TVET CERTIFICATE III in Crop production

LEGUME CROPPING

CRPLC302

GROW LEGUMES

Competence

Credits: 7

hours: 70

Learning

Sector: Agriculture and food processing

Sub-sector: Crop production

Module Note Issue date: October, 2020

Purpose statement

This module describes the skills, knowledge and attitude required to grow legumes. It is designed for learners who have successfully completed Nine years basic education or 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 select the site for legumes growing, conduct legume plantation, and handle harvested produce of legumes. Qualified learners deemed competent may work in various places including Site/ field, Office, Legumes garden performing in range of tasks related to crop growing he/she can work alone or with others under supervision.

Table of Contents

	4.2Proper application of harvesting techniques specific to legumes species and market requirement	
	4.3 Effective application of handling techniques specific to legumes species and market requirement	
	4.4 Proper record keeping as required by supervisor	

Total pages: 43

Introduction

This module describes the skills and knowledge required to apply cropping techniques for vegetable crops production (beans, soya beans, groundnuts and peas,) mainly grown in Rwanda.

Species names

Vernacular (Local) names	**Scientific name**	**Family**
Beans	***Phaseolus vulgaris***	Phabaceae
Soya Beans	***Glycine max***	Phabaceae
Ground nuts	***Arashis ipogea***	Phabaceae
Peas	***Pisum sativum***	Phabaceae

Importance of legumes

- ✓ Legumes are major sources of plant protein to humans
- ✓ They help to restore soil fertility by fixing (N_2) into the soil
- ✓ They are generally leaf crop that provide effective soil cover. In this way, they help in soil and water conservation.
- ✓ The by-products from crushed legumes seeds are nutritious feed for livestock such as groundnut cake.
- ✓ Legumes have a short maturity periods so they can be produced twice in year.
- ✓ Legumes are sources of oil used for cooking and soap manufacture.
- ✓ Deep rooted such as pigeon peas recycle nutrients
- ✓ In this module, the focused crop as examples for legumes are: Beans, Soy beans. Groundnuts and peas.

Learning Unit 1 –Prepare for legume establishment operations

LO 1.1 – Select tools and equipment referring on legumes species

- Content/Topic 1. Types of tools used in legumes growing

According to their purposes, legumes growing tools are classified into the following groups:

1. **Land clearing tools and equipment**

These are tools and equipment for cutting grasses, shrubs and trees trunks for further facilitating the next land preparation activities like first tillage. A variety of this tool is selected according to background of the field and its usefulness in land clearing operation**:** Some of tools are for example: machete, slasher, axe, sow chain, sickle, hand hoe and knapsack sprayer in case of chemical land clearing.

In intensive legume production, mechanical land clearing by using tractor can also be used.

2. **First tillage tools and equipment**

These are tools used to uproot tree stump, tree roots by digging the cleared land up to 35cm deep.

In this operation, manual or mechanical methods can be used according to the farmer financial means and soil structure and texture. Tools that are mostly used in manual method are hand hoe, forked hoe, axe, pick and pick axe. In mechanical method, traction animal and its equipment and tractor are used.

3. **Second tillage tools and equipment**

Like in the first tillage**,** manual or mechanical methods can be used according to the farmer financial means, structure, and texture of the soil. The purpose of this operation is to softening the soil for easy sowing of seed and its germination. In manual method, we can use hand hoe, forked hoe. In mechanical method, traction animals and tractor are used.

In some area with big clod after second tillage, rake for loosening and levelling the ground is used before sowing seed.

4. Legume maintenance tools and equipment

These are tools for weeding, hoeing, earthing up and pests and diseases control in legume crops.

Example: hand hoe, and knapsack sprayer, ropes for staking peas,…

5. Legume harvesting tools and equipment

Tools and equipment used in manual harvesting of legumes are variable depends on the legume specie.

Some need to up root while others need to be cut by using sickle, big sickle, darat, gandosa and small axe. For soya bean, a hand hoe can be used when the soil texture does not easy uprooting. In case of flesh and green bean a charp knife can be used. Around these harvesting tools, there are tools that can help in collection of pods like sacs, bucket, basin, and wheelbarrow to transport the harvested product from the farm to the drying area.

6. Legume produce handling tools and equipment

Handling tools and equipment for legumes include threshing tools, winnowing tools, drying tools, sorting tools, seed treatment tools, weighing and packaging tools and storage tools.

Table 1. Activity and example of manual handling tools

Activity	**Example of tools**
Threshing	Sticks
Winnowing	Winnowing basket
Drying	Drying mats, plastic sheeting
Sorting	Sorting siever
Seed treatment	Coating pump or duster
Weighing	Balance
Packaging	Plastic bag of 5okg 100kg or jute bag of 50kg

	or 100kg
Storage	Pallets, hygrometer and thermometer

- Content/Topic 2. Tools and equipment selection criteria

Tools and equipment used in legume growing are selected according to the below criteria:

- **Activity to be done**

Farmers select tools differently depend on the agricultural to be done. Tools used in land clearing are different from tools used in first tillage and second tillage respectively. Likewise, tillage tools and equipment are different from those harvesting and handling.

- **Working conditions of tools and equipments**

During farming practices, tools and equipment with high speed are more likely than those of medium and low speed. Otherwise, tools and equipment with defects are not selected during farming activities.

- **Availability and accessibility**

In farming activities, farmers prefer to buy and use available locally farming tools. This selection also depends on their financial means to access on the tool and equipment.

- **Cost**

The cheapest tools and equipment are more likely than the expensive tools and equipment. It means that the cost of the tools and equipment may incite farmers to buy it or not.

