Crop Production and Marketing Management

Level IV

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Module Title: Monitoring Crop Establishment and Maintenance

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Table of Contents

LG # 42	LO#1-Gathering information of input planning

Instruction sheet

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

- Identifying and obtaining ***documents*** of the crop production plan
- Gathering Information similar time activities to planting
- Identifying the specific target area, or paddock, for planting
- Gathering information trash levels and seedbed conditions

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

- Documents within the organization that detail the requirements of the crop production plan identify and obtain.
- Information regarding activities that will be occurring at a similar time to planting is gather through discussion with colleagues and management, and by reading the production/management plan
- The specific target area, or paddock, for planting identify from the production/management plan
- Information regarding the trash levels and seedbed conditions gather by viewing the site and through discussion with colleagues

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.

5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
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Information Sheet 1- Identifying and obtaining documents of crop production plan

1.1 Introduction

Crop planning is a critical and often overlooked part of farming. A crop plan, developed before the season starts, helps growers calculate how much of each crop to plant in the greenhouse each week, when they will be transplanted in the field, timing and quantity of harvest on a weekly basis through the growing season (to plan for CSA deliveries and farmers markets for example) and succession planting or cover cropping to make maximum use of limited acreage. These plans can be complex, and as every grower knows, often are tweaked and revised as the season progresses and from season to season as the farm develops. Having a plan at the outset, however, can significantly reduce the stress and chaos of a production season, and can contribute to the profitability and productivity of the market farm.

Crop planning considers what, when, where and which plants to grow in relation to their requirements for space, sunshine, water, maturation, season of planting and tolerance for each other. It involves a cropping pattern in which different categories of vegetables are raised, followed by a system of crop rotation to keep the cycle going and to provide a suitable, healthy environment for plants to grow. For a family food garden, crop planning means raising vegetables that will provide for the nutritional needs of the household members all year round. Crop plans must include varieties of crops.

1.2. Identifying documents of crop production plan

Production planning covers all of the details surrounding how your farm operation will produce products for market and environmental issues,

This can include considering the production capacity of your land, the varietals or breeds you select for your climate and production practices, the types of equipment, buildings, and facilities you have or need, your production practices, and more. While the best tools for planning are personal experience, either from your own farm or working on similar farms nearby your land,

The documents that outline the organizations production planning for the specified period the policies and procedures in relation to chemical handling and OHS, as well as the way in which potential environmental impacts should be approaches.

Self-check 1	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Define Crop planning.(5 point)
2. Discuss briefly production plan details.

Test II: say true or false

1. Crop production plan doesn't indicate yield estimation.
2. The best tools for planning are personal experience,
3. Crop planning involves cropping patterns.
4. During crop planning identifying documents is not mandatory.
5. Crop planning is a critical and often overlooked part of farming.
6. Crop planning considers what, when, where and which plants to grow.

Test III: choice

1. Crop planning considers
    A. what plants to grow
    B. where plants to grow
    C. when plants to grow
    D. None

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

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

Information Sheet 2- Gathering Information at similar time of planting

2.1 Introduction

A growing season is the time period when the weather allows plants to grow. Growing seasons vary for different regions and different plants. planting crops out of their planting date will more likely result in lower yields, no matter how much fertilizer you use or how well you take care of the crop.

2.2. Planting time information's

i. **Moisture:** When the cropping season approaches towards the rainy (humid/wet) period, seeds may be sown when the soil is dry before rain but when the sowing season approaches towards the rainless (dry) period, seeds should be sown on semi-dry (optimum moisture for seed germination of the crop concerned) or wet soil conditions. By increasing the seed water content prior to sowing and sowing seeds more shallowly, the time from sowing to field emergence can be reduced and this can curtail the period in which the sown seeds could be affected by an adverse change in the seedbed, from the favorable conditions in which they are sown. This can be brought about by the equilibration of the seeds with a humid atmosphere or by soaking seeds to allow the preliminary process of germination to proceed, but not enough to permit radicle emergence.

