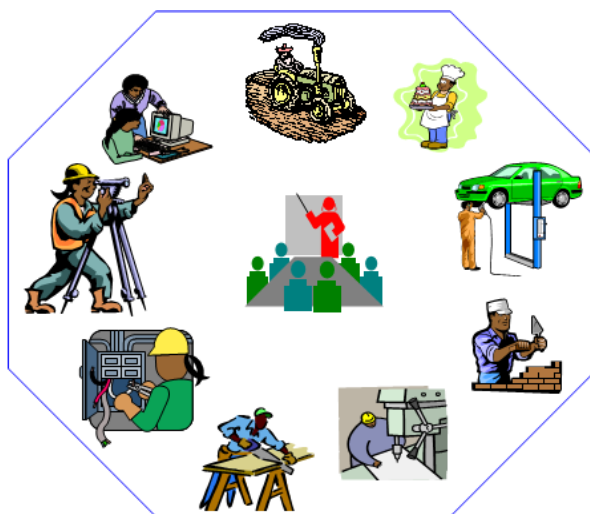# Fruit and Vegtable Processing

Level-III

Based on May 2019, Version 2 OS and March. 2021, V1 Curriculum

Module Title: Performing Fresh Produce Grading Equipment

LG Code: IND FVP3 M05 LO (1-2) LG (13-14)

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March, 2021

Bishoftu, Ethiopia

Table of content

Contents

LG #13	LO #1-Confirm produce grading specifications

Instruction sheet

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

- Describing features of the grading equipment and process
- Examining characteristics of produce and confirming grading purpose
- Confirming customer and packaging requirements
- Determining grading specifications

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

- Describe features of the grading equipment and process
- Examinine characteristics of produce and confirming grading purpose
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1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
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6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,
8. If your performance is satisfactory proceed to the next learning guide,

9. If your performance is unsatisfactory, ask your trainer for further instructions or go back to "Operation sheets".

Information Sheet 1- Describing features of the grading equipment and process

1.1 Features of the grading equipment and process for fruit and vegetable

Grading is the assessment of a number of attributes to obtain an indication of overall quality of a fruits and vegetables. This term is often used interchangeably with sorting but strictly means 'the assessment of overall quality of a fruits and vegetables using a number of attributes'. Sorting (that is separation on the basis of one characteristic) may therefore be used as part of a grading operation but not vice versa.
Grading: Selected fruit and vegetable are graded according to size and colour to obtain uniform quality. This is done by hand or machines such as screw grader and roller grader. Grading is carried out by operators who are trained to simultaneously assess a number of variables. Apples are graded with the assistance of coloured cards that show the required characteristics of different grades in terms of colour distribution across the fruit, surface blemishes and size and shape of the fruit.

In some cases the grade of fruits and vegetables is determined from the results of laboratory analyses. In general, grading is more expensive than sorting owing to the higher costs of skilled operators. However, many attributes that cannot be examined automatically can be simultaneously assessed, and this produces a more uniform high-quality product.

Grading is completed by means of accurate equipment for each product of the product category. Most of the mechanical graders depend on the size of the materials, but some devices use differences in the shape, density and surface properties of the products to be sorted.

Grading machinery: Mechanical fruit graders are categorized by their working principles as weight grader, fruit color grader and fruit color, size grader and weight grader which categorizes fruit by their color and size. Grading will be completed manually or by

automatic grading lines. Sizing grading is subjective (visually) with the usage of standard size gauges. Round product elements can be simply graded with sizing rings. Grading basically divides the material into different homogeneous groups according to its exact features based on shape, size, color and quality. This saves the time and energy on different processing performances. Grading has altered very slightly in the period of last fifty years. Although, the grading procedure is purely mechanical. A basic mechanical grader consists of a chain conveyor belt and a bag at the end. Smaller products fell through the chain, simplifying the grading method. Four types of grading machines for fruits are:

a) Roller Grader
b) Screens Grader
c) Weight Grader
d) Diving Belt Grader

1.1.1 Screens Machines Grader

There is variety of fruits which are graded with the help of vibrating screens made up of plastic, stainless steel and copper, which do not respond chemically with the products. The material to be graded is passed over to the rotary screen or vibrating screen. At the end of the screen, the smallest material passes from the beginning to the middle and finally the largest. In this way, it makes dissimilar classes of fruits such as orange, apple, kinnow, and vegetables like tomato and potato.

Figure 1: Orange screens machines grader

1.1.2 Roller Grader

This type of graders is fast, precise and reasons little damage to fruit. These are widely used in the fruit industry. Each roller rotates in a counter clockwise direction. The fruit is continuously rotated so that each piece has a chance to record its lowest dimension with the space in the grader. Roller conveyers with fixed space among the rolls are used for eliminating small fruit, twigs and leaves.

Figure 2: Carrot roller grader

1.1.3 Diverging Belt Grader

It is extensively used grader, which contains of two belts. These belts diverge as they move. The fruit is passed on and between the belts. Subsequently the distance between two belts rises regularly and systematically, the smaller parts will drop among the belts at the beginning of travel while the larger parts will be carried more and will be dropped later.

Figure 3: Orange diverging belt grader

1.1.4 Weight grader

The grading is completed based on the weight of product. This technique is precise, fast and there is least damage to fruits. This is also used for large size products like oranges, apples, potato kinnow, mango, eggs, tomato etc. These are especially adapted for sorting material, which cannot be handled by other procedures, due to their shape or texture. The material to be graded is positioned in individual cups by automatic feed, which is then passed through the sorter, where it is indexed with the help of spring-loaded trips. The spring tension is gradually weakened from the start to the end of the movement. Initially a large portion is the discharge whereas the lighter fraction is the next and the lighter at the end. This kind of grading does not depend on their size and shape of the material.