- **Tools and equipment efficiency**

Tools and equipment also may be selected depends on how well they perform a given agricultural activity. It may also be selected depends on how well it minimizes the farming cost. eg. Farming by using machine (tractor) works well the land (first tillage and second tillage) and minimizes cost compared to that of using work force (manpower).

- **Durability**

Tools and equipment with long lifespan are more preferable than those with low lifespan.

- **Maneuverability**

Tools and equipment that are easy to handle are more likely than those with difficulty to handle.

LO 1.2 – Assess occupational Health and Safety (OHS) hazards and risks for reporting to the supervisor

- Content/Topic 1. Types of hazards associated with legume growing

In farming activities there are different types of hazards that are related to tools, equipment, chemicals and environment hazards around farming area.

Those hazards may be found or in area where legume growing activities are performed. Therefore, hazards associated with legume growing are:

1. **Biological hazards**

These are hazards relative to animals, plants and microbes around or in the land being prepared for legume growing.

Hazards related to animal: Are hazards from stinging animals like bees, ants, termites and snake**.**

Hazards related to plant: Are hazards from venomous plants, plant with needle leaves, and thorny plant.

Hazards related to microbes: are hazards from microorganisms than penetrate our skin and cause different diseases such as endo and ectoparasitic diseases. eg. worms, ticks…

2. **Chemical hazards:** are hazards from pesticides applied on seeds, pesticide application and fertilizers application.
3. **Physical hazards :include**

Tools and equipment-associated hazards: accidents from sharpened tools like hand hoe, machete and noise or vibration from farming machines that can harm the farmer's ears.

Environmental hazards: Hazards from other farms like bad smell, noise and vibration that can cause different health problems. They may be from accident due unidentified holes, stones and residues from previous economic activities.

- Content /Topic2. Hazards risks

Risks associated with **Biological hazards** in legume growing are:

Health problem: like diseases, painful on harm part, loss of some of part of the body like leg and arm, , etc.

Risks associated with **Physical hazards** in legume growing are Fire problem, hearing problem, heart problems…

Risks associated with Chemical hazards in legume growing are blindness, self-intoxication, Air pollution that main source of diseases, and Destroying beneficial insects, soil microorganisms and fishes

LO 1.3 – Select PPE according to the desired operation

- Content/Topic 1. Types/ categories of PPE according to the desired operation

PPE: is used to prevent exposure to infectious materials. In other words, it acts as barrier to stop the spread of germs. Infectious materials can be air born in the form of droplets, or happen through contact routes.

The selection of appropriate PPE is based upon the hazard assessment. One can follow the following assessment steps:

- Identify the potential hazard
- Determine the types of protective equipment available for the present hazards
- Evaluate the effectiveness of PPE
- Select the appropriate protective equipment

Depends on the identified hazard, the selected PPE should fulfill some of or the following conditions on which **SAFETY** stands for.

- The equipment should protect the head/**Skull**
- The equipment should protect the **Arms**
- The equipment should protect the **Face**
- The equipment should protect the **Ears/Eyes**
- The equipment should protect the **Toes**
- The equipment should protect **Yourself**

S
A
F
E
T
Y

Types of PPE are:

1. **Eyes and face protection equipment:** they include

- **Face shields**: Covers the face with a clear plastic screen. They protect the face from infectious droplets and contact with contaminated materials. Without a face shields, germs can gain access through the mucous membrane like those in the mouth, eyes and nose.
- **Goggles and glasses**: protect the eyes from infectious droplets and in the same cases, from contact with infectious agents.

2. **Hand protection equipment**

Gloves: Cover the hands and wrists protecting the skin from contact and droplets exposure. Gloves are most widely used type of PPE.

3. **Body protection equipment**

- **Gowns**: Protect clothing and skin from droplets and contact with infectious materials. Some are placed over clothing and tied in the back, adequately covering the arms and torso and parts of the legs. Other are more like a long drape or suit that covers most of the body.

- **Head covers**: protects the spread of germs through droplets or contact routes. It can also prevent some accident injury like up down fall mass over the head.
- **Shoes covers/ Rain boats:** Prevent accident on the toes and feet

4. **Respiratory protection equipment:**

A face cover fitted with a finer filter that removes small particles than masks. Respirator are classified in number and letter. We have respirator with 95, 99 and 100. It means the percentages of particles that are removed by the filters are 95%, 99% and 100% respectively.

They are also classified as N, R and P as the ability to resist to oil. N respirator is not oil resistant; R respirator is more resistant to oil while P respirator is oil proof.

5. **Hearing protection equipment:** To protect the farmer from noise during farming activities where noisy machines are used

- Content/Topic 2.PPE selection criteria

During selecting PPE, one should consider the following criteria:

- **Potential hazards/Working environment** : one have to assess the environment by identifying all available hazards
- **Compatible/Available PPE to the hazard** : one match PPE to the hazards
- **Level of protection/Effectiveness of PPE to the hazards**: Ability of PPE to protect the exposed person to varieties of infections.
- **Fitiness/Size to properly fit the user**: Not too small or not too large compared to the size of the user.
- **Use orTask to perform**: PPE used by a farmer during tillage activities is different from those used during pests and diseases control.
- **Durability of PPE**: Has long life span
- **Awareness of limitation/Frequency to be used**: It should be reusable after properly cleaning.
- **Cost of PPE**: Even though the PPE should protect the user, it should not be expensive

LO 1.3 – Identify environmental implications of legume growing for discussing with supervisor

- Content /Topic 1. Types of impact of legumes growing on environment

There are **negative** and **positive impacts** of legume growing.