ii. **Photosensitivity**: Certain crop varieties will not flower unless the critical day length is received for a minimum number of total days. Accordingly, planting date should be arranged so that the plant gets just sufficient time to complete its vegetative growth phase. For instance, Corchorus olitorius seeds if sown before mid-April, premature flowering would occur as the plant get the critical day length earlier before completing its vegetative growth properly.

iii. **Thermosensitivity:** Planting date of thermosensitive crop varieties should be arranged so that the plants become able to escape the adverse temperature range.

Self-Check – 2	Written test

Name…… ID…… Date…….

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

Test 1 give short answer

1. List activities done at similar time of planting.
2. Discuss how moisture affecting planting time.
3. What is photosensitivity?
4. How the moisture is affect crop planting?

Test 2 say true or false

1. Planting time is varies from time to time based on agro climatic conditions.
2. There are no activities with similar time of planting rather than watering.
3. Beneficial organism is any organism that harms the growing process.
4. By increasing the seed water content prior to sowing and sowing seeds more shallowly.
5. Certain crop varieties will not flower unless the critical day length is received for a minimum number of total days.
6. A growing season is the time period when the weather allows plants to grow.

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

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

Information Sheet 3- Identifying specific target area, or paddock of planting

3.1. Introduction

The geographical location of the final plant can have strong influence on the success of the planting operations.

3.2. Selecting site

There are seven master keys to good site selection for crop production farming purposes;

1. Climatic factors

These factors are referring to rainfall, humidity, wind pressure and direction, temperature etc. They must be favorable to the farming enterprise you choose. Be it crops or animals. Different types of crops do well under a certain range of climatic conditions, likewise, certain animals. So, it is important to consider the factors that will benefit your farming enterprise. Avoid those that will not.

2. Socio-economic factors

Socio-economic factors include infrastructure, population, settlements, market, labour and others. Infrastructure includes access roads, electricity, water, telecommunication, health facilities, police station etc. The presence of these makes it good to site a venture like a poultry farm. However, nearness to the urban settlement may make it unsuitable. Another example is security and health. Some ventures may require the presence of health facilities and police presence. You may also need a market close to your farm and available labor. You must do careful research to assess the suitability of a farm site in the presence or absence of all or a combination of the socio-economic factors.

3. Edaphic factors

Edaphic factors are related to soil conditions like structure, fertility, texture, porosity, consistency etc. These soil factors determine a suitable farming enterprise. Be it crops or animals. Lands with clayey soils may be good for fish farming, with all other factors favorable. Some lands are prone to flooding and/or erosion. If you have the resources, you can manage and turn them for a profitable farm eg. fish farming. However, with a crop farm like vegetables and tree crops in mind, avoid such areas. as it will not favor the crops.

4. Environmental factors

Your farming operations should not have a negative result on the environment. Some farming activities, when exposed to human or animals, can be harmful. This is usually the case when you site farms close to the urban area. On the other hand, the environment may also have a negative impact on your farm, reducing productivity. Some farms are forced to move or change operation when urban development's catch up. It is therefore very important to consider this factor in the selection of your site for farming.

5. Government policies

Various governments make policies that help them to achieve growth in agriculture. You can take advantage of it a 2nd set up your farm in a location likely to benefit from the implementation of the policy. For example, the government may decide to cut taxes for farms in a particular area or zone of the country. Also, the government may increase the allocation of subsidized fertilizer and other agro-inputs for certain areas of the countries. You may build a farm in such areas to take advantage of it. You must consider government policies in your site selection for farming purpose.

6. Biotic factors

This is relating to the presence or absence of some harmful or beneficial organisms. In site selection for farming purposes, you may consider the natural population of certain organisms like bees and other pollinators. Fewer pests and disease-causing organisms. Where the farming venture involves tree crops, farmlands in forest areas are better. However, you must avoid places with a long history of pests and diseases. Also, you should be careful in choosing a site with certain dominant weeds which are difficult to control.

