TVET CERTIFICATE III IN CROP PRODUCTION

VEGETABLE CROPPING

CRPVG 302

Grow vegetables

Competence

Learning hours: 70

Credits: 7

Sector: Agriculture and Food processing

Sub-sector: Crop Production

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Purpose statement

This module describes the skills, knowledge and attitude required to grow vegetables. It is designed for learners who have successfully completed Nine years basic education its equivalent and pursuing TVET Certificate III in crop production or any other related qualifications. At the end of this module, learners will be able to prepare for vegetables crops establishment operations, prepare the site for vegetables (Cabbage, Carrots, Tomatoes, Egg-plant, onions, amaranths, pumpkin and sweet peppers growing, carry out planting, and post planting operations and harvest vegetables. Qualified learners deemed competent may work in various places including Site/field, Office, Nursery and Vegetable garden performing a range of tasks related to crop growing he can work alone or with others under supervision.

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Learning Unit 1 – Prepare for vegetables crops establishment operations.

INTRODUCTION TO VEGETABLES

Vegetables are usually known woody herbaceous plant that may be eaten raw or cooked during the main part of a meal. They are usually grown on small plots and are often irrigated.

Vegetables are important sources of many nutrients, including potassium, dietary fiber, folate (folic acid), vitamin A, and vitamin C. Diets rich in potassium may help to maintain healthy blood pressure.

There are at least four definitions relating to fruits and vegetables:

Fruit (botany): the ovary of a flowering plant (sometimes including accessory structures),

Fruit (culinary): any edible part of a plant with a sweet flavor,

Vegetable (culinary): any edible part of a plant with a savory flavor.

Vegetable (legal): commodities that are taxed as vegetables in a particular jurisdiction

Amaranth foliage is used as a vegetable and as an animal food especially in the tropics and subtropics. It is an excellent source of bio-available iron, and vitamin A. It is also high in protein.

S/N	English name	Scientific name	Family
1)	Cabbages	***Brassica oleracea var. capitata***	**Brassicaceae** (Cruciferae)

2)	Carrots	***Daucus carota***	**Apiaceae**
3)	Tomatoes	***Lycopersicon esculentum***	Solanaceae
4)	Egg-plants	***Solanum melongena, S. macrocarpon***	Solanaceae
5)	Onion	***Allium cepa L.***	Amaryllidaceae.
6)	Pumpkins	***Cucurbita pepo***	Cucurbitaceae
7)	Sweet Pepper	***Capsicum annum***	Solanaceae
8)	Amaranths	***Amaranthus ssp.***	**Amaranthaceae**

LO 1.1 Selection of tools and equipments referring on vegetables species.

Content/Topic 1: **Classification of tools and equipment for vegetables growing**

- ✓ **Land preparation tools and equipment:** include the panga, axe, hand hoe, mattock, pick axe, forked hoe, spade, shovel, wheelbarrow, garden shear, garden trowel, slashes, rubber boots, gloves, and sprayer used for herbicides application.
- ✓ **Planting material preparation tools and equipment:** Includes panga, knives, gloves, , wheelbarrow, secateurs, baskets.
- ✓ **Vegetables maintenance tools and equipment:** panga, axe, hand hoe, rubber boots, gloves, head cover, mattock, pick axe, forked hoe, manure fork, spade, shovel, wheelbarrow, watering can, spring balance, rake, knapsack sprayer, sprinkler, hose pipe, pruning saw, pruning knife and secateurs.
- ✓ **Fertilizers application tools and equipment:** includes sprayer, gloves, balance, baskets, garden hoe and forked hoe.
- ✓ **Vegetables harvesting tools:** Harvesting snips, knives, Secateurs, rubber boots, gloves, head cover, Picking crates, baskets, bins, sheeting, sacs
- ✓ **Vegetable produce handling tools and equipment:** wheelbarrow, sacs, rubber boots, gloves, head cover, sheeting, winnowers, baskets, bins, sickles, plows, combined harvesters.

- ***Content/Topic 2:*** **Selection criteria of tools and equipment used for vegetables crops.**

Tools and equipment used in vegetables are selected based on the following criteria:

- ✓ **Activity to be done**: tools, materials and equipment are selected also according to the type task performed.
- ✓ **Working conditions of tools and equipment**: select tool or equipment which is in proper functioning for minimizing hazards and working well.
- ✓ **Availability and accessibility**: tools or equipment should be easy avail on the market and more accessible in the working area
- ✓ **Cost**: it is necessary to consider the various costs of maintenance or spare parts. It is better to opt for simple equipment with lower costs and a longer life span. Cost of purchasing or hiring tractors services are very high so peasant farmers cannot afford. This explains why hand hoes are still dominant in farming operations.
- ✓ **Tools and equipment efficiency**: tools or equipment can work according to level of automation (performance) or easy utilized for proving more productivity.
- ✓ **Durability**: selected tools or equipment should have long shelf-life and remain functional, without requiring excessive maintenance or repair, when faced with the challenges of normal operation over its designed lifetime.
- ✓ **Manoeuvrability**: the equipment should move (work) easily and freely. Its mobility is simple.

LO 1.2 –Proper assessment of occupational Health and Safety (OHS) hazards and risks for reporting to the supervisor.

- **Content/Topic 1: Types of hazards associated with vegetables growing and hazards risks:**

Generally, there are three types of hazards:

- ✓ **Biological hazards:** refer to organisms or organic matters produced by these organisms that are harmful to plant and human health.
- ✓ **Physical hazards:** are the agents, factors or circumstances that can cause harm with contact to the plants.
- ✓ **Chemical hazards:** these are type of occupational hazard caused to chemical in the workplace. Physical hazards:

Hazards risks:

- ✓ **Risks associated with Biological hazards in vegetables growing:** these include parasites like bacteria, virus, fungi, insects, plants, birds, animals and human.
- ✓ **Risks associated with physical hazards in vegetables growing:** namely explosive, farmable, gases, burnt, wound.
- ✓ **Risks associated with chemical hazards in vegetables growing:** Some commonly used workplace chemical hazards includes: different pesticide used in vegetable growing have the degree of toxicity for both human being Pesticides are poisons and, unfortunately, they can harm more than just the pests at which they are targeted. They are toxic and exposure to pesticides can cause a number of health effects. They are linked to a range of serious illness and diseases from respiratory problem to cancer. Pesticides also contaminate soil, water and other vegetation. In addition kill insects or weeds. They can be toxic to a host of other organisms including birds, fish, beneficial insects and other non-targeted plants.

LO 1.3 – Select PPE according to the desired operation

- **Content/Topic 1: Types of PPE used and criteria used to select for vegetables crops growing.**

PPE can be considered in the following categories, based on the types of protection afforded by equipment:

- ✓ Hand protection: gloves
- ✓ Head protection: helmet, hat, caps.
- ✓ Respiratory protection: half-mask, cartridge.
- ✓ Eyes and face protection: goggles, shields, facemask.
- ✓ Body protection: gowns, clothes, coverall.
- ✓ Hearing protection: earplugs
- ✓ Foot protection: boots, shoes.