Types of **negative impact** associated with legume growing are:

- **Deforestation**: Due to intensive legume requirements that leads to cutting of natural and cultivated forest.
- **Water scarcity**: caused destruction of some underground water sources and intensive watering of legumes
- **Water pollution**: caused by intensive use of pesticides and fertilizers to increase legume production
- **Air pollution**: Caused by intensive use of pesticides, fertilizers and crop residues
- **Water lodging:** Caused by watering and irrigation of cultivated crops (legumes)
- **Soil erosion**: caused by over cultivation of the land that destroy its structure and forest cutting.
- **Loss of wild biodiversity**: caused by deforestation and wetland drainage in search of land for legume growing
- **Genetic diversity** : caused by searching of productive legume varieties
- **Outbreak of new pest and diseases**: legumes growing has led to destruction of repellent plants and food of insects. Lack of food for those insects makes them severe pests for other plants. In this, case they transmit unexpected diseases. Not only these, but also specific pests and diseases of legumes are incited by their intensive growing.

Types of **positive impact** associated with legume growing are:

- **Ecosystem preservation:** shade and microclimate created by legumes recall small animal and plants to grow.
- Nitrogen Fixation: legumes fixe atmospheric nitrogen in the nodules found on their roots. This nitrogen fixation will improve soil fertility.

- Carbone sequestration: is a process of capturing and storing atmospheric carbon dioxide. it one method of reducing the amount of CO_2in the atmosphere with the goal of reducing global climate change.
- Erosion control: legumes act as plant cover and therefore, contribute to the control of splash erosion.

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

LO 2.1 Select legume species according to market and enterprise target

- Content /Topic 1. Priority legumes species grown in Rwanda

The priority legumes species grown in Rwanda are beans, soybeans, peas and groundnuts.

Table 2.Priority of legumes grown in Rwanda and examples of varieties for each specie

<table>
<tr><th>Species</th><th>Beans</th><th>Soy beans</th><th>Groundnuts</th><th>Peas</th></tr>
<tr><td rowspan="8">Varieties</td><td>Bush varieties</td><td rowspan="8">Bossier
Peka 6
and449/ 16.
SC SQUIRE
SC SEQUEL,
SC SAGA,
SB 24</td><td rowspan="8">HNG18,
HNG17,
Valencia24,
Valencia34</td><td>Bush varieties</td></tr>
<tr><td>✓ RWK 10, RWR2076, RWR2091, RWR2318, RBBB243.</td><td>Miranda</td></tr>
<tr><td>Semi-climber</td><td>Climbing /snap peas (indeterminate)</td></tr>
<tr><td>Rab 487, Urugezi, RWR221(Rwandarugari) A 321, RWR 719, RWR 1783</td><td>Kyondo, nyagashaza</td></tr>
<tr><td>Climbing (indeterminate)/snap beans</td></tr>
<tr><td>Vuninkingi (mountain beans) G 685 high altitude, above 1800m</td></tr>
</table>

	G2331, RWV296, RWV 524, Kitabi 1, Flora (59/1-2) for very high altitude Ngwinurare, widely used in middle and high altitude. RWV 2872, RWV1129, RWV 2361 Green beans: Saxa, Rayal Nel			

- Content /Topic2. Selection criteria of legume species

Legume species to be grown are selected according to the following criteria:

- **Adaptability on ecological conditions**

The farmers should consider soil type, rainfall, temperature, and altitude of the region where legume specie is going to be grown.

- **Productivity**

The most important goals of farmers is to get high production of their crops in both quantity and quality.so that, farmers always reclaim high productive legume varieties to their agricultural research institution.

- **Marketability**

As economic activity, cultivation of legume varieties that are more preferable than others on the market is an important thing to farmers with aim to maintain their household food security but also to generate income.

- **Life cycle**

Apart from high production, legume varieties with short life cycle are more preferable than others.

LO 2.2 – Identify field according to legumes requirements

- Content/Topic 1. Ecological requirements

Table 3.Ecological requirements for beans, soybeans, groundnuts and peas

Ecology / Crops	Soil	Rainfall	Temperature	Altitude	Preferable region in Rwanda
Beans	✓ Sandy roam soil ✓ Deep soil ✓ Rich in organic matter (fertile) ✓ Aerated ✓ Well drained soil ✓ $P^{H:}$ 6,0 to 7,5	300mm to 400mm per growing season	Optimum is 18°C to 25°C	Range from 600m to 2700m sea level	✓ Imbo, ✓ Impala ✓ Mayaga ✓ Eastern plateau
Soy beans	✓ Deep soil ✓ Well aerated ✓ Rich in organic matter ✓ Well drained soil ✓ $P^{H:}$ 6,0 to 6,5	✓ Good rainfall 500mm to 750mm	Warm climate To range from 21°C to 30°C	Below 1900m form sea level	✓ Imbo ✓ Shore Lac Kivu ✓ Central plateau ✓ Mayaga ✓ Bugesera ✓ Eastern plateau ✓ Eastern savanna
Ground nuts	✓ Sandy loam soil ✓ Deep soil ✓ Loosen and Well aerated ✓ Well drained soil ✓ $P^{H:}$ 5,5 to 6,5	Annual rainfall range 600 to 1500mm	✓ Warm climate 20°C to 30°C	Up to 1000m sea level	✓ Imbo ✓ Mayaga ✓ Bugesera ✓ Eastern plateau ✓ Savana
Peas	✓ Volcanic soil ✓ Deep soil ✓ Loosen and Well aerated ✓ Rich in organic matter ✓ Well drained soil ✓ pH of 5,5 to 6,5	✓ Average annual rainfall of 1000mm is preferable. ✓ Resistant on frost	✓ Optimum T° range from 15°C to 25°C	Range from 1800m to 2700m sea level	✓ Volcanic soil ✓ Congo Nil crest ✓ Buberuka high land

- Content/Topic 2. Field background

✓ **Previous crop**

Before planning to grow any legume, the farmer must have information on the previous crop to respect crop rotation principle. Last crop (respect of crop rotation plan) with advantages of crop rotation, which are to control pest and disease, maintenance of soil fertility, soil erosion control, control of weeds, proper utilization of nutrients

✓ **Fertilization types**

This will give farmers the information on the type of fertilizer to apply during legume sowing.