7. Economic factors

If you want your agricultural business to thrive, then this factor is the most important to consider. It includes the cost, benefits and terms of lease or acquisition. You need to carry out a feasibility study of the site to make sure that it will yield enough returns to sustain your farm. This will give you an idea and a better knowledge of the site that will give you the highest returns.

3.3. Clearing land

Land clearing is the development of land with the intention of creating a potential use for agricultural purposes. Land clearing requires the removal of native cover including trees, bushes and boulders from the land surface. The land is subsequently broken to create a workable bed into which a crop can be seeded.

3.4. Preparing land

Land preparation typically involves ploughing, harrowing, and leveling the field to make it suitable for crop establishment, land preparation releases nutrients to the soil, destroying /reducing weeds and ants nest, it also improves the soil and plant contact and reduces the incidence of pests and diseases infestation.

The first layer of soil that is ploughed and made ready is often referred to as the primary tillage. This opens the soils up for aerating and boosts the growth of microorganisms that improve fertility of the soil. The second step is harrowing, also known as secondary ploughing. This involves breaking down the soil into smaller, minute particles. It is often accompanied by rototilling which further smoothens the density of the soil which is suitable to make a good seedbed for the crops. Further, it improves the topography of fields in order to facilitate proper irrigation and drainage. It helps to obtain good recovery of fertilizer nutrients and eliminates and controls weed.

Self-Check – 3	**Written test**

Name…… ID…… Date…….

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

Test I: give short answer

1. Discuss about land preparation in detail.
2. Write the importance of land preparation.
3. Write importance of land clearing.
4. The first layer of soil that is ploughed and made ready is often referred to as _____

Test II: say true or false

1. Socio-economic factors include infrastructure, population, settlements, market, labor and others..
2. Tillage is not considered under land preparations.
3. Site selection is not necessary for planting.
4. Land clearing requires the removal of native cover including trees, bushes and boulders from the land surface.

Test III: choice

1. Land preparation typically involves
   A. Ploughing
   B. Sowing
   C. Weeding
   D. Thinning
2. Socio economic factors used during site selection crop productions
   A. Infrastructure,
   B. Population,
   C. Settlements,
   D. All

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

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

Information Sheet 4- Gathering information of trash levels and seedbed conditions

4.1. Introduction

Seedbed preparation is very location-specific and varies with climate, soil type, crop, management level, and available equipment.

Seedbed "fineness" refers to the degree to which clods are broken down and the soil smoothed over. The need for this depends mainly on seed type, seed size, and whether hand planting or mechanical Planting will be used.

Seed type: Monocot plants like the cereals (maize, sorghum, etc.) have one cotyledon (seed leaf) and break through the ground in the shape of a spike which helps them handle some cloudiness. Dicot plants (pulses like beans, cowpeas, peanuts, and virtually all vegetables) have 2 cotyledons and emerge from the soil in a much more blunt form, actually dragging the 2 seed leaves (formed from the 2 halves of the seed) with them. They have less clod-handling ability than most monocots, although seed size also makes a difference.

Seed size: As a rough rule, the larger the seed, the less the need for a fine seedbed. Large seeds have more energy and can also emerge from greater depths. A seed like maize is not only large but is a monocot too, so it has especially good clod-handling ability. Peanuts, beans, and most other pulses are large seeded, but this advantage is partly offset because they are dicots. The small seeds of millet and sorghum lack some power, but being monocots is a help. Note that smaller seeds (i.e. lettuce, cabbage, onions, amaranth, require shallower planting than larger seeds (i.e. pulses, okra, maize, squash, etc.) and that a cloddy seedbed makes it difficult to be precise with planting depth.