Figure 4: Mango apple weight grader
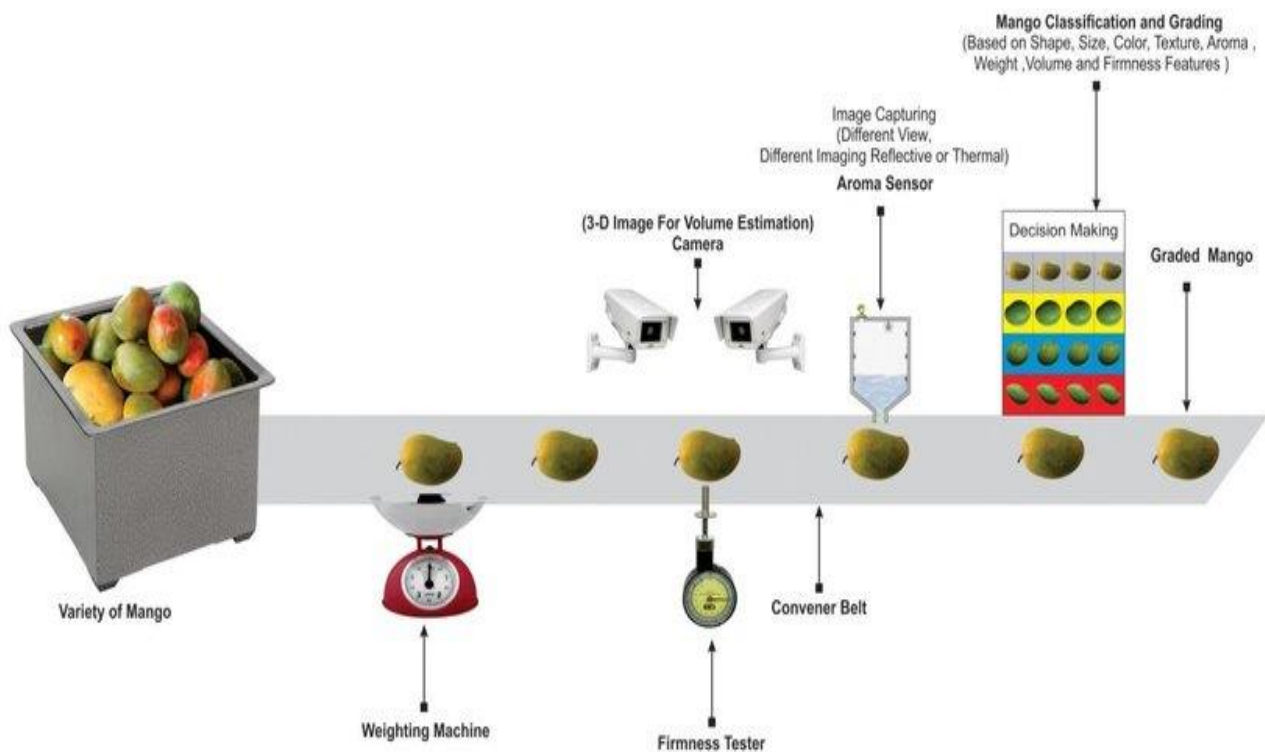
Figure 5: Fruit sorting and grading system

Self-check 1	Written test

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

Test I: Choose the best answer among the given alternative

1. Which of the following type of graders is fast, precise and reasons little damage to fruit. (2 pts)
   a. Product grader
   b. Roller grader
   c. Belt grader
   d. All

Test II: Write short answer for the following questions

1. List and describe the types of grading machines for fruits and vegetables ? (4pts)

Note: Satisfactory rating above ≥3 points   Unsatisfactory - below 3 points

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

Score = _____

Rating: _____

Objective: To prevent contaminants and defects of mango fruit

Materials:

- Scissor
- Clean water
- Washer machine
- Grader machine
- Mango fruit

Procedure:

Sorting and grading procedure of Mango

1. Desappe of mango fruit
2. Cleaning /washing of mango fruit
3. Apply vapour heat treatment of mangoes at 46 ^{o}C for 10 min
4. Sort and grading mango fruit manual/ mechanically
5. Set the grade according to the minimum requirements of mango
6. Package and label mango fruit

LAP TEST	Performance Test

Name…………………………   ID…………………Date………………

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **6** hour. The project is expected from each student to do it.

Task 1: Perform grading of Mango

Information Sheet 2- Examining characteristics of produce and confirming grading purpose

2.1 Examine characteristics of produce (fruit and vegetable)

Fruit maturity degree is significant as industrial maturity is required for some processing / preservation methods while for others there is the need for an edible maturity when the fruit has full taste and flavour. Special attention is given to size, appearance and uniformity of fruit to be processed. Temporary storage before processing has to be as short as possible in order to avoid : flavour Losses, texture modification, weight losses and other deterioration that can take place over this period. Fresh Fruits and Vegetables at reception mostly checks the following character :

- Colour
- Texture
- Taste
- Flavour
- Appearance
- Refractometric extract

- Variety
- Sanitary evaluation
- Density
- Total sugars
- Total acidity

Once it has left the tree, the organoleptic properties, nutritional value, safety and aesthetic appeal of the fruit deteriorates in varying degrees. The major causes of deterioration include the following:

- Growth and activity of micro-organisms
- Activities of the natural food enzymes
- Insects, parasites and rodents
- Temperature, both heat and cold
- Moisture and dryness
- Air and in particular oxygen
- Light and time

Vegetables varieties: Vegetable processors must appreciate the substantial differences that varieties of a given vegetable will possess. In addition to variety and genetic strain differences with respect to weather, Insect and disease resistance, varieties of a given vegetable will differ in size, shape, time of maturity, and resistance to physical damage.

When vegetables are maturing in the field they are changing from day to day. There is a time when the vegetable will be at peak quality from the stand-point of color, texture and flavour. This peak quality is quick in passing and may last only a day. Harvesting and processing of several vegetables, including tomatoes, corn and peas are rigidly scheduled to capture this peak quality. After the vegetable is harvested it may quickly pass beyond the peak quality condition. This is independent of microbiological spoilage; these main deteriorations are related to:

a. Loss of sugars due to their consumption during respiration
b. Production of heat when large stockpiles of vegetables are transported or held prior to processing.
✓ At room temperature some vegetables will liberate heat at a rate of 127,000 kJ/ton/day; this is enough for each ton of vegetables to melt 363 kg of ice per day.
c. Since the heat further deteriorates the vegetables and speeds micro-organisms growth, the harvested vegetables must be cooled if not processed immediately.