✓ **Pesticide types**

This will give to farmers the information on type of pesticide applied and their effect on diseases and pests life cycle breaking down. So that, he/she decides if he/she can apply an effective pesticide that will help to legume to thrive well without pests and diseases attack.

✓ **Pests and diseases**

Before deciding to grow any legume, the farmer should know if the type of pests and diseases found in the previous crops are not specific to legumes.

- Content /Topic 3. Field accessibility

✓ **Infrastructure:**

The site desired for beans, soybeans, groundnuts and peas growing should be near the road for facilitating the transport of fertilizers, seeds and legume produces.

✓ **Market:** Near transformation unit, School and City to facilitate the commercialization of legume produces.

✓ **Field slope:** Field topography /slope of the land, length and width of land have to be taken into consideration before planning legume growing

LO 2.3– Clear the land according to the site selected

- Content/Topic 1. Importance of land clearing

Land clearing can be used to remove dead plants, rotting tree stumps, and other such threat, preventing the spread of wildfire and protecting the structures on the plots nearby.

Dense areas with a lot of trees and plants provide natural shelter for pests and increasing their population.

- Content/Topic 2. Site obstacles

Site obstacles are different things that are found in the land subjected to be used for crop growing and subsequently delay land preparation activities.

Different obstacles found on the land to be cleared are:

- Shrubs/ bushes
- Stones
- Stumps
- Holes

- Content /Topic 3. Tools and equipment used in land clearing

These are tools and equipment for cutting grasses, shrubs and trees trunks for further facilitating the next land preparation activities like first tillage. A variety of this tool is selected according to background of the field and its usefulness in land clearing operation**:** Some of tools are for example: machete, slasher, axe, sow chain, sickle, hand hoe and knapsack sprayer in case of chemical land clearing.

In intensive legume production, mechanical land clearing by using tractor can also be used.

- Content /Topic 4. Methods/ways of land clearing

  - Manual clearing

By using simple farm tools like machete, slasher, axe, sow chain, sickle, and hand hoe. It consists of using workers equipped with the above simple farm tools.

  - Mechanical clearing

The land is cleared by using machines like tractors equipped with specific tools to cut trees, tree stumps, bushes and grasses.

- Chemical spray clearing

The land is cleared by using specific herbicides to the grasses or herbs to be remove on the land. It consists on spraying dissolved herbicide on the grasses.

LO 2.4 – Till the land for legume growing according to their requirements

- Content/Topic 1. Tillage types

Tillage is the mechanical manipulation of soil with tools and implements for obtaining conditions ideal for seed germination, seedling establishment and growth of crops.

There are two types of tillage in land preparation:

- **Primary tillage**

It consist of initial/first plowing in order to remove tree stumps, tree roots by digging the cleared land up to 35cm deep.

In this operation, manual or mechanical methods can be used according to the farmer financial means and soil structure and texture. Tools that are mostly used in manual method are hand hoe, forked hoe, axe, pick and pick axe. In mechanical method, traction animal and its equipment and tractor are used.

- **Secondary tillage**

Deeper plowing where large clods are broken to give the fine soil structure. The purpose of this operation is to softening the soil for easy sowing of seed and its germination. In manual method, we can use hand hoe and or forked hoe. In mechanical method, traction animals and tractor are used.

In some area with big clod after second tillage, rake for loosening and levelling the ground is used before sowing seed.

- Content/Topic 2 .Cultivation methods in legumes growing

- ✓ **Flat cultivation method**

The seeds are sown by broadcasting or drilling them on flat land without formation mound.

- ✓ **Mound cultivation**

The seeds are sown by broadcasting or drilling them on raised be environment for germinating seeds and plants. In area with clay or poorly draining soil, the mound provides superior drainage compared to planting directly in a traditional bed since any excess moisture drains more quickly from the mound.

- Content /Topic 3. Objectives of primary tillage and secondary tillage

Objectives of tillage

The main objectives of tillage are:

- ✓ To prepare a good seed bed which helps the germination of seeds.
- ✓ To create conditions in the soil suited for better growth of crops.
- ✓ To control the weeds effectively.
- ✓ To make the soil capable for absorbing more rain water.
- ✓ To mix up the manure and fertilizers uniformly in the soil.
- ✓ To aerate the soil.
- ✓ To provide adequate seed-soil contact to permit water flow to seed and seedling roots.
- ✓ To remove the hard pan and to increase the soil depth.

To achieve these objectives, the soil is disturbed / opened up and turned over.

Types of preparatory tillage

a. Primary tillage

b. Secondary tillage

a) Primary tillage: The tillage operation that is done after the harvest of crop to bring the land under cultivation is known as primary tillage or ploughing. Ploughing is the opening of compact soil with the help of different ploughs. Country plough, mould board plough, bose plough, tractor and power tiller drawn implements are used for primary tillage.