4.2. Preparing seed bed

There are basically 3 types of seedbeds: flat beds, raised beds, and sunken beds. The best type to use depends much more on the particular climate and soil conditions than on the crop.

1. **Flat Beds**

Flat beds are used where water availability is adequate and there are no drainage problems. In some areas, crops like maize, sorghum, beans, and potatoes are started out

on a flatbed; as the season progresses, soil is thrown into the crop row to mound up the plants; this is called "hilling-up" and is done to control in-row weeds, provide support, and improve drainage. (Potatoes are also hilled up to keep the developing tubers covered with soil.) Hilling-up only works with plants that have enough stem height and leaf clearance to tolerate partial burial.

2. Raised Beds

Crops can also be grown on raised-up beds or ridges. They are especially advantageous for clayey soils under high rainfall or wherever else drainage is likely to be poor. They can also be used in many other situations. Where crops are furrow irrigated, raised beds or ridges are essential so that the water can flow down the furrows between them.

Height of raised beds: Raised beds are usually 10-30 cm high. The best height depends mainly on soil texture and moisture considerations. For example, raised beds are often 2030 cm high on clayey soils under high rainfall where poor drainage is likely to be a problem. On coarser-textured soil under the same conditions, bed height might be 15-20 cm. When raised beds are used in drier conditions, a bed height of 10 cm or leas may be best to avoid excessive moisture loss due to evaporation from the exposed sides.

Width of raised beds: Typically they are 100-130 cm wide.

Raised beds may have several advantages:

- Much better drainage compared with flat or sunken beds.
- They provide a double layer of topsoil, because they're made by dragging in topsoil from the surrounding alleyways. (Because of this, they're also likely to be looser than flat or sunken beds.)
- In temperate regions, raised beds warm up more quickly in the spring, which may benefit cold-sensitive crops and even permit earlier planting.
- Plants on raised beds are easier to reach when doing hand operations such as weeding and thinning.

Raised beds usually aren't a good choice during the dry season, because they dry out more quickly than flat or sunken beds; also, water tends to run off them and be lost into the alley-ways. These disadvantages can be partly overcome by mulching the bed with

straw or rice hulls, making a lip around the bed's edge to reduce run-off, and by reducing bed height to 10 cm or less

Fig. 1: Two types of raised beds. **Bed A** is best suited to high-rainfall areas. **Bed B** has a lip around all 4 sides which helps prevents water from running off (helpful in drier conditions).

3. Sunken Beds

In dry regions, especially on sandy soils with low water-holding capacity, vegetables can be planted in sunken beds (i.e. shallow basins) about 100-130 cm wide and 2-5 cm below the surrounding soil level. Sunken beds conserve water much more effectively than raised beds for 2 reasons:

- Sunken beds don't have the exposed sides of raised beds from where considerable moisture can be lost by evaporation.
- None of the applied water is lost by runoff.

One **disadvantage** of sunken beds is that some topsoil is lost in the usual method of construction. (They're made by pulling off soil from the bed area and placing it in the surrounding alleyways). This probably won't affect crop growth, as long as the topsoil is of normal depth let least 15 cm) and enough compost or manure is added. Here are 2 ways of building sunken beds without sacrificing topsoil:

- First take off the topsoil, and then replace it after removing enough subsoil to sink the bed enough.

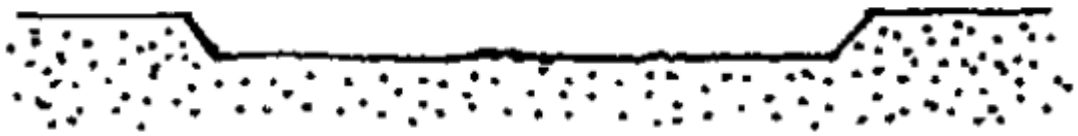

Figure 2: a sunken bed. Depth shouldn't exceed about 4 cm.

Self-Check – 4	Written test

Name…… ID…… Date…….