Other personal protective equipment may include PPE for specific task such as disposable clothing for working with chemicals, radiation hazards, welding, painting.

PPE Selection criteria for vegetable growing:

- ✓ **Use**: PPE should be easy to use in the manner does not cause contamination or damage to operator.
- ✓ **Potential hazards**: PPE are selected in order to minimize hazards at workplace.
- ✓ **Availability:** PPE may be selected depending on their availability on market and affordable costs.
- ✓ **Exposal to hazards**: when there is potential source of dangers at workplace which can pose direct threat to person or group of people health; the hazards should reduced by wearing PPE
- ✓ **Level of protection:** PPE will protect the user against health or safety risks at work and minimize exposure to a variety of hazards.
- ✓ **Fitness**: The User must wear the PPE which are fitting with his/her body for working in good conditions.
- ✓ **Awareness of limitation**: Some PPE is used for specific jobs.
- ✓ **Compatibility**: the operator wears the PPE which are compatible to the task performed.

LO 1.4: Identify environmental implications of vegetables growingfor discussing with supervisor

- **Content/Topic 1: Environmental impact assessment (EIA):**

Definition.

Environmental impact assessment (EIA): is a process of evaluating the likely environmental impacts of a proposed projects or development, taking into account inter-related socio-economic, cultural and human health impacts, both beneficial and adverse.

It is the assessment of the environmental consequences (positive/negative) of a plan, policy, program, or actual projects prior to the decision to move forward with the proposed action.

Types of impacts of Vegetables and equipment on environment

Agriculture is essential in sustaining human life; the practices associated with it have been known to have certain impacts on the environment. Some of the environmental impacts of agriculture include climate change, pollution, soil degradation, and deforestation.

A) Negative impact:

The most notable of these effects includes climate change, deforestation, pollution, and general environmental degradation

Climate Change

Agriculture and climate change have a reciprocal relationship.

Climate change affects agricultural production through precipitation levels and temperature variations. In return, poor agricultural practices increase climate change. The most significant climate change associated with agriculture is brought about by methane, nitrous oxide and carbon dioxide, all of which are greenhouse gases released into the Earth's atmosphere from farming.

Pesticides and fertilizers application affect the quality of air through production of compounds like phosphorus, nitrate and ammonia.

Pollution

In order to enhance agricultural production quantity and quality, several additives to the soil are used in farming. The widely used are pesticides and fertilizers, which end up as pollutants in water run-off from the soil. This run-off can adversely affect more people and animal wildlife.

Positive impact:

Agriculture affects the environment positively in the following ways:

Agriculture preserves ecosystems

Agriculture helps preserve valuable ecosystems. A perfect example is the extensive farming of increasingly rare permanent grasslands.

Grasslands provide habitat to a great number of animals and native plants. Both methods naturally maintain and enrich these habitats, promoting healthy re-growth of unique high biodiversity vegetation.

Agriculture boosts soil fertility

One of the key features of sustainable agriculture is the focus on the health of soils.

Practices such as crop rotation, cover cropping, no-tillage and the application of compost improve soil fertility naturally and can even speed up the process of new topsoil formation.

In addition to preventing the exhaustion of soils, and therefore, helping secure stable yields, these practices increase biodiversity of favorable soil fauna and flora.

Soils rich in organic matter and flourishing with life also contain greater concentrations of the natural enemies of pests, thus supporting the growth of more resilient crops.

Agriculture retains soil and prevents erosion

Loss of soils is one of the biggest threats to our wellbeing, and intensive agriculture with monoculture fields is known to be one of its main contributors. Farmers, however, have the ability to reverse this damage.

In perennial systems, vegetation with deep roots helps to hold the soil together and prevent erosion. This is especially the case when farmers have constructed swales and other types of earthworks that help to stabilize steep slopes, or when applying techniques with low soil disturbance such as no-tillage.

Agriculture has a role in the water cycle

Plants and trees in agricultural systems help to retain and add water to underground aquifers.

This process is most effective when the crops being grown are perennials that continue to grow every year and have deep, well-established root systems.

Agriculture can conserve water

Modern farming methods such as strip or no-till, dry farming and planting of cover crops significantly reduce the need to irrigate.

The higher the water content in the soil, the less irrigation is needed during dry spells to preserve crops, which saves significant amounts of water over the long term.

In certain forms of agriculture, properly processed sewage, wastewater, and sludge can be used on the landscape instead of disposing it as waste.

In these cases, wisely chosen vegetation acts as a "living filter", getting rid of pollutants, while utilizing water for growing. This method saves farmers' money, conserves water, and recycles nutrients.

- **Content/Topic 2: Types of impact on vegetables crop growing on environment:**

✓ **Negative impact:**

- **Deforestation**: is the permanent removal of trees to make room for something besides forest. This can include clearing the land for agriculture or grazing or using the timber for fuel, construction or manufacturing.

- **Water scarcity**: is the lack of sufficient available water resources to meet the standard water demand within the region. Water scarcity can also be caused by climate change

(droughts, lack of rainfall or pollution); increased human demand; and over use of water.

- **Water pollution**: occurs when harmful substances often chemicals or microorganisms contaminate a stream, river, lake, ocean, aquifer and other body of water, degrading water quality and rendering it toxic to human, plant or the environment. Roots and tuber crops increase water pollution by using pesticides during pests and diseases control.

- **Air pollution:** is the mixture of sold particles and gases in the air. Car emissions, chemicals from factories used as pesticides, dust, pollen and mold spores may be suspended as particles. Contributors to poor air quality in Rwanda include the industrial sector, vehicle emissions, and agricultural waste burning.

- **Water logging:** excessive supply of water reduces air in the soil spaces. It is the process in which field is filled with excess water; it is saturation level soil with the water. In the process of water logging the level of underground water is too high. Water lodging is when water logging goes too far and destroys the crops.
- **Soil erosion**: is the displacement of the upper layer of soil; it is a form of soil degradation. It occurs when the impact of water or wind detaches and removes soil particles, causing the soil to deteriorate. Agriculture practices for Vegetables cropping can increase soil erosion.
- **Loss of wild biodiversity**: biodiversity or biological diversity refers to a number of genes, species, individual organisms within a given species and biological community within a defined geographical area, ranging from the smallest ecosystem to the global biosphere. Decreasing in soil microorganisms read to low plant decomposition
- **Genetic diversity**: is the total number of genetic characteristics in the genetic makeup of a species, it range widely from the number of species to differences within species and can be attribute to the span of survival for a species. Each individual species possesses genes which are the sources of its own unique features.

- **Outbreak of new pests and disease**: for 80% of the food we eat and 98% of the oxygen we breathe, plants are a pillar of the life on earth. Up to 40% of food crops are lost to plants pests and diseases each year according to the FAO.