But cooling only slows down the rate of deterioration, it does not prevent it, and vegetables differ in their resistance to cold storage. Each vegetable has its optimum cold storage temperature which may be between about 0-10^{0}C. The continual loss of water by harvested vegetables due to transpiration, respiration and physical drying of cut surfaces results in:

- Wilting of leafy vegetables
- Loss of plumpness of fleshy vegetables
- Loss of weight

In many processing plants it is common practice to process vegetables immediately as they are received from the field. To ensure a steady supply of top quality produce during the harvesting period the large food processors will employ trained field men; advise on growing practices and on spacing of plantings so that vegetables will mature and can be

harvested in rhythm with the processing plant capabilities. This minimizes stockpiling and need for storage. Varietal differences then further extend into warehouse storage stability, and suitability for such processing methods as canning, freezing, pickling or drying.

General Quality attributes of fruits and vegetables are:

a) Appearance

- Very important for consumer purchasing behaviour
- Basis for most quality systems
- Size
- Color
  - ✓ Very important quality attribute
  - ✓ May change after harvest (climacteric fruit)

b) Texture

- Most important quality attribute of products such as apple

c) Flavour

- Flavour is aroma + taste (+ texture)
  - ✓ Taste
    - ➢ Dissolved chemicals interacting with receptors in taste buds on tongue Sweet, acid, bitter, salty, umami
  - ✓ Aroma
    - ➢ Volatiles released by fruit / vegetable and perceived by olfactory epithelium on tongue
    - ➢ Some volatiles synthesised during mastication

d) Ripeness

- Important for picking date
- Difference between climacteric and non-climacteric fruit
  - ✓ Climacteric fruit: ripen after harvest so pick mature but unripe (at or just after climacteric minimum)
  - ✓ Non-climacteric fruit: do not ripen after postharvest so pick ripe „
- All fruit properties which change ripening can be used, e.g., starch, color, firmness, respiration rate, ethylene production

e) Freshness

- The quality of being in a new, natural condition and not old or preserved by processes
- Leafy vegetables: fluorescence measurements
  - ✓ Energy captured by reaction centre
    - o Transport of electrons (photosynthesis)
    - o Heat dissipation
    - o Emission as photon at lower wavelength (fluorescence) If fluorescence is high then photosynthesis is low

f) Safety

- **Phytofarmaceuticals**
  - ✓ Sampling plans required for most quality standards such as Global GAP „

- **Microbiology**
  - ✓ Human pathognes
    - o Usually not important for fresh fruit and vegetables
    - o Important for cut vegetables; chlorination to desinfect washing water
  - ✓ Spoilage: Phytopathogens (Botrytis cinerea, Monilinia , Penicillium,…); opportunistic spoilers: most imporant source of postharvest losses

- **Fungicides** often used before harvest : (almost) no postharvest treatments allowed in Belgium „

- **Mycotoxins** - Patulin (apple juice), ochratoxin A
  - ✓ Very toxic substances produced by fungi
  - ✓ Detection: HPLC

- **Foreign materials**
  - ✓ Stones, weeds
  - ✓ Detection: X-ray (food process industry)

g) Nutritional and health components

- Recently increased interest
- E.g., tomatoes with enhanced lycopene content
- Vitamins, ORAC value (Oxygen Radical Absorbance Capacity)
- Mainly marketing instrument

2.1 Confirming grading purpose of fruit and vegetable

Grading is basically separating the fruit and vegetable in different homogenous groups according to its specific characteristics like size, shape, color and on quality basis. It saves time and energy in different processing operations and separates immature, over-mature, scarred and damaged fruits.

Purpose:

- Reduction of variability
- Have all fruit fit the holes of the liners
- Provide customers with desired sizes
- It saves time and energy in different processing

Grading attributes

- Size (weight, image processing)
- Shape
- Absence of defects
- Firmness
- sugar content
- Internal disorders

Self-check 2	Written test

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

Test I: Choose the best answer among the given alternative

1. Which character fresh fruits and vegetables checks at reception ? (2pts)
   a. Colour
   b. Texture
   c. Taste
   d. All

Test II: Write short answer for the following question

2. Define the following quality attributes ? (4 pts)

   a. Appreance

   b. Flavour

Note: **Satisfactory rating above-≥3 points**   **Unsatisfactory - below 3 points**

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

Score = _____

Rating: _____

Information Sheet 3- Confirming customer and packaging requirements

## 3.1 Confirming customer requirements

In general sense, quality is defined as degree of excellence .

Quality is:

- Fitness for use
- Conforemance to requairement
- Performance to the standard, expect by the consumer
- Meeting the customer need, the first time and every next time
- Quality is meeting or exceeding customers expection

Minimum quality specifications for fresh fruit and vegetables in all classes, subject to the tolerances allowed, the produce must be:

I. Intact; however, the following is allowed, provided the edibility and keeping quality is not affected:

   ✓ Hollowness provided the surrounding tissue is sound,fresh and not discoloured,

   ✓ Slight damages and cracks

   ✓ Missing peduncle/calyx provided the adjacent tissue is notdamaged

II. Sound; produce affected by rotting or deterioration such as to make it unfit for consumption is excluded

   - Clean, practically free of any visible foreign matter
   - Practically free from pests
   - Practically free from damage caused bypests
   - Free of abnormal external moisture
   - Free of any foreign smell and/or taste
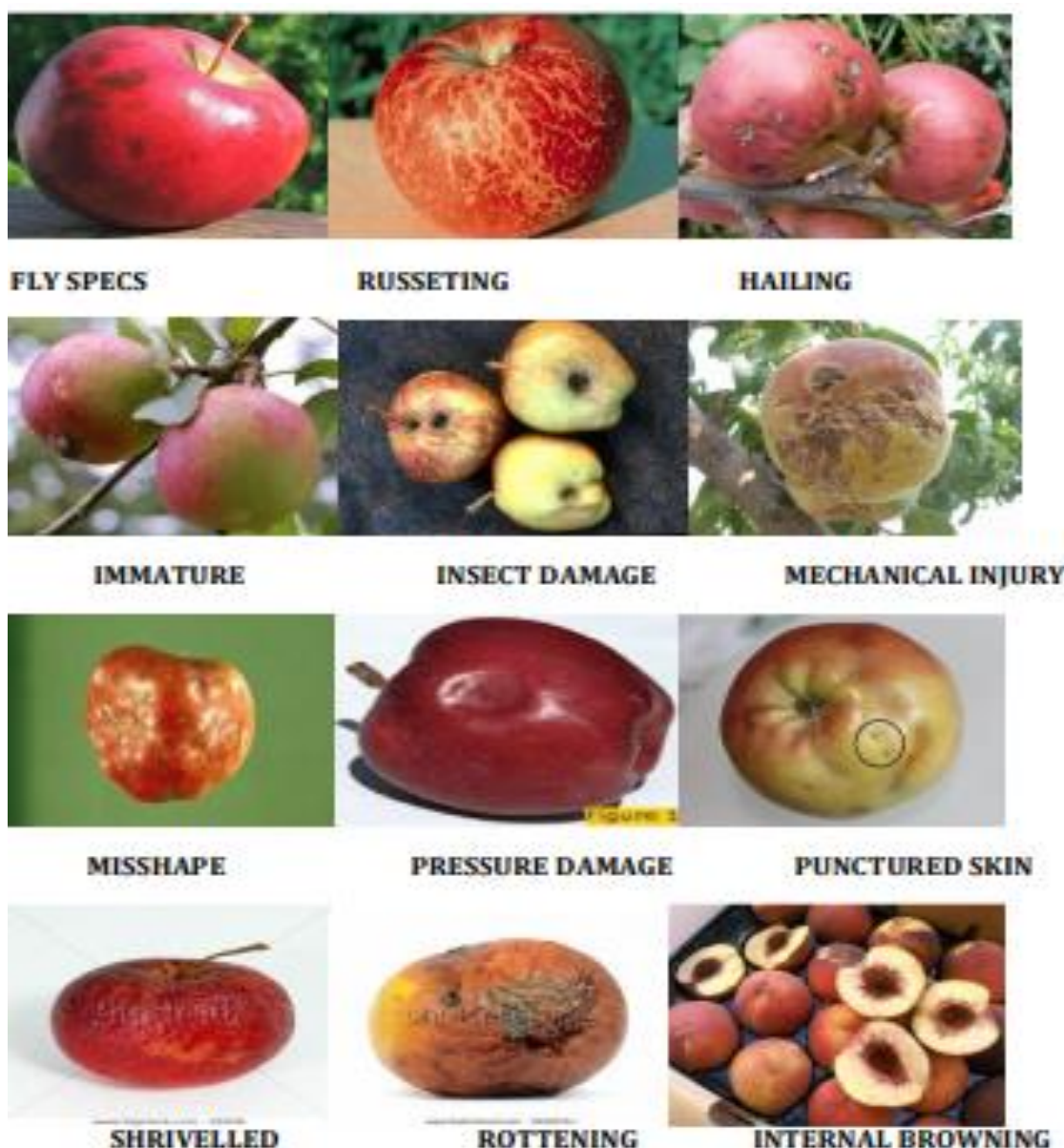
Figure 6: Apple fruit defect

3.2 Confirming packaging requirements

Packaging fresh fruits and vegetables is one of the more important steps in the long and complicated journey from grower to consumer. Bags, crates, hampers, baskets, cartons, bulk bins, and palletized containers are convenient containers for handling, transporting, and marketing fresh produce.

Page 19 of 48	Federal TVET Agency Author/Copyright	TVET program title- Fruit and Vegetable Processing -Level-II	Version -1
			October 2020

Packaging is constantly changing with the introduction of new materials, technology and processes. These may be due to the need for improved product quality, productivity, logistics service, environmental performance and profitability. A change in packaging materials, however, may have implications for consumer acceptance. The aim is a fitness for purpose approach to packaging design and development that involves selection of the most appropriate materials, machinery and production processes for safe, environmentally sound and cost effective performance of the packaging system. Packaging should be designed to prevent physical damage to produce, and be easy to handle. A properly designed produce container should contain, protect, and identify the produce, satisfying everyone from grower to consumer.

The most important points packaging requirements are:

- Recyclability/biodegradability - most produce packaging are going to be recyclable or biodegradable, or both.
- Variety- different sizes and designs of produce packages
- Sales appeal - spice up sales appeal
- Shelf life- every commodity to increase time period and reduce waste
- Containment-the container must enclose the produce in convenient units for handling and distribution.
- Protection- protect the produce from mechanical damage and poor environmental conditions during handling and distribution. to supply buyers, torn, dented, or collapsed produce packages usually indicate lack of care in handling the contents.
- Identification- identify and supply useful information about the produce

Modified atmospheric packaging for fruit and vegetable:-

- Closed package with selectively permeable film
- Film types
  - ✓ High permeability
  - ✓ Low permeability
  - ✓ Microperforated
- CO_2 increases, O_2 decreases
- Avoid fermentation

- ✓ Permeability not too low
- ✓ Temperature stability
- High relative humidity
  - ✓ Limited moisture loss
  - ✓ Condensation risk

Self-check 3	Written test

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

Test I: Choose the best answer among the given alternative

1. Volatiles released by fruit / vegetable and perceived by olfactory epithelium on tongue is_____? (2 pts)

   a. Colour   c. Aroma

   b. Ripness   d. All

Test II: Write short answer for the following question

1. Define the following terms ? (4pts)
   a. Safety
   b. Freshness

Note: **Satisfactory rating ≥3 points   Unsatisfactory - below 3 points**

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

Score = _____

Rating: _____

Information sheet 4– Determining grading specifications

4.1 Determining grading specifications

Grade standards provide the fruit and vegetable industry with a uniform language for describing the quality and condition of commodities. Current grade standards for fruits and vegetables use attributes based on sensory characteristics, shelf-life considerations, palatability, or a combination of these factors. During recent years "health consciousness" has increased among consumers. Furthermore, a growing number of studies has demonstrated health benefits from various nutrients contained in relatively large amounts in fruits and vegetables). Consequently, questions arise about the feasibility and desirability of incorporating nutrient attributes into current standards or replacing the current sensory-based standards with nutrientbased standards.

