identify storages for cleaning

Step4-identify cleaning agents if necessary

Step5-apply cleaning activity

Step 6-Keep good sanitation procedures

LAP Test 1	Practical Demonstration

Name: _____ Date:_____

Time started: _____ Time finished: _____

Instruction:

1. Perform Cleaning of storage facility
2. Store products separately
3. Avoid mechanical injury with good sanitation

List of Reference Materials

- WILLS, R .B.H. Post-harvest and handling and storage of fruits and vegetables FAO/GCP/CPR/008/BEL, Beijing, China, 1988.
-
- 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
- HANDLING OF FRESH FRUITS, VEGETABLES AND ROOT CROPS TRAINING MANUAL-

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

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