✓ **Positive impact:**

- **Ecosystem preservation**: vegetables preserve the ecosystem providing organic matter after decomposition.
- **Nitrogen fixation:** some vegetables (vegetables vegetables) help to fix atmospheric nitrogen and then that nitrogen becomes able used by other crops.
- **Carbon sequestration:** a process of capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change.
- **Erosion control**: cover crops are excellent plants for erosion control. These hardy easy to grow plants send out nets of roots that help hold top soil in place while also reducing competitive weeds.

Learning Unit 2 – Prepare the site, tools, materials and equipment for vegetables growing

LO 2.1: Select vegetables species based on market and enterprise target

- Content / Topic 1: **Priority vegetable species grown in Rwanda**

The priority vegetables species found in Rwanda are classified into leaf, stem, fruits, vegetables flowers, roots and bulbs vegetables. The following table summarizes the

Class	**Example of crops**
Leafy	Cabbage, lettuce, amaranth, spinach,
Roots and bulbs	Carrots, beet root, Radish, onion, garlic.
Stem	Amaranth, spinach,
Fruits	Tomato, egg-plant, pepper, chayote, pumpkin, cucumber, water melon
Vegetables	Green bean, soybeans, garden peas, lima bean
Flower vegetables	Cauliflower

- Content / Topic 2: Selection criteria for vegetable species.

✓ **Adaptability:** Vegetables crops especially cassava, potatoes, yam and taro contribute significantly to human food availability in developing countries. They are also used for animal feed and various industrial applications. Their broad agro-ecological adaptability and adaptation to marginal environment, great flexibility in mixed farming system, ability to produce reasonable yields where most crops cannot and their capacity to provide high quality od carbohydrates make them the basis for food security at household level.

✓ **Productivity:** Vegetables productivity has to improve global food security, especially in the regions with marginal soils fertility and low input agricultural systems.

✓ **Market requirements:** Vegetables have to enhance production through improved technologies and develop the processing and marketing infrastructure for Vegetables. The farmers connect with processors, markets and relevant effective and sustainable services to increases agricultural productivity and profitability. They may empower developing capacity within farmers-based and other trade organizations.

✓ **Life cycle:** Vegetables chosen must grow rapidly and shortest growing season of the Vegetables.

L O. 2.2: Identify field according to vegetables requirements and market standards

- Content / Topic 1: Ecological requirement for vegetables requirements.

✓ **Climatic requirements:** the basic ecological requirements for vegetables are Temperature, Rainfall, Altitude, Wind, Relative humidity. They are summarized in the following tabl

CROPS				
Ecological factor	**Cabbage**	**Carrot**	**Tomato**	**Eggplant**
Temperature	Optimum temperature ranges from 15^0C-24^0C	Optimum temperature ranges from 13^0C-24^0C	Optimum temperature ranges from 18^0C-29^0C	Optimum temperature ranges from 21^0C-32^0C
Rainfall	It requires the well distributed rainfall and ranges between760mm-2250mm	It requires the well distributed rainfall and ranges between760mm-2250mm	It requires the well distributed rainfall ,a in cool climate ranges from 20mm/week to 70mm/week	It requires the well distributed rainfall and ranges between760mm-2250mm
Altitude	it varies from 700m above sea level	it varies from 1500m-2900m	it varies from 1500m-2900m	it varies from 1500m-2900m

CROPS				
Ecological factor	**Onion**	**Amaranths**	**Pumpkin**	**Sweet pepper**
Temperature	Onion produce bulbs more rapidly at warm (21^0C to 26^0C) that at cool 15^0C to 21^0C) temperature.	Amaranth cannot tolerate cold temperatures. They are grown on optimum temperature of 21^0C to 30^0C.	Cucurbits are primarily warm-season crops, although breeders have succeeded in developing cultivars from several species that can be cultivated more or less successfully in cooler regions. However, the optimum temperature range is 18-30^oc and the plant does not stand	Pepper thrives in climates with growing season temperatures in the range of 18 to 27°C during the day and 15 to 18° C during the night.

			frost at all.	
Rainfall	it can be grown as a rained crop even at elevation of 1500 to 2000 m between April and August	Amaranth appears to be fairly slow growing at first, but it can be very drought tolerant once established. It can successfully be grown areas with less than 250 mm of yearly rainfall.	Pumpkins are grow during rainy season where the precipitation is ranging about 500 to 1300 mm.	The crop is grown extensively under rain fed conditions and high yields are obtained with rainfall of 600 to 1250 mm, well-distributed over the growing season. Heavy rainfall during the flowering period causes flower shedding and poor fruit setting, and during the ripening period rotting of fruits.
Altitude	According to Rao and Purewal (1954), it can be grown as a rained crop even at elevation of 1500 to 2000 m between April and August	It can grow in altitude of 900 – 2400 m above sea level and is common in middle altitudes and highlands (1400-2400).	Common pumpkins are grown above 1200 m in altitude.	it can be grown at wide range of altitudes.

- Content / Topic 2: Edaphic requirements for vegetables.
  - ✓ **Edaphic requirements:** Soil pH, Soil fertility, Soil Depth, and Well drained soil

CROPS				
Ecological factor	**Cabbage**	**Carrot**	**Tomato**	**Eggplant**
Soil pH	It Grows well in all types of soil but best in deep ,well drained, fertile loam with pH of 5.5-6.5	It requires well drained sand loams, loams or silty loam soil with pH of	It requires deep, well drained, fertile and sandy loam soil with pH of 5.5-7.0	It requires deep, well drained, fertile and sandy loam soil with pH of 5.5-6.8

CROPS				
Ecological factor	**Onion**	**Amaranths**	**Pumpkin**	**Sweet pepper**
Soil pH	onion can be grown on various soils. But sand loam, silly loam and deep filiable soils are best suited for onion crop. The optimum PH range is between 6 and 7	It can be grown on all types of soil, but loam soil is most suitable for its cultivation. Fine seed bed necessary for this crop and this can be done by repeated ploughing	There are four main characteristics of soil you should be concerned about. (Sandy, Clay, Loam, PH level). PH level is extremely important for pumpkins. The ideal PH level for a pumpkin is 6.5 or slightly acidic.	Light-textured soils with adequate water holding capacity and drainage are preferred. Optimum pH is 5.5 to 7.0 and acid soils require liming. Water logging, even for short periods, causes leaf shedding

✓ **Field background**

- **Previous crop:** vegetables are grown respecting the crop rotation basing on their types.
- **Fertilization types:** we apply the fertilizer depending on the vegetable species.
- **Pesticides types:** we grow vegetables basing on the pesticides used to the previous season.
- **Pests and disease:** What are the diseases and pests are occurred to the previous season.

✓ **Field accessibility**

- **Infrastructure:** vegetable are easily destroyed and damaged if transported to the market on bad road. Road to the market must therefore available and be in good conditions.
- **Market:** The vegetable garden should be near a market to avoid spoilage and physical damage to produce as a result of long distance transport.
- **Field slope:** Gentle slope is highly recommended

LO 2.3: Clear the land according to the site selected.