Objective of primary tillage is to obtain a reasonable depth (10-15cm) of soft soil incorporate crop residues, kill weeds by burying or cutting and exposing the root, and to aerate the soil.

b. Secondary tillage: The tillage operations that is performed on the soil after primary tillage to bring a good soil tilth are known as secondary tillage. Secondary tillage consists of lighter or finer operation that is done to clean the soil, break the clods and incorporate the manure and fertilizers. Harrowing and planking is done to serve those purposes. The objective of second tillage is to incorporate fertilizers, reduce the soil to a fine tilth, and level the surface or control weeds.

Tilth is the physical condition of soil obtained out of tillage (or) it is the result of tillage. The tilth may be a coarse tilth, fine tilth or moderate tilth.

LO 2.5 – Apply soil amendment complying with legumes requirements

- Content/Topic 1. Objectives of soil amendment application

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.

- Content/Topic 2. 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 3. Selection criteria 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.

- Content /Topic 3. 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 are Inorganic 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 legume production

- Content/Topic 1. Importance of planting pattern

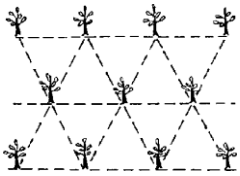
During growing season, the inter-row spaces are hoed two to four times and the rows are weeded to conserve moisture and improve aeration. As a result, the soil's microbiological activity increases and mobilization of nutrients is intensified.

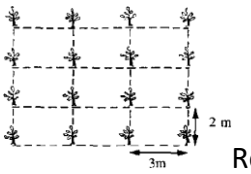
The most common used planting patterns are square spacing or triangular spacing where the distance between the rows are the same as along the rows. If strip clearing or weeding are used, a rectangular pattern where trees are closer in the rows, than between the rows might reduce labour input.

- Content/Topic 2. Different planting patterns for legume growing

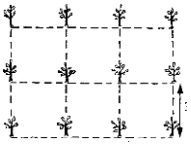
Different planting patterns for legume growing are:

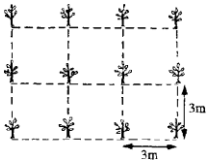
- ✓ **Square**: In square planting, one plant or a group of plants in a common hill occupies the corners of a square, which has 4 sides of equal length.
- ✓ **Double planting pattern/ twine row planting pattern:** Double-row planting, as the name suggests, involves planting two rows of about **8 inches** 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



Sowing density calculation for twine row planting pattern

Sowing density= $\frac{\mathbf{n\ X\ S}}{\left(\frac{\mathbf{D+L}}{\mathbf{2}}\right)\mathbf{X\ l}}$

n:number of seed in hole; **S**:Surface/area; **D**: Distance between double rows; **L**: Distance between rows; **l**: distance between crops.

For other planting pattern, sowing density is calculated as follow:

Sowing density= $\frac{\mathrm{nX\ S}}{\mathrm{LXl}}$ where **n**: is number of seeds per hole; **S**: surface/area**; L**: Distance between rows; **l** :distance between crops.

- Content/Topic 3. 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 shows farmer income and expenditures. eg. Produce sales, operating expenses, equipment purchases, depreciation records,…

Production records includes 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 entreprise 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
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- Content/Topic 2. Content of record form

The contents of record form are the following:

- ✓ Legume species if possible variety
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- ✓ 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

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Learning Unit 3 – Carry out planting and post planting operations

LO 3.1 – Prepare legumes seeds as required by legume species

- Content/Topic 1. Pre-treatment methods

Preparation of seeds/ Variety selection

Table 3 .Selection of goods varieties; some important varieties are detailed in table below:

Crops	**Beans**	**Soy beans**	**Groundnuts**	**Peas**
Varieties	**Bush varieties**	Bossier Peka 6 and449/ 16. SC SQUIRE SC SEQUEL, SC SAGA, SB 24	HNG18, HNG17, Valencia24, Valencia34	**Bush varieties**
	✓ RWK 10, RWR2076, RWR2091, RWR2318, RBBB243.			Miranda
	Semi-climber			**Climbing (indeterminate)**
	Rab 487, Urugezi, RWR221(Rwandarugari) A 321, RWR 719, RWR 1783			Kyondo, nyagashaza
	Climbing (indeterminate)			
	Vuninkingi (mountain beans) G 685 high altitude, above 1800m G2331, RWV296, RWV 524, Kitabi 1, Flora (59/1-2) for very high altitude Ngwinurare, widely used in middle and high altitude. RWV 2872, RWV1129, RWV 2361 Green beans: Saxa, Rayal Nel			

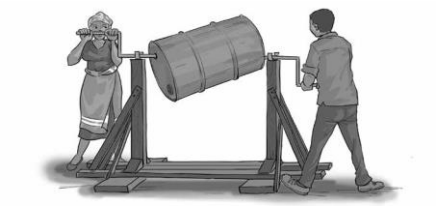
Sorting

This involves removal of diseased, damaged and mis-shapen seeds (Beans, soybeans, groundnuts and peas) and other foreign materials including stones, plant debris etc. Prior to planting the seed should be sorted; small, shriveled, immature, skinned, split or otherwise damaged and moldy seed should be rejected

Grading

Consisting of homogenization of legumes seeds by separating them according to their proper sizes.(Small, medium, large).

Seeds pre-treatments



Simple hand-operated mixing drum for applying pesticides to seed

A combined insecticidal and fungicidal seed dressing is required for presenting soil born diseases.

Most grain legumes plant have nodule on their roots containing bacteria which fix a major part of nitrogen required by the crop. Basing on this inoculation with specific bacterial is also required mostly: Soybeans (*Rhizobium Japonicum*)

Germination test

-Obtain a sample from a seed lot

-Count a known number from the sample

-Provide conditions favorable for germination or plant a known number of seeds and water them for some days.