Tolerances are legal limits on unacceptable size, quality, and condition grading factors. Tolerances generally are stated in percentage terms and can vary by product, use, or size of the individually packaged product. For example, the tolerances for U.S. Number 1 apples for processing illustrate the variety of forms that tolerances can take:

- No more than 10 percent of apples with quality and condition defects including no more than 2 percent of apples with decay,
- Percent with internal breakdown and 5 percent with wormholes, and
- The apples cannot be further advanced in maturity than generally firm ripe

Grading factors listed in standards for fresh and processed fruits and vegetables can be broadly divided into four main categories:

1) Size
2) Quality
3) Condition
4) Tolerances

Size can be described by diameter, length, weight, and uniformity of sizing .

Quality factors, defined as "the combination of the inherent properties or attributes of a product which determines its relative degree of excellence generally refer to attributes that remain permanent once the commodity is harvested or processed.

✓ Examples include variety, cleanliness, and shape for fresh fruits and vegetables; and color, clarity, and flavor and aroma for processed fruits and vegetables.

Condition refers to: "the relative degree of soundness of a product which may affect its merchantability and includes those factors which are subject to change and may result from but not necessarily limited to age, improper handling, storage or lack of refrigeration.

Tolerances are legal limits on unacceptable size, quality, and condition grading factors. They generally are stated in percentage terms and can vary by product, use, or size of the individually packaged product.

Size, quality, and condition grading factors have three elements in common:

1) Measurable or observable,
2) There is a common body of knowledge which allows a widespread acceptance of how the factor will be applied in determining the grade, and
3) The factor varies among individual specimens of the commodity.

The existence of tolerances reflects this variability by allowing a sample to obtain a given grade even though all specimens in the sample do not meet minimum quality, condition, and size.

United States Standards for Grades of Cabbage

Cabbages of all grades must:

(a) be properly packaged;

(b) have similar varietal characteristics;

(c) be trimmed so that the butts are no longer than 13 mm (½ inch) and there are no more than six wrapper leaves per head

(d) have heads that are not withered or burst

(e) have heads that do not plainly show the formation of a seed stem; and

(f) be free from decay

No. 1 Grade Requirements:

In addition to meeting the requirements for all grades, cabbages graded No. 1 must

(a) have, in the case of cabbages of the Savoy type, heads that are not soft;

(b) have, in the case of cabbages of types other than Savoy, heads that yield only slightly to pressure;

(c) have all outer leaves that are damaged by worms, disease or other factors removed;

(d) if prepackaged, not vary by more than 51 mm (2 inches) in diameter; and

(e) be free from any other damage, defect or combination of damage and defects that materially affects the appearance, edibility or shipping quality of the cabbages.

No. 2 Grade Requirements:

In addition to meeting the requirements for all grades, cabbages graded No. 2 must

(a) have heads that are not soft; and

(b) be free from any other damage, defect or combination of damage and defects that

(i) seriously affects the appearance, edibility or shipping quality of the cabbages, or

(ii) cannot be removed without the loss of more than 15% of the edible portion of a head of cabbage.

General Tolerances:

In the grading of cabbage, the requirements, as applicable, are considered to be met in the case of a lot of cabbage when not more than

1. In the case of a lot of cabbage inspected at the time of shipping or repackaging, 10%, by count, of the cabbages in the lot have defects, including not more than

(i) 2% that are affected by decay, and

(ii) 5% that have the same defect other than decay; and

2. In the case of a lot of cabbage inspected at a time other than at the time of shipping or repackaging, 10%, by count, of the cabbages in the lot have permanent defects, including not more than 5% that have the same permanent defect.Condition defects apply against the grade of a lot of cabbage only when the lot is inspected at the time of shipping or repackaging.

Self-Check – 4	Written test

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

Test I: write true if the statement is correct and false if the statement is incorrect

1. In general sense, quality is defined as degree of excellence . (2pts)

Test II: Write short answer for the following question
1. Write minimum quality specifications for fresh fruit and vegetables? (4pts)

Note: **Satisfactory rating ≥ 3 points   Unsatisfactory - below 3 points**

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

Score = _____

Rating: _____

LG #14	LO #2- Program grading equipment

Instruction sheet

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

- Entering specifications into computer to set grading parameters
- Using equipment components to enable grading out comes
- Testing and monitoring program or equipment operation to ensure standards
- Investigating problems or inconsistencies in grading outcome to determine cause and corrective actions.
- Completing documentation and recording of grading specifications for customer.

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- Entere specifications into computer to set grading parameters
- Use equipment components to enable grading out comes
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7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,

8. If your performance is satisfactory proceed to the next learning guide,

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Information Sheet 1- Entering specifications into computer to set grading parameters

1.1 Entering specifications into computer to set grading parameters

Computer Vision (CV) is the process of applying a range of technologies and methods to provide imaging-based automatic inspection, process control and robot guidance in industrial applications. While the scope of CV is broad and a comprehensive definition is difficult to distil, a generally accepted definition of computer vision is 'the analysis of images to extract data for controlling a process or activity'.

Size, shape and color analysis:

Size, which is the first parameter identified with quality, has been estimated using machine vision by measuring either projected area, perimeter or diameter. Size measurement is important for determining produce surface area.

The shape is one of the important visual quality parameters of fruits, vegetables, etc. Currently human sorters are employed to sort fruits based on shape. Shape is a feature, easily comprehended by human but difficult to quantify or define by computer. Most of the machine vision shape detection work has been done on industrial objects, which have definite structure. Fruit and vegetable are unique in nature and the growing environment causes various boundary irregularities which influences their shapes. Image processing offers solution for sorting of fruits based on their shape.

Colour is also an important quality factor that has been widely used. The colour of an object is determined by wavelength of light reflected from its surface. In biological

materials the light varies widely as a function of wavelength. These spectral variations provide a unique key to machine vision and image analysis.

The fruits sorting and grading are considered the most important steps of handling. Sorting and grading are major processing tasks associated with the production of freshmarket fruit, vegetable and crop type.

The image processing can be highly applied on agricultural applications for various purposes like:

1. To detect diseased leaf, stem, fruit and roots.
2. To determine size & shape of fruits and plant.
3. To estimate chlorophyll content of a plant.
4. Measurement of plant leaf area.
5. Weed detection

The image related parameters colour, size, and shapes are found in real time and the fruits are graded and sorted as per user requirement.

Machine vision based sorting system consists of a computer and video cameras to perceive fruit images, process their images, and make suitable inspection decisions. Grading decisions required in many agricultural processes, which are otherwise difficult, can be taken up by machine vision.