- Content / Topic 1:Definition and importance of land clearing.

✓ **Land Clearing**: Land clearing is the process of removing trees, stumps, brush, stones and other obstacles from an area as required to increase the size of the crops producing land base of an existing farm or to provide land for a new farm operation.

✓ **Importance of land clearing**:

- Land clearing destroys plants and local ecosystem and removes the food and habitat on which other negative animals.
- Clearing allows weeds and invasive animal to spread, affects greenhouse gas emissions and can lead to soil degradation, such as erosion and salinity, which in turn can affect water quality.
- It contributes to land degradation, salinity and declining water quality.
- It stabilize the land and improves appearances;

- It prevents hazards as stumps and stones are removed;
- To incorporate manure and other organic matter into the soil;
- To make subsequent operations possible.
- To make primary cultivation easy
- To make movement of animals and machines easy during cultivation.

- Content / Topic 2: Site obstacles for vegetables land clearing.

These obstacles are the following:

✓ **Shrubs/ bushes:** these should be removed by appropriate tools and equipement for easy soil preparation (pick ax).

✓ **Stones:** these can damage tools or equipment during land preparation. They must be removed before tillage. They can damage the blades of some tools.

✓ **Stumps:** they can pose a risk on tools and equipment.

✓ **Holes:** these can hampers to the use of mechanization.

All obstacles should be removed before any operation for more proper working of tools and equipment.

- Content / Topic 2:**Methods/ways of land clearing.**

✓ **Manual clearing**: is the removal of unwanted or dangerous vegetation with chainsaws and other hand tools.

It is known as slashing or clearing. This is the safest and least expensive method of clearing land; however, it only works in small areas because there is a great deal of labour involved. If you are clearing a large piece of land, manual clearing would be more expensive and time-consuming.

✓ **Mechanical clearing**: during this process, land clearing equipment is used. It makes it possible to clear the ground quickly.

They will have the necessary equipment to move heavy rocks, push over trees and stumps, and to rip out the root balls and grind the stumps into the ground. This is often used for large area.

✓ **Chemical spray clearing**: it is typically used to clear out small plants and weeds before burn-off. In some cases, dangerous chemical are necessary through an aerial spray or

chemical spray in order to eliminate the ground cover so that the soil can be prepared and made suitable for planting crops.

LO 2.4: Till the land for vegetables growing according to their requirements

- **Content /Topic 1:Types of Tillage and cultivation methods:**

✓ **Primary tillage:** this is the initial opening of land by ploughing. Primary cultivation can be done by using hand hoe, ox-plough, disc plow and moulboard plough.

✓ **Secondary tillage**: this is done after primary tillage; it involves turning and breaking of soil clods to ensure the fine tilth. Second tillage is usually done after 3-4 weeks from primary cultivation. This period enables the trash to decompose properly. Common implement used are the disc harrow, spring-tined harrow and spring-tined harrow.

✓ **Cultivation methods:**

Cultivation refers to the use of animal or tractor drawn equipment or hand to work the soil in preparation for planting and has five main purposes:

- To break up and loosen the soil to favor seeds germination, seedling emergence and root growth;
- To chop up and/or bury the previous crop's residues so they will not interfere with the new crop;
- To control weeds;
- To incorporate (mix into the soil) liming and fertilizers (chemical or organic);
- To shape the kind of seedbed most suited to the particular soil, climate and crop (i.e., raised beds, ridges, flat seedbeds.)

Methods:

1. **Flat cultivation:** Root and tuber crops may be grown on the land relatively low. This shape is used where soil moisture is adequate for crop growth and where there are no drainage problems.
2. **Ridges cultivation:** Ridges are hips of soil put across a garden to reduce surface run-off under heavy rainfall. Ridges are commonly used in the growing of Irish-potatoes and sweet potatoes. Root and tuber crops can be planted on performed beds of any length, 60-105cm wide by 18-30cm high with 3-5 defined planting rows per bed. Farmers may form ridges and then plant root and tuber crops on the top of the ridges. These ridges

have advantages of irrigation and drainage of water from bed surface and avoid negative effects of ponding and associated waterlogging. Ridges are oriented along the contours on slopping land, to maximize rain infiltration and minimize erosion.

3. **Mound cultivation**: The mounds are usually 16-20cm high and 20-25cm wide. Mounds are smaller than ridges.

- **Content /Topic 2:Objectives of primary tillage and secondary tillage:**

✓ **Primary tillage:**

- It helps in improving soil structures so as to facilitate water infiltration, soil aeration and plant root development.
- It enables burying of crop residues of the previous seasons which rot and form organic manure.
- Primary cultivation controls weeds by burying weed seeds and weed plants.
- In case of light soils, this operation can give a fine bed for planting.
- It eases secondary tillage.

✓ **Secondary tillage:**

- It turns the soil bringing rotten organic matter near the surface for plant use;
- It makes the soil fine for easy germination of seeds;
- It makes the soil soft for easy planting;
- It breaks big soil clods to loosen particles which facilitate root penetration;
- It ensures a leveled garden;
- Sometimes fertilizers are also applied to the garden during this operation;
- It also helps in chopping and mixing the trash in the soil. Secondary cultivation can be done once or twice depending on the following factors:

a) **The land tenure of soil clods**: if the original clods are very big, it may require carrying secondary cultivation twice. In light soils such as sand loams, secondary tillage can be done.

b) **Availability of trash**: when there is mush trash, for instance, in a garden where sugar has been harvested, it will require more operations. This will ensure that trash has been fully incorporated into the soil.

c) **Size of seeds to plant**: small seeds need a fine bed so more secondary operations may be needed before planting such seeds.

d) **Types of weeds in the field**: annual weeds when ploughed in the soil easily decay and may require one secondary operation. Perennial weeds on the other hand require more secondary operations to remove the stolon and rhizomes. This makes it more difficult and expansive to prepare the seedbed.

e) **Topography**: the nature of landscape determines the number of secondary operation. In the areas with steep slopes such as hills and mountains, secondary cultivation may not even be carried out. In flat areas where there is less risk of soil erosion, farmers can carry out a number of secondary operations.

LO 2.5 – Apply soil amendment complying with vegetables requirements

- **Content/Topic 1. Objectives of soil amendment application and Types of soil amendment.**

The reason for soil amendment is to provide a better environment for roots and plant growth. This includes the improvement of the soil structure and water holding capacity, the availability of nutrients, and the living conditions for soil organisms, which are important for the plants to grow.

Types of soil amendment

- ✓ **Organic amendments:** they include farmyard manure, compost manure, and green manure. The application of organic amendments makes good use of natural resources and reduces the need of synthetic inorganic fertilizers. Soil structure, nutrient composition and microbiological activity of soil are usually increased following the application of organic amendments.