-After few days, count the number that has germinated

-Calculate the viability, that is: $\frac{\text{Number of seeds germinated} \times 100}{\text{Number of seeds planted}}$

- Content/Topic 2. Characteristics of good legume seeds

The characteristics of good legume seeds are:

- ✓ **Viability**: Seeds viability is the ability of seeds to germinate if provided with necessary conditions after a period of dormancy or just after harvest. If a seed is capable of germinating, it is said to be **viable.**
- ✓ **Purity:** a good seed should not be mixed with other varieties of the same species or different species, without inert materials or any other impurity.
- ✓ **Germination rate:** A high percentage of more 80 indicates 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:** 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.
- ✓ **Required size:** A good seed should be proportionally of the same size.

LO 3.2 – Sow legumes seeds referring on legume species, quality and market standards

- Content/Topic 1. Spacing of beans, soybeans, peas and groundnut/ planting density

Table 4.Spacing of each legume species

Legume species	Spacing/sowing density
Beans	Spacing varies with climate, soil fertility, varieties and cultural practices Spacing for **bush varieties** are 40cmx10cm by using one seed per hole. For **climbing varieties** are 40cm x20cm by using 2seeds per hole. Planting density vary from 60kgs to70kgs per ha
Soybeans	Spacing varies with climate, soil fertility and varieties.

	In general the spacing are: Spacing used is **40cmx10cm or** **40cmx20cm** Planting density vary from 70kgs to 100kgs per ha
Groundnuts	Close spacing is highly recommended for preventing Rosette on groundnuts and vary with variety and soil fertility. Spacing used are: **20cmx20cm (two seeds)or** **20cmx10cm (one seeds)**
Peas	Spacing vary with variety and soil fertility. Spacing used are: **40cmx20cm (two seeds)** Planting density vary from 55kgs per ha.

- Content/Topic 2. Methods of sowing

➢ **How to Sow Beans**

Sow beans where they are to grow, against their supports or, for bush types, 20cm apart with 40cm left between each row. Use a hoe to scratch out rows or dig individual planting holes with a trowel. Drop in two seeds per hole, so they fall about 2cm **apart, and 5cm deep.** For **climbing varieties** are 40cm x20cm by using 2seeds per hole. Planting density vary from 60kgs to70kgs per ha

➢ **How to sow Soybeans**

Seedling depth 2-3 cm in heavy soils and 3-4 cm light soils. Spacing varies with climate, soil fertility and varieties.

In general the spacing are:

Spacing used is **40cmx10cm or 40cmx20cm.** Planting density vary from 70kgs to 100kgs per ha.

Seed rate- Soya bean grown for grain purpose needs about 20-30 kg seed/ha but for fodder crop needs about 70-75 kg/ha.

➢ **How to sow peas**

Spacing vary with variety and soil fertility. Spacing used is **40cmx20cm (two seeds)** while planting density vary from 55kgs per ha.

➢ **How to plant groundnuts**

Close spacing is highly recommended for preventing Rosette on groundnuts and vary with variety and soil fertility.

Spacing used are:

20cmx20cm (two seeds) or 20cmx10cm (one seeds)

If box ridges are spaced at 75 cm apart, double rows of groundnut can be planted along them at a row spacing of 30 cm.

LO 3.3 – Maintain legume plantation according to legumes requirements and market quality standards

- Content /Topic 1. Different maintenance practices

1. **Irrigation/Watering:** When it is not raining, it is important that the farmer bring water to the crop for helping them to continue them growing process.
2. **Gapping/ Gap filling:** it consists of resowing the seeds in the holes where the previous ones were not germinated.
3. **Weeding:**

Proper weeds management is needed for successful production of beans. Beans yield losses arise from competition between and weeds for light, water, space and nutrients. The first weeding is performed 3weeks after planting while the second weeding just before flowering, an addition of 100kgs of DAP per ha in row placement during weeding for bush varieties while for climbing varieties an addition of 200kgs N.P.K per ha or 150kgs DAP+50kgs of Urea per ha during weeding is required.

4. **Earthing up:** It consists of bringing the soil around the roots zone of the plant. to save cost of labor, this practice is carried out at the same time as weeding practice in legume cropping.
5. **Hoeing:** It is a practice of softening the soil to improve aeration of the plant roots zone.
6. **Staking**

Staking for climbing beans is required during first weeding by using stakes of 2m in height. Plant pole beans at least 15cm apart, with rows around 60cm apart. The traditional way to grow beans is against parallel rows, joined where they cross at the top.

For beans, the following maintenance activities should be done:

7. Caring for Beans

Seedlings may sometimes need a little encouragement to latch on to their supports, but they'll quickly find their own way up. Bush types rarely need much support, though top-heavy plants, will appreciate short stalks, twigs or peas ticks to keep them off the ground.

8. Pinch out

The tops of pole beans once they've reached the top of their supports. This prevents them from becoming an ungainly tangled mass, and it concentrates the plants' efforts into producing more flowers and beans.

- **Maintenance of groundnuts**

1. Weeding

Weeding groundnut needs to be done with care:

• Avoid covering the developing plants with soil as this increases the risk of disease and reduced yield.

• Take care when walking through the field when the crop is flowering to prevent disturbing the flowers.

• At pegging, avoid disturbing the soil near the plants: at this stage pull weeds by hand and avoid use of hoes.

2. Crop rotations

Groundnut should not be grown on the same piece of land for successive years. Rather it should be grown in a rotation system, with groundnut being grown every 2 to 5 seasons. There are several reasons for this, including:

• To prevent build-up of pests and diseases, such as nematodes, white mould, leaf spots and insect population

• To avoid depletion of soil nutrients and improve organic matter

• To improve physical structure of soil and avoid loss of humus due to the soil loosening that occurs at harvest.