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

Test I: Short Answer Questions

1. Write difference between sunken and raised seed bed.?
2. Mention all seed bed types.

Test II: say true or false

1. Sunken beds are used In dry regions,.
2. Large seeds have more energy.
3. Flat beds are used where water availability is adequate.
4. Raised beds usually aren't a good choice during the dry season.
5. The larger the seed, the less the need for a fine seedbed.
6. Smaller seeds require shallower planting than larger seeds.

Test III: choice questions

1. Used for dry season
   A. Raised Beds
   B. Sunken bed
   C. Flat bed
   D. None
2. Specification for sunken seed bed
   A. 100-130 cm wide and 2-5 cm depth
   B. 100-130 cm wide and 10-30 cm high
   C. 100-120 cm wide and 10 cm depth
   D. 80 cm wide and 5 cm depth

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

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

Operation Sheet 1- preparing seed bed

Tools and Materials

- Rake
- Spade
- Shovel

- String
- Rope
- Wheelbarrow
- Hoe etc.

Steps:

1. Prepare tools and equipment
2. Select site
3. Make layout
4. Plough the land
5. Level the seed bed

LAP TEST	**Practical demonstration**

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: prepare flat, raised and sunken seed beds.

LG #43	LO #2- Prepare planting plan

Instruction sheet

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

- Determining the agricultural crop and methods of planting

- Assessing and calculating the resources for planting operations
- Setting the target dates for planting
- Selecting and organizing chemical applications
- Preparing plan for detrimental environmental impacts
- Identifying and assessing OHS hazards
- Identifying and obtaining approvals for planting operations
- Determining measurable indicators, specifications and targets

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

- The agricultural crop and methods of planting to be used determine from the organizations production /management plan and availability of the seed
- The resources require for the planting operations assess and calculate from the area to be cultivate the method of planting to be use, and the appropriate timelines
- The target dates set for planting, including the sequencing for planting each paddock, in line with the overall production/management planning for the organization
- The chemical applications that require prior to and post planting select and organized to occur at an appropriate time
- The plan prepare to ensure that any potential detrimental environmental impacts minimize or eliminate including the proper disposal of containers, drums and other wastes
- OHS hazards identify, assess, and the planting plan provides for responsible actions by the operators and management
- Any approvals that require for the planting operations identify, sought and obtain
- Measurable indicators, specifications and targets determine based on the production/management plan and the method, resources, and seed to be use

Learning Instructions:

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Information Sheet 1- Determining agricultural crop and methods of planting

1.1 Introductions

A planting plan is a construction document that shows the location, quantity, and other characteristics of vegetation to be planted in the landscape. It should be easy to read and understand.

Once the inventory, analysis, size and shape of use areas, paths and all other features have been determined, the planting plan can be created. Specific plant species selection is the last element to be determined. Plans can be hand drawn or with simple residential landscape design software.

1.2 Choosing the right plants

Choosing which plants to use can be overwhelming. First determine where the plant will go, its size and form, pattern, texture, and color of the plants to be used. This will help narrow down which species are adapted your area. Make sure that plants are appropriately hydro zoned for the conditions on the property and the local climate.

Now that you have a location, it's time to decide what to plant. You'll want to maximize your space and grow plants suited to your local area, as well as considering the time vs. reward corn, for example, is delicious, but takes up lots of space and takes months to get a single harvest, while pole beans are quire space efficient and produce beans for weeks.

Easy to grow: For the beginning, having vegetables that are basically foolproof is a great plan. Plants like Chinese cabbage, tomatoes, gourds like squash and eggplant, greens such as lettuce or Swiss chard, and root vegetables like taro tend to be very simple.

Suitable for your region: When planning your farm, pay a visit to your farmer's market and find out what's already grown locally. This will help you to ensure you aren't fighting an uphill battle in getting a plant that isn't exactly suited to your area to thrive plus, by growing what other farmers are growing, you can always go to those folks for help if needed.

There