The main purpose of using organic amendments is to loosen the soil and create large pores to increase:

1. Aeration
2. Drainage
3. Usable water holding capacity
4. Nutrient holding capacity
5. Decrease growing medium weight

- ✓ **Inorganic amendments:** They include lime, Perlite, Dolomite and Gypsum. Inorganic amendment are used to increase:

1. Aeration
2. Drainage
3. Decrease excessive water holding capacity
4. Decrease or increase growing medium weight

The use of inorganic materials as soil amendment results in an increase in soil pH. The use of these amendments is beneficial due to their large-scare availability as most of them are industrial byproducts. Among inorganic amendment, Ca(Calcium) is important for decreasing Cd (Cadmium) uptake and toxicity in plants.

- **Content /Topic 2. Selection criteria and sources of soil amendments**

When selecting soil amendments, one should take into consideration the following criteria:

- ✓ **Soil pH:** this is the acidity (if pH of the soil is less than 7)and alkalinity (if the pH is more than 7) of the soil
- ✓ **pH of amendment:** the amendments to applied should be relative to the pH of the soil. For this reason, acidic amendments are applied in alkaline soil while alkaline amendments are applied in acidic soil.
- ✓ **Soil texture:** Organic amendments are applied in sandy soil to improve not only its fertility but also its water holding capacity.
- ✓ **Soil alkalinity:** It is defined as the soil basicity with pH>7.

Sources of soil amendment

There are two main sources of soil amendments, such as **on farm soil amendment** and **off farm soil amendment.**

On farm soil amendments: they include farmyard manure, compost manure, and green manure. They derive from farm residues and leaves of agroforestry trees after decomposition in compost or buried in the soil.

- ✓ **Off farm soil amendments:** These areInorganic amendments, which are manufactured in industries. They derive from minerals after transformation in industries. For example lime comes from oxidation of limestone in industry.

LO 2.6 – Make out planting pattern according to the vegetables production

- **Content/Topic 1. Importance of planting pattern**

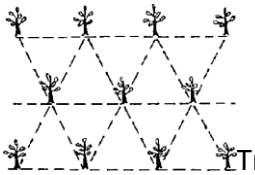
During growing season, the inter-row spaces are hoed two to four times and the rows are weeded to conserve moisture and improve aeration. As a result, the soil's microbiological activity increases and mobilization of nutrients is intensified.

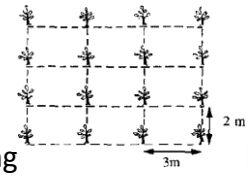
The most common used planting patterns are square spacing or triangular spacing where the distance between the rows are the same as along the rows. If strip clearing or weeding are used, a rectangular pattern where trees are closer in the rows, than between the rows might reduce labour input.

- **Content/Topic 2. Different planting patterns for vegetables growing and Criteria of field lay out selection**

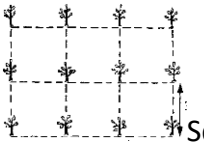
Different planting patterns for vegetables growing are:

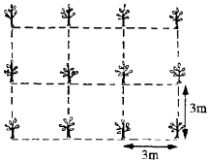
- ✓ **Square**: In square planting, one plant or a group of plants in a common hill occupies the corners of a square, which has 4 sides of equal length.
- ✓ **Double planting pattern/ twine row planting pattern:** Double-row planting, as the name suggests, involves planting two rows of about **8 inches** apart. The double row planting technique allows you to grow two rows in almost the same amount of space as one row would require.
- ✓ **Triangle/Staged:** The triangular or hexagonal pattern of planting arrangement is based on an equilateral triangle, a triangle with three equal sides that is formed by connecting 3 closest plants with an imaginary line.


Triangle spacing



Rectangular spacing


Square spacing



Criteria of field lay out selection.

There are two important criteria of field lay out selection:

- ✓ **Spacing:** Is the distance between two rows of plants and the distance between two plants or two groups of plants
- ✓ **Pathway:** Is a passing area within the field through which a farmer moves to supervise or to carry out some maintenance activities in the crops.

All these two criteria determine the number of plant rows to put in the field.

LO 2.7– Keep record as required by supervisor

- **Content/Topic 1. Importance of farm records**

Keeping records is the backbone of managing one's agribusiness. Efficient management a farming operation requires that records be maintained to enable the farmers to make informed decision affecting their profits.

There are 2 main types of records that a farmer must keep:

- Financial records
- Production records

Financial records concern the financial dealings of the farm. These records show farmer income and expenditures. eg. Produce sales, operating expenses, equipment purchases, depreciation records,…

Production records include things such as crop yields, plant population, quantity of inputs used and loss through death.

Importance of farm records

1. Farm records are used to evaluate the performance of any farm or farm enterprise within a given period of time
2. Records are an aid to managerial control
3. farm record provide figure for farm planning and budgeting
4. Farm records tells a farmer how is being earned

5. farm records enable the farmer to obtain loans from banks and their financial institution
6. farm records tell a farmer where they are gaining progressively or loosing

- **Content / Topic 2. Content of record form and methods of recording.**

The contents of record form are the following:

- ✓ Vegetables species if possible variety
- ✓ Date
- ✓ Activity: includes planting activities and maintenance activities
- ✓ Site location: local administrative entities and the distance from the main road
- ✓ Quantity
- ✓ Unity/ Designation
- ✓ Field size
- ✓ Purpose of growing: include research purpose or market production purpose

Methods of recording

They are 2 main methods of recording:

- ✓ Written recording: consists of using a pen to fulfil a record form. It is also known as hard copy recording.
- ✓ Soft recording on computer: consists of fulfilling a record form found in a computer by using keyboard or other part of a computer that can permit to enter data within it.

Learning Unit 3 – Carry out planting and post planting operations

LO 3.1 – Prepare vegetables seeds as required by vegetables species

- **Content / Topic 1. Characteristic of good vegetable seeds.**

Good vegetable seeds are characterized by:

- ✓ **Viability:** a viable seed is one which is capable of germination under suitable conditions. The definition includes dormant but viable seeds, in which case the dormancy must be broken before viability can be measured by germination.
- ✓ **Purity:** Seed is considered pure if it appears normal in terms of size, shape, and general outward appearance. Conversely, seed that is too small, has been partly eaten by insects, or exhibits fungal stains is regarded as impure.
- ✓ **Germination rate:** The germination rate describes how many seeds of a particular plant species, variety or seed lot are likely to germinate over a given period. It is a measure of germination time course and is usually expressed as a percentage, e.g., an 85%. germination rate indicates that about 85 out of 100 seeds will probably germinate under proper conditions over the germination period given.

$$\textbf{Germination rate} = \frac{Number\ of\ germinated\ seeds}{Number\ of\ sown\ seeds}\ \textbf{X 100}$$

A high percentage of more than 80% indicate that the seeds are viable and suitable for planting while for a lower percentage, the seeds are of low viability and therefore not suitable for planting.