Groundnut is considered as soil depleting crop if the whole plant is removed but a soil improving crop if the vines and leaves are returned to the soil.

- **Maintenance of soybean**

At the time of sowing one deep ploughing and two harrowings should be given to maintain optimum moisture at sowing.

After care

Keep plot weed free up to 40 days by one or two hoeings, two weedings up to 40 days. Herbicides such as Toke 25, 1.5 to 2 Kg/ha pre-emergence before sowing controls the weeds.

Crop Rotation and inter cropping

Mixed with maize, Sesamum etc. Inter cropping with Cotton, drilled paddy sorghum, cotton, sugarcane. It can be rotated with wheat, potato, gram, tobacco

- **Maintenance of peas**

It is necessary to keep the crop weed free in the very early stages of growth, first weeding at 10cm height while the second one is at 20cm height in the same time with Earthing up.

Staking for climbing peas is required during second weeding by using stakes of 1m in height.

- Content/Topic 2. Control of main pests and diseases of legumes

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

- **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 primarly for crop growing, but some methods can be applied to homes at well.
- **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.

- **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.

- **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.

Table 5.Main pests and diseases of legumes

Legume species	**Pests and disease**		
Beans	**Pests**	**Symptoms/ damages**	**Control**
	Aphids	Called also *aphis fabae* Suck sap causing the plant to wilt. Leaves become yellowish and curl. Colonies formation on leaves stems and pods. Plant desiccation	Field sanitation Application of approved insecticides
	Beans fly	Called also *Melanogromyza phaseoli* Attack on stem and lead to yellowing and slow development.	Field sanitation Early planting Seeds pre-treatment by insecticides Application of insecticides
	Disease		
	Anthracnose	Fungal disease caused by *colletotricum lindemuthianum.* Brick-red to black lesions on leaves along the veins and vein lets. Lesions also on petioles, branches, cotyledons, stem and pods. Black spots on pods which	Crop rotation Use of resistant varieties Field sanitation Use of approved fungicides (Dithane M_{45})

		develop into sunken cankers containing pinkish masses of spores.	
	Ascochyta blight	Fungal disease caused by *Phoma exigua var diverrsipora* Seed borne disease Dark-grey to black zonate lesions. Small black spores. Premature leaf dropping	Crop rotation Use of resistant/tolerant varieties Use of clean seeds Field sanitation Use of approved fungicides (Dithane M_{45})
	Common bean rust	Fungal disease caused by *Uromyces appendiculatus* Chlorotic or white spots which develop into reddish brown pustules on the lower and upper surface of leaves. Small whitish spots on the lower surface of leaves that turn red and then form brown pustules. Can spread to pods	Early planting Crop rotation Field sanitation Crops debris incorporation Use of fungicides (Dithane M_{45})
	Bacterial blight	Bacterial disease caused by *Xanthomonas campestris pv.phaseoli* Soaked lesions on under surface of the leaves Small watery spots that turn brown and are surrounded by a yellow margin. Disease spread to pods and causing them to rot.	Crop rotation Use of resistant varieties Use of clean seeds Uprooting and destruction of affected plant.
	Mosaic	Viral disease Leaves deformation Leaf rolling and stunting	Use of resistant varieties Use of clean seeds Uprooting and destruction of affected plant

Table6. Main pests and disease of soybean and peas

Legume species	**PESTS AND DISEASES**		
SOYBEANS	**PESTS**	**SYMPTOMS**	**CONTROL**
	Leaf hoppers	Severe defoliation of soybeans seedlings**.**	Azodrin and surecide are effective

	Pod borers	The feeding of this pest is associated with webbing of flowers, pods and leaves with faeces.	Azodrin and surecide
	DISEASES		
	Root rot(Sclerotium rolfsii and Rhizoctonia solani, blight	Roots rot of weakened plants.	Resistant varieties, avoiding waterlogged sites
	Mosaic virus	Leaf distortion and blistering, stunting of growth, distortion of flowers and small pods.	Avoiding using infected seeds for replanding
PEAS	**PESTS**	**Symptoms**	**Control**
	Pea weevil *Bruchus pisorum or Sitona lineatus*	Most serious storage insect pest of field peas.	Fumigate the seed immediately after harvesting and also spray in the field before harvest to destroy the females before their deposit their eggs on the pods.
	Pea aphids *Acyrthosiphon pisum*	Direct feeding on the growing points of peas causes the characteristic distortion and **yellowing** of leaves and pods. Crops beginning to flower are most at risk.	Spraying with a chemical like Cypermethrin, Rocket

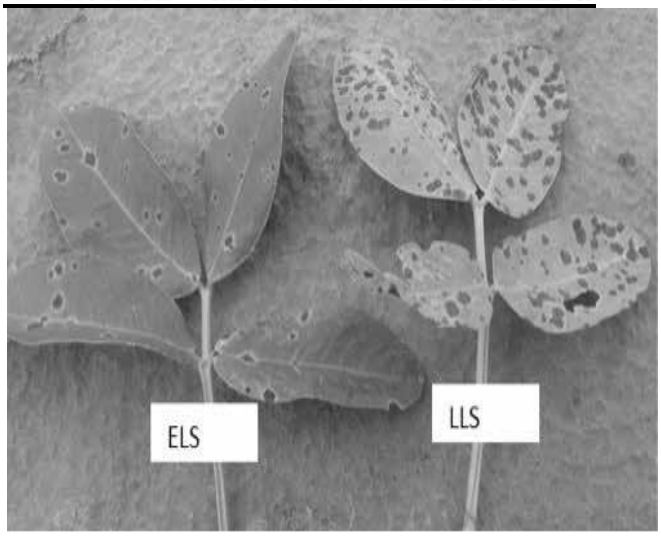
	Silver Y moth (*Autographa gamma*)	The caterpillars of the silver **Y** mouth cause damage by feeding on the foliage and pods of vining peas.	**Chemical Control:** Monitoring of silver Y moth is carried out using a pheromone-based funnel trap **Cultural control:** Early-maturing peas may miss the moth flight period and control will be unnecessary.
	Powdery mildew (*Erysiphe pisi*)	Leaves and stems become covered with a white 'dusty' film. Diseased tissue can then become discolored and pods may also be severely infected and the produce is spoilt both by the surface pod infection and the failure of such pods to fill adequately	**Chemical control:** There are no fungicides approved in peas for the control of powdery mildew **Cultural control:** Several varieties are completely resistant to powdery mildew and these are particularly useful for main crop and late season planting