Computer mission vision system essentially involves three main processes namely image acquisition, image processing and decision-making. Cameras under appropriate lighting conditions carry out image acquisition. The visual information is converted from analog to digital format. The acquired images are analyzed by image processing hardware and/or software to extract the required object features and quality parameters. Based on these results, a decision on the fruit quality is taken by software considering the end user's requirements.

Size: The fruit size is another quality attribute used by farmers - the correct size fruit is considered of better quality. The size is estimated by calculating the area covered by the fruit image. To compute the area, first the fruit image is binarized to separate the fruit image from its background. Consider following picture is a original picture captured by camera, this was taken by OpenCV to find shape by background extraction function


Original Image   Background Extraction   Edge Detector
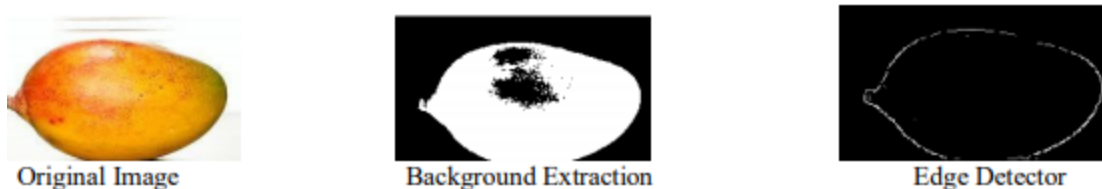
Figure 7: Mango picture captured by camera to determine size and shape

Shape: The farmers use shape irregularity as a quality measure. Fruits having regular shapes are considered of better quality. It estimated from the outer profile of the fruit image. Using an edge tracking operator can estimate the out most edge points of the fruit image. Have many edge detecting techniques in this canny edge detector is used to detect the edges.

Colour: Colour based identification is important to grade the fruits. The easiest way to detect and segment an object from an image is the colour based methods. The colours in the object and the background should have a significant colour difference in order to segment objects successfully using colour based methods. In database already all the data"s are stored to find required one. As per required the OpenCV libraries, distributed by us, on the Microsoft Windows operating system are in a Dynamic Linked Libraries (DLL). These have the advantage that all the content of the library are loaded only at runtime, on demand, and that countless programs may use the same library file. This means you have ten applications using the OpenCV library, no need to have around a

version for each one of them. But need to have the DLL of the OpenCV on all systems where you want to run the application.

Original Image | colour identification
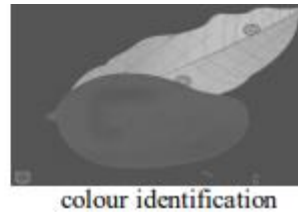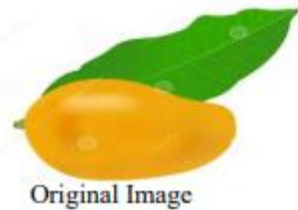
Figure 8: Mango grading using colour

Self-Check – 1	Written test

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

Test I: write true if the statement is correct and false if the statement is incorrect

1. The shape is one of the important visual quality parameters of fruits, vegetables

Test II: Write short answer for the following question

1. Write the purposes of image processing applied on fruit and vegetable? (4pts)

Note: **Satisfactory rating ≥ 3 points   Unsatisfactory - below 3 points**

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

Score = _____

Rating: _____

Information Sheet 2- Using equipment components to enable grading outcomes

2.1 Using equipment components to enable grading out comes

a. Sorting Table

The Bellmer sorting table offers an optimal visual control of process. At this point the sorting table allows the user to observe the quality of the products visually. Accordingly, the user overviews the complete procedure and can quickly sort out bad products or leaves. This process step influences the quality of the end product and the later process steps. Generally, the sorting table for the sorting of the raw material is installed before the crushing process. Moreover, due to food handling, it is made of stainless steel and adapted to hygiene standards.

Besides, the sorting table includes a spraying device to clean the products from impurities with fresh water. Here the spray water quantity is adjustable by manual valves. Also, a synthetic band of the sorting table is equipped with a scraper for easy removal of adherent dirt. Furthermore, it allows the user to adjust the speed of the sorting band. With our know-how and experiences in project planning, we recommend you the right equipment for your application. The Bellmer sorting table is easy to clean and maintain and simplifies your sorting procedure.

Figure 9: Sorting table for fruits

Figure 10 : Cleaning, sorting and grading line

Componets of optical color sorter for fruit and vegetable sorting features:

a. Customized image algorithm

Advanced image algorithm, which can customize specific algorithm according to different sorting materials: color sorting and shape sorting available.

b. Full color CCD cameras

Angelon vision system converts the captured targets into image signals through CCD cameras, and then transmits the signals to a dedicated image processing system. The 2048*∞pixels grade high resolution CCD color cameras with sharpness up to 0.01mm2 can identify subtle color differences and defects successfully.

c. Lower damage ratio by Belt-type structure design

Horizontal transporting by uniform and stable conveyor makes less collision for the materials. So that its damage ratio is much lower than that of traditional chute-type color sorter.

d. Intelligent real-time display of actual material image

Real-time checking the targets marking situation is available on the 21-inch LED computer screen through the real-time display system of actual material image, which is easy for engineers to adjust sorting parameters both on site and by remote.

e. Long life and full color LED light source

With uniform color, high brightness, and long life when using the white LED light source in our full color sorters.

f. Remote interconnection system

Remotely diagnoses each color sorter and assist with equipment operation are available after obtaining customers' authorization.

g. Precise target technology

Accurately identify materials' defects and impurities, and blow the target defects through the combination of the latest CCD cameras and target positioning program, which can increase the sorting accuracy and reduce the optimized carryover a lot.