- ✓ **Moisture content:** The moisture content is the amount of water in the seed and is usually expressed as a percentage. It can he expressed on either a wet weight basis (where it is expressed as a percentage of the fresh weight of the seed) or on a dry weight basis (where it is expressed as a percentage of the dry weight of the seed). A good seed must be dry. When the seed is not sufficient dry, it rots during storage or may quickly lose its viability. The farmer should check if the seed meets the minimum water content.
- ✓ **Health:** A good seed must be free of diseases transmissible by the seed. It should not be severely attacked by other diseases otherwise it must be treated against them.
- ✓ **Non defects/good size:** A good seed should be proportionally of the same size.

- **Content / Topic 2. Determine the rights pretreatment methods.**

✓ **Soaking:** Throw your seeds into a small bowl or cup filled with warm water (just enough to cover the seeds). For thick-skinned seeds like peas, aim for 8 to 10 hours (or overnight, assuming you soak them right before bed and sow them first thing in the morning). For thin-skinned seeds like snap beans, soak for 2 to 4 hours

✓ **Scarifying:** Scarification in botany involves weakening, opening, or otherwise altering the coat of a seed to encourage germination. Scarification is often done mechanically, thermally, and chemically. The seeds of many plant species are often impervious to water and gases, thus preventing or delaying germination.

✓ **Stratification:** In horticulture, stratification is a process of treating seeds to simulate natural conditions that the seeds must experience before germination can occur. Many seed species have an embryonic dormancy phase, and generally will not sprout until this dormancy is broken.

✓ **Chemical treatments:** Using suitable chemical reagent such as concentrated sulfuric acid and potassium nitrate to soften the seed coat.

✓ **Pre-germinant:** It's a pretty easy way to check old seeds and get a bit of a jump when sowing seeds. This can also be done with brand new seeds if you want to. You can pre-germinate almost any vegetable seed and works well with cucumbers, squash, beans, peas, okra, and even tomatoes.

✓ **Germination rate test:**

- Obtain sample from the seed lot;
- Count a known number from the sample;
- Provide favorable conditions for germination or plant a known number of seeds and water them for some days.
- After few days count the number that has germinate

- **Content / Topic 2.Seedbed types.**

✓ **Raised:** is a form of gardening in which the soil is enclosed in three-to-four-foot-wide (1.0–1.2 m) containment units ("beds"), which are usually made of wood, rock, or concrete and which can be of any length or shape


- ✓ **Flat:**


- ✓ **Sunken**:As opposed to building soil above ground with a raised bed, a sunken is a bed below ground where it is cooler and wetter. This type of bed appears to work better than a raised bed.


Sunken bed

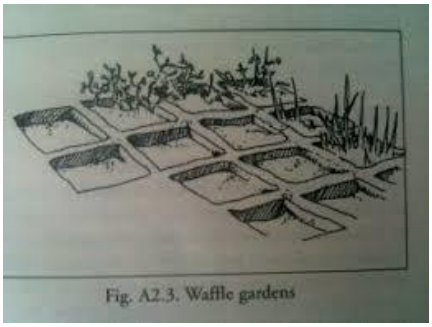


Fig. A2.3. Waffle gardens

L O 3.2: Plant vegetables referring to vegetables species and market standards.

- **Content / Topic 1.Spacing/plant density of priority vegetables in Rwanda.**

The following table summarizes the sowing procedures for cabbage, carrots, tomato, eggplant, onion, sweet pepper, amaranths and pumpkin.

Parameter / Crop	Spacing	Density
Cabbage	60cm between rows and 40cm in rows	4 plants/m^2
Tomato	100cm between rows and 50cm in rows	2plants/m^2
Carrots	30cm between rows	0.4-0.5 g /m^2
Eggplant	80cm between rows and 50-60cm in rows	3plants/ m^2
Onion	20-25cm between row and 5-10 cm in row	450.000 plant/ha
Pumpkin	1.5 m between rows and 2 m in rows	3333 plants/ha
Amaranths	60cm between rows and 40cm in rows	4 plants/m^2
Sweet pepper	60cm X 120cm	10.000 plant/ha

- **Content / Topic 2. Methods of sowing.**

  - ✓ **Broadcasting**: This is a method of planting whereby seeds are scattered in prepared garden by use of hand or machines and later covered with light soil.
  - ✓ **Row sowing**: This is when seeds or cuttings are planted in rows at regular intervals. It is also common with crops like cabbage, tomatoes, sweet pepper, pumpkin, egg plants and onions.
  - ✓ **Seed drilling**: is used for carrots seeds because they are tiny, they need to be sown shallowly.
  - ✓ **Sowing in pots/Sleeves**: Seeds are directly placed in the pots where they germinate and grow until they reach the full maturity.
  - ✓ **Seed dibbling**:

- **Content / Topic 3. Field transplanting.**

- ✓ **Bare roots:** Bare root plants are plants that go dormant during the winter and can be dug up and stripped clean of all soil, leaving their roots completely bare. They can then easily be propagated and transplanted. Many vegetables and berries do best when planted during the winter.
- ✓ **Containerized:** Growing vegetables in containers is possible, but there are some that grow easily and produce heavily in containers.

Examples:

Tomatoes	Green beans	Sweet peppers	Carrots
			

- **Content / Topic 4. Selecting seedling**

Selection criteria of seedlings are the following:

- ✓ Healthy (without pests and diseases)
- ✓ Resistance to diseases
- ✓ Vigorous(Well grown seedlings)
- ✓ Size (Required size: growth condition: number of leaves, height)
- ✓ Good feature (not deformed)

- **Content / Topic 5. Seedling pretreatment.**

- ✓ **Trimming / paring:** This is the removal of excess roots or leaves before transplanting
- ✓ **Hardening off:** Seedlings towards transplanting are exposed to conditions they are to meet in the field (acclimatized).
- ✓ **Grafting:** is a tool normally used in vegetable crops to improve production. Grafting consists of the use of a vigorous plant to replace the root

system of a cultivar of economic interest but that is susceptible to one or more stress factors.

L O 3.3: Maintain vegetable plantation according to requirements and market quality standards

- **Content / Topic 1. Vegetables maintenance practices.**

  - ✓ **Watering:** Regular watering and preferably heavy watering once or twice week should be practiced. Loosen the soil around the seedling using a piece of stick or garden fork.
  - ✓ **Weeding**: By uprooting should be carried out regularly
  - ✓ **Thinning:** This is the removal of overcrowded seedlings a few days after germination. The removed seedlings are thrown away. This practice is done to reduce competition for nutrient and space.
  - ✓ **Mulching:** To conserve moisture, improve on water infiltration and control of weeds. We can use the dried materials between plants. Their arrangement helps to maintain the soil moisture and to reduce the growth of weeds.
  - ✓ **Earthing up**: In carrots, onions and cabbages can be done.
  - ✓ **Gapping (Gap filling)**: It is carried out where seedlings failed to establish or damaged by pests except for carrot.
  - ✓ **Pruning:** Prune where necessary especially vegetables which have many branches.
  - ✓ **Staking**: Can be done especially in tomatoes, eggplant and pepper.
  - ✓ **Fertilizer/Manure application** to improve on the yield should be done as recommended.

- **Content / Topic 2. Control of main pests and diseases of vegetables crops methods.**

There are four methods of plants pests and diseases control in vegetables:

- ✓ **Cultural control methods:** Is using the production or utilization methods of a commodity with a concern for insect management. Sanitation is destroying the habit associated with deprived of shelter, protection from natural enemies, overwintering sites, etc.

In agriculture, culture control is the practice of modifying the growing environment to reduce the prevalence of unwanted pests using cultural before chemical control can reduce detrimental effects to the ecosystem surrounding the growing environment.

- ✓ **Mechanical control methods**: is the management and control of pests using means such as fences, barriers or electronic wires. It includes also weeding and change of temperature to control pests. Many farmers at the moment are trying to find sustainable ways to remove pests without harming ecosystem.
- ✓ **Physical control methods:** Is a method of getting rid of insects and small rodents by killing, removing or setting up barriers that will prevent further destruction of one's plant. These methods are used primarily for crop growing, but some methods can be applied to homes at well.
- ✓ **Chemical control methods:** Chemical pesticides are often used to control diseases, pests or weeds. Chemical control is based on substances that are toxic (poisonous) to the pests involved. When chemical pesticides are applied to protect plants from pests, diseases or overgrowth by weeds, we speak plant production.
- ✓ **Biological control methods:** Biological control, the use of living organisms to control pests. A natural enemy such as a parasite, predator, or disease organism is introduced into the environment of a pest or, if already present, is encouraged to multiply and become more effective in reducing the number of pest organisms.

Main pests and diseases of vegetables.

Crop	Diseases and causal agents			Pests
	Fungal diseases	**Bacterial diseases**	**Viral diseases**	
Cabbage	-Downy mildew (*Peronospora parasitica*), -Grey leaf mould	-Black rot (*Xanthomonas campestris* pv. *campestris*)	Turnip mosaic virus (TuMV)	-Cutworm (Agrotis segetum) -Aphids (Breviconyne blassicae) -Diamondback moth (*Plutella xylostella*)

	(*Alternaria brassicae*), -Club root (*Plasmodiophora brassicae*), -Damping off *(Sclerotium rolfisii)*			
Tomato	-Tomato blight *(Phytophtora infestans)* -Damping off *(Sclerotium rolfisii)* -Fusarium wilt *(Fusarium oxysporium)*	-Bacterial wilt *(Pseudomonas solanacearum)*	-Tobacco mosaic virus	-Aphids *(Diuraphis noxia)* -Looper caterpillars *(Achaea janata)*
Carrots	-Leaf blight *(Alternaria dauci)*	Carrot bacteriosis *(Xantomonas campestris pv. carotae)*	Carrots virus Y	Aphids Cutworm

Egg-plant	-Early blight (Alternaria tomatophilia) -Cercospora leaf spot *(Cercospora melongenae)* -Damping-off (Fusarium Pythium spp. Rhizoctonia spp) -Powdery mildew *Leveillula taurica)*	**-Bacterial wilt** *(Ralstonia solanacearum)* -Cercospora leaf spot (Ceercospora spp.) -Alternaria rot *(Alternaria alternate)* -Fusarium wilt *(Verticillium spp.)*	-Eggplant blister mottled virus (EBMV)	-Aphids *(Myzus perscicae)* -Colorado potato beetle (*Leptinotarsa decemlineata)*
Onion	-Down mildew *(Peronospora destructor)* -Pulp blotch (*Alternaria porri)* Stemphylium leaf blight *(Stemphylium vasicarium)*	Bacterial blight *(Xanthomonas axonopodis pv.)*	-Yellow dwarf (OYV00)	-Thirps *(Thysanoptera)* -Onion fly /maggot *(Lucilia sericata)*

Pumpkin	-Powdery mildew *(Golovinomyces orontii)* -Downy mildew *(Peronospora sparsa)*	-Bacterial spot *(Xanthomonas cucurbitae)* -	-Cucurbita mosaic virus (CMV) -Squash mosaic virus (SqMV) -Zucchini yellow mosaic virus (ZYMV)	-White speck *(Erebia claudina)*
Amaranths	-Dumping off *(Rhizoctonia spp.)*	-Bacterial leaf spot *(Amaranthus cruentus)*	-Wet rot *(Choanephora cucurbitarum)*	-Amaranthus sten weevil *(Xypolixus truncatulus)* -Amaranthus caterpillar *(Hymenia recurvalis)* -Leaf beetle *(Chrysomelidae ssp.)*
Sweet pepper	-Bacterial spot *(Xanthomonas euvesicatoria)*	-Gray mold *(Botrytis cineria)* Powdery mildew *(Leveillula taurica)*	-Pepper mild mottle virus (PMMV)	-Broad mites *(Polyphagotarsonemus latus)* -Leaf miners *(Liliomiza trifolii)* -Pepper weevils *(Anthonomus eugenii)*

L O 3.4: Keep record as required by supervisor

- **Content / Topic 1. Importance and methods of farm records keeping.**

Importances of farm records keeping are:

- ✓ Farm records are used to evaluate the performance of any farm or farm enterprise within a given period of time
- ✓ Records are an aid to managerial control
- ✓ Farm record provide figure for farm planning and budgeting
- ✓ Farm records tells a farmer how is being earned
- ✓ farm records enable the farmer to obtain loans from banks and their financial institution
- ✓ Farm records tell a farmer where they are gaining progressively or loosing

Methods of recording.

They are 2 main method s of recording:

- ✓ Written recording: consists of using a pen to fulfill a record form. It is also known as hard copy recording.
- ✓ Soft recording on computer: consists of fulfilling a record form found in a computer by using keyboard or other part of a computer that can permit to enter data within it.

- **Content / Topic 2. Content of record form.**

The contents of record form are the following:

- ✓ Planting records: this records the planting density (spacing), labors, expenses.
- ✓ Variety/planting materials records: all expenses related to the improved variety should be recorded.
- ✓ Weeding records: expenses or payment for labors must be recorded.
- ✓ Fertilizers application records: it shows amount of fertilizers used on a given areas, when and how fertilizers are applied include labour payments.
- ✓ Vegetables species, if possible its variety
- ✓ Date
- ✓ Activity: includes planting activities and maintenance activities
- ✓ Site location: local administrative entities and the distance from the main road
- ✓ Quantity

- ✓ Unity/ Designation
- ✓ Field size
- ✓ Purpose of growing: include research purpose or market production purpose

Learning Unit 4 - Carry out harvesting and post harvesting operations

L O 4.1: Identify maturity stages according to specific market requirements

- **Content / Topic 1. Types of maturity**

There are two types of maturity:

- ✓ **Utility maturity:** is defined as the time when the plant is harvested for a given purpose before attaining or showing a physiological maturity stage**.** The harvested products may be used as fodder for animal or for soil improvement in case of vegetables.
- ✓ **Physiological maturity**: is defined as the time when dry matter accumulation in the kernel or seeds ceases, in other words the grain stop "filling".

- **Content / Topic 2. Physiological signs of maturity for vegetables crops**

Parameter / **Crop**	**Maturity time (life cycle)**	**Maturity signs**	**Crop period**
Cabbage	2-3 months after transplanting	-Cabbage can be harvested anytime after the heads form. -Cut the cabbage heads when they are solid (rigid to hand pressure) but before they crack or split	Cabbages are harvested During 10 days after maturing
Tomato	3-4 months after transplanting, .	-They are harvested when red in colour for human consumption, -For fresh market tomatoes, they	The first fruit can be harvested 10-14 weeks after sowing, harvesting

		are often harvested at the pale-green stage and ripened in storage.	continue for about two months.
Carrots	3 months after planting	-Leaves start yellowing -Cracking of the soil	First, pull up the biggest carrots to allow the remaining to grow up.
Eggplant	2-3 months after transplanting	The fresh fruits ready to be harvested are of big size depending on variety	Flowering starts 6 to 8 weeks after transplanting, first fruits can be harvested about 5-6 weeks after flowering. Harvesting is done during 3months.
Onion	3-4 months after transplanting	-Neck fall is the indication of maturity. -The best time to harvest onion is when 60 to 70% of tops have broken over. -Development of red pigment and the characteristics pregnancy of the variety are also important harvest indices.	Ripe bulb crop is ready for harvest in 3 to 4 months after transplanting.
Pumpkin	3 months after planting	-Fruits should be harvested at full stage of maturity when the rind has hardened -Colour changes from green to yellow or orange. Some varieties remain green only after full maturity.	Fruits require 110 to 120 days for maturity from sowing.
Amaranths	Maturity Period: 6 weeks after transplanting.	First harvest is at a plant height of 30 cm.	With multiple harvests, young leaves & tender shoots are picked at 2 to

			3-week interval
Sweet pepper	2-3 months after transplanting	Generally, peppers are harvested in the mature green stage depending on variety. They should be of good shape, waxy, firm and shiny.	Most sweet peppers mature in 60-90 days

- **Content / Topic 3. Methods of maturity indices determination.**

Methods of maturity indices determination are:

- ✓ **Visual methods:** By using our naked eyes, one can differentiate a mature vegetables species from a young one.
- ✓ **Physical methods:** By using signs of physical change, by measuring the relative humidity of the seeds and reduction of weight and dryness of the seed and its hardness by using our teeth.
- ✓ **Chemical methods:** By testing the accumulation of dry matter in laboratory or using relative reagents to test the accumulation of starch in the seed.
- ✓ **Physiological method:** By observing and using a physiological signs shown by a physiological mature vegetables.
- ✓ **Computation method:** By counting the period from sowing to a given date and compare it with the life cycle of the vegetables species

L O 4.2: Apply specific techniques of harvesting specific to vegetables species and market requirements

- **Content / Topic 1. Parts to be harvested on vegetables and Harvesting techniques on vegetables crops.**

  Parts to be harvested on vegetables

The following table shows the parts to be harvested for vegetables:

Parts to be harvested	**Example of crops**
Leaves	Cabbage, lettuce, amaranth, spinach,
Roots	Carrots, beet root, Radish.
Bulbs	Onion, garlic.
Stem	Amaranth, spinach,
Fruits	Tomato, egg-plant, pepper, chayote, pumpkin, cucumber, water melon
Vegetables	Green bean, soybeans, garden peas, lima bean
Flowers	Cauliflower

Harvesting techniques for vegetable crops.

- ✓ **Manual harvesting:** The mature vegetables plants are harvested by using manpower hands. It consists of uprooting mature plant, cutting mature plant above the soil and or picking dry pods while other parts of the plant are omitted in the field. In manual harvesting, the harvested vegetables are dried and most of the case wait for manual threshing and winnowing.
- **Selective harvesting:** according to dictionary, selective harvesting is the practice of removing individual plants a small group of plants leaving, other plants standing to anchor the soil.

In forestry, selective harvesting is a forestry practice of cutting some of the trees in area of land, while allowing others to grow. During selective harvesting, the farmer can harvest the best vegetables plant that shows good performance in production and good health that may be used for the next vegetables production. This practice can also be performed in agricultural research institutions when a new plant variety is being tested.

- **Non-selective harvesting:** This is the harvesting the all plant in the field without considering any trait. The best performance plants and the worst one are harvested mixed together.

- ✓ **Mechanical harvesting:** The mature plants are harvested by using specific harvesting machine or tractor. Most harvesting tractor are equipped with threshing and winnowing equipment. This means, threshing and winnowing practices are performed in the field during harvesting.

L O 4.3: Apply techniques of handling specific to vegetable species and market requirements

- **Content / Topic 1 Practices of vegetables produce handling.**

- ✓ **Pre-cooling:** means quickly removing the heat from freshly harvested fruits and vegetables to reduce the loss in quality of produce once it's been picked. Likewise, precooling increases the shelf-life of fresh produce. Higher quality and longer shelf-life means more profits to produce growers.
- ✓ **Sorting:** It is a practice of separating remains residues and vegetables grains (with bad shape or broken) with good vegetables.
- ✓ **Grading:** Grading is done by using a grading machine that allows the grains of the same size to heap together.
- ✓ **Trimming:** This is the removal of excess roots or leaves before transplanting
- ✓ **Washing:** after harvesting vegetables particularly for carrots, it is necessary to wash them with water in order to remove the soil particles found from their outer layer.
- ✓ **Drying:** It consists of putting harvested vegetables on the sunshine and allow them to dry enough before threshing or shelling.
- ✓ **Cooling:**

- **Content / Topic 2 Packaging.**

Characteristics of packages:

- Visible
- Easy transport
- Esthetic
- Status
- Dependability
- Adaptability
- Security
- Not being too heavy

- ✓ Types of packages used in vegetables
  - Wood.
  - Pallets literally form the base on which most fresh produce is delivered to the consumer. ...
  - Wire-Bound Crates. ...
  - Wooden Crates and Lugs. ...
  - Wooden Baskets and Hampers. ...
  - Corrugated Fiberboard.
  - Pulp Containers

- **Content / Topic 3Labeling characteristics of vegetable produce**

Characteristics of good label are:

- ✓ **Readable:** Written with large characters that allow easy to read
- ✓ **Visible:** the label should large enough for easy to identify/to see by the consumers.
- ✓ **Understandable:** The words and the pictures should explain and give more information to consumers.
- ✓ **Presentable:** Colors and pictures used to demonstrate the product should attract the consumers.

L O 4.4: Keep records as required by the supervisor

- **Content / Topic 1 Importance of records keeping and Content of record form.**

Importance of farm records keeping are:

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- **Content / Topic 2 Labeling characteristics of vegetable produce**

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