Diseases of groundnuts

Chlorotic rosette disease

Mosaic rosette disease

Green mosaic disease groundnut



Early and late leaf spots of

Chlorotic rosette disease and Mosaic rosette disease: Symptoms vary to a great extent, depending especially on the time of infection and the cultivar of groundnuts concerned. Mild symptoms consist of a faint mottling and chlorosis of the young leaves, veins generally remaining a darker green than interveinal tissues. More severe symptoms include the curling of the leaves in some cultivars and the shortening of internodes. The use of health ground seeds and resistant varieties.

Early and late leaf spots of groundnut: Leaf spots are associated with distinct species of Cercospora of which the perfect or Mycosphaerella states are unknown in Africa and thus have no pathological consequence.

Symptoms comprise small dark brown to almost black, restricted and well defined spots on both the upper and lower leaf surface. In wet conditions similar spots occur on the stems, petiole, and gynophores, and it is when this type of infection occurs that the greatest loss in yield results. It is caused by air borne diseases. The use local available fungicides like Lidomil, Dithan M45 can be effective.

LO 3.4 – Keep record as required by supervisor

- Content/Topic 1. Importance of farm records keeping

Importance of farm records keeping are:

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Learning Unit 4 – Harvest legumes

LO 4.1 – Identify maturity stage based on market requirement

- 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 legumes.

- ✓ **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 legume crops

Table 6.Physiological signs of maturity for legumes

Parameter / **Legume species**	**Maturity signs**

Beans	-Yellowing of leaves -Drying of pods -Hardness of seeds -The pods should be firm and snap when they are bent -Leaves shedding
Groundnuts	-Vines start yellowing -Leaf shedding -Seed color changes to the desirable one -Hardness of the pods
Soybeans	-Drying of pods -Shedding of leaves and drying of stem --Hardness of seeds
Peas	-Drying of vines and leaves -Color change from green to grey -Leaf shedding

- Content /Topic 3. Crop period

Table 7.Crop period to achieve physiological maturity

Parameter / **Legume species**	**Maturity time (life cycle)**
Beans	2 to 3months.70 to 90 after sowing for bush types 90 to 150days for climbing types
Groundnuts	3 to 3.5months after sowing
Soybeans	100 to 130days after sowing depending on variety
Peas	110 to140days after sowing

- Content /Topic 4. Methods of maturity indices determination

Methods of maturity indices determination are:

- ✓ **Visual methods:** By using our naked eyes, one can differentiates a mature legume 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 legume.
- ✓ **Computation method:** By counting the period from sowing to a given date and compare it with the life cycle of the legume species

LO 4.2 – Apply harvesting techniques specific to legumes species and market requirement

- Content /Topic 1. Different parts to be harvested on legume crops

Different parts to be harvested on legume crops are:

- ➢ Pods: It is harvested as vegetables in the case of beans when the pods are still fleshy.
- ➢ Grains: Is the obtained products after threshing of dry fruits (pods) of legumes and winnowing. For beans and peas, grains can be harvested as green beans before drying of pods.
- ➢ Leaves: The leaves of some legumes like beans can be harvested as vegetables. However, in soil fertility improvement, legume leaves can be buried in the soil as green manure.

- Content /Topic 2. Harvesting techniques on legume crops

- ✓ **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 legume plant that shows good performance in production and good health that may be used for the next legume 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.

- Content /Topic 3. Harvesting methods

In crop production there are two harvesting methods:

- ✓ **Manual harvesting:** The mature legume 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 legumes are dried and most of the case wait for manual threshing and winnowing.
- ✓ **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.

LO 4.3 – Apply handling techniques specific to legumes species and market requirement

- Content /Topic 1. Techniques of product handling

There are different techniques of product handling after harvesting practice:

- ✓ **Drying:** It consists of putting harvested legumes on the sunshine and allow them to dry enough before threshing or shelling.
- ✓ **Shelling/ threshing**: It a practice of removing the shell on legume grain by the use of stick or a threshing machine.
- ✓ **Winnowing:** It is a practice of separating residues from pods, stem and dust with legume grains.

- ✓ **Sorting and grading:** It is a practice of separating remains residues and legume grains (with bad shape or broken) with good legume grains. Grading is done by using a grading machine that allows the grains of the same size to heap together.
- ✓ **Moisture content determination:** it is the practice of measuring the relative humidity (RH%) of the harvested grains by the use of hydrometer.
- ✓ **Pest control:** It consists of pesticides application to control store pests like Bean Bruchids (bean weevil). The farmer should dust the harvested legume grains after moisture content determination.

- Content /Topic 2. Packaging

Characteristics of good packages are:

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

- Content /Topic 3. Labeling

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.

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