h. High-quality customized valves

With high frequency and strong motivation, they can accurately blow off some high density materials like minerals, waste metal flakes, etc.
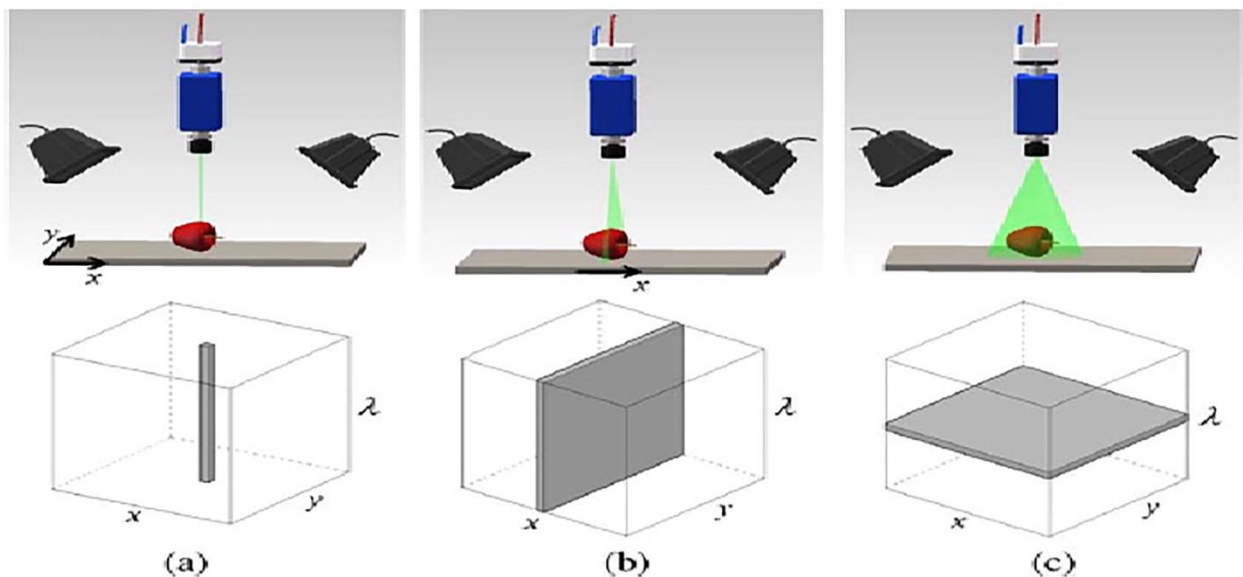
i. Uniform feeding system

Different vibrators are used for different materials. Angelon used motor vibrators and electromagnetic vibrators to ensure smooth feeding for different materials.

Figure 11: Optical Color Sorter
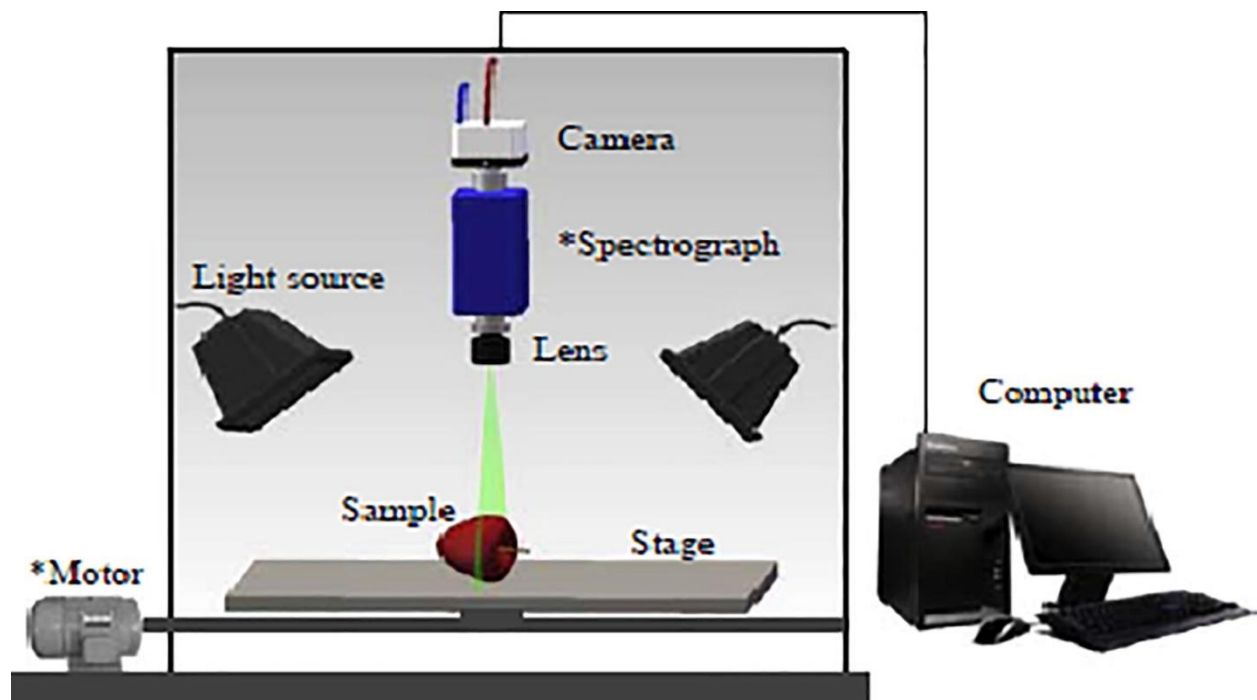
Figure 12. A classical computer vision system

Figure 13. Hyperspectral image scanning mode (a) Point scanning (b) Line scanning (c) Area scanning

BLUEBERRY COLOR SORTING

Figure 14: Blueberry color sorted by Optical Color Sorter

Self-Check – 2	Written test

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

Test I: Choose the best answer among the given alternative

1. _____are part of graing line ? (1.5pts)
   a. Product dump and wash tank   c. Inspection conveyors
   b. Brush washers   d. All

Test II: Write short answer for the following questions
1. Write componets of optical color sorter**?** (4pts)

Note: **Satisfactory rating ≥ 3 points   Unsatisfactory - below 3 points**

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

Score = _____

Rating: _____

Information Sheet 3- Testing and monitoring program or equipment operation to ensure standards

3.1 Testing and monitoring program or equipment operation to ensure standards

Testing and monitoring program:

Testing and Monitoring (ITM) program that is made up of the following components:

- Legislative requirements
- Inspection, testing and monitoring schedules
- Maintenance and service records
- Workplace inspections checklists
- Corrective action procedure

Testing and Monitoring Schedules:

Testing and Monitoring Schedule" which identifies what items of equipment need to be tested, the relevant legislation and/or standards that apply to that equipment, and the frequency of testing. The frequency for testing will be determined by:

- The level of risk;
- Relevant legislation
- Manufacturer's recommendation (as per operating manual or other material provided by the manufacturer)

Engineering controls are regularly inspected and tested to ensure their integrity. Engineering controls, including safety devices need to be regularly inspected and tested to ensure their integrity, effectiveness and correct operation. Examples of these types of engineering controls may include the following (not exhaustive):

- Fume cupboards,
- Biosafety cabinets,
- Gas detection systems,
- Machinery guards,

- Emergency stop buttons,
- Local exhaust ventilation
- Pressure relief devices

Self-Check – 3	Written test

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

Test I: Choose the best answer among the given alternative

1. Testing and Monitoring (ITM) program that is made up of the following components includes_____?(2 pts)

   a. Legislative requirements
   b. Inspection,testing and monitoring schedules
   c. Maintenance and service records
   d. All

Test II: Write true if the statement is correct and false if the statement is incorrect

1. The frequency for testing will be determined by the level of risk (2pts).
2. Corrective action procedure is part of testing and monitoring program (2pts).

Note: **Satisfactory rating above– ≥3 points   Unsatisfactory - below 3**

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

Score = _____

Rating: _____

Information Sheet 4- Investigating problems or inconsistencies in grading outcome to determine cause and corrective actions.

4.1 Investigating problems or inconsistencies in grading outcome to determine cause and corrective actions.

Bruising appears as a result of impacts and compressions of the fruits against other fruits, parts of the trees, containers, parts of any grading and treatment machinery and on any uncushioned surfaces. Severity of damage to the fruit is primarily related to:

(i) height of fall;

(ii) initial velocity;

(iii) number of impacts;

(iv) type of impact surface and size; and

(v) physical properties of the fruit, related or not to maturity.

Fruits may be classified into different types regarding their most evident physical properties, which are responsible for their susceptibility to bruising. Such a classification is very inaccurate, as many fruits may change from one type to another during ripening or when subjected to different conditions. Nevertheless, some groupings may be made

1) Rigid fruits are those whose strength is based on a mostly rigid structure, surrounded by a thin elastic skin: apples, pears, peaches, nectarines, apricots, avocados, mangoes, papaya, kiwi fruits, potatoes, etc. In this type of commodity resistance is based in the fruit flesh, in its histological and physiological characteristics mainly.

2) Liquid fruits are made up by a liquid or 'soft' mass contained in a mostly elastic skin, their resistance being based on this skin: examples include plums, tomatoes, grapes, cherries and berries. It is known that many rigid fruits gradually become soft as they mature.

3) Mass of the fruits is crucial in bruising susceptibility, since impact energy is, as known, directly dependent on the dropping mass. Small fruits will be handled much more safely than large fruits.

4) Thick-skinned fruits, like melons, water-melons and bananas are very resistant to impacts, but skin rupture problems may occur with these fruits.

5) Fibrous fruits like pineapples react in a very different manner to impacts, and have not been widely studied.

6) The stone in fruits is the cause of internal bruising for higher-energy impacts in some fruits and varieties.

External damage of the fruit skin can be caused by friction and abrasion against bin walls and conveyors. Oranges are especially susceptible to this type of damage, as are other citrus fruits. Also, some pear varieties are very easily damaged by abrasion. Peeling or 'scuffing' of potatoes and other produce has been studied, and some testing devices exist to measure susceptibility to this type of damage on the skin. Cuts and punctures represent severe damage, caused by inappropriate equipment or handling; they are not related directly to fruit properties, and can be avoided by proper care of the equipment and of the handling systems.

Corrective Action:

1. Retrain any employee found not following the procedures in this SOP.

2. Reject the following:

   • Over-ripe or unripe fruit

   • Bruised fruit

   • Immature fruit

Self-Check–4	Written test

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

Test I: Choose the best answer among the given alternative

1. _____ are those whose strength is based on a mostly rigid structure, surrounded by a thin elastic skin? (2 pts)
   a. Rigid fruits Testing
   b. Thick-skinned fruits
   c. Grading

2. _____are made up by a liquid or 'soft' mass contained in a mostly elastic skin, their resistance being based on this ? (2pts)
   a. Liquid fruits
   b. Fibrous fruits
   c. Thick-skinned fruit
   d. All

Test II: Write short answer for the following questions

1. Write the cause of mechanicl damage (2pts)

Note: **Satisfactory rating above ≥ 3 points - below 3 points Unsatisfactory**

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

Score = _____

Rating: _____

Information Sheet 5-Completing documentation and recording of grading specifications for customer.

5.1 Completing documentation and recording of grading specifications for customer.

Apple fruit characterstics:- Apple will be fine grained, sweet, juicy, mature and good smelling. It should be of normal bloom. Glossy smooth skin, stem intact (if removed broke should be clean). Color of apple will be characteristics of the variety.

Banana fruit characterstics: - Banana will be sweet, aromatic, firm with starchy fresh and no foreign smell or taste. It will have normal bright bloom with color generally ranging from green, yellow to orange. The size of banana will vary according to variety in the range of 150-250 mm. it will be offered in bunches.

Mango fruit Characterstics: - Mango will be mature, ripe firm, juicy, yield slightly to finger pressure, sweet pleasant aroma. The color generally range from light green to yellow (lemon/golden) to orange as per variety. It is generally available from March to August.

Pine Apple-Ananas Fruit Characteristics. Pine Apple will be sweet, firm, juicy, strong sweet aroma and taste, texture not chalky or fibrous

Generally:- All fruits fresh will be fresh, ripe, sweet , wholesome, mature, wellformed of good even size. It will have characteristic color, taste, aroma, shape and visual appearance, as applicable to each fruit fresh and its varieties. The fruit fresh should mature naturally on trees or under normal storage conditions. It will be practically free from insects and pests infestation and totally free from fungal or bacterial rot. It will also be free from signs of improper storage, handling and transportation.

Self-Check – 5	Written test

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

Test I: Write true if the statement is correct and false if the statement is incorrect

1. Apple is fine grained, sweet, juicy, mature and with good smelling fruit. (2pts)

Test II: Write short answer

1. Write fresh fruit customer requirement of fruit and vegetable? (4)

Note: **Satisfactory rating above – 3 points Unsatisfactory - below 3 points**

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

Score = _____

Rating: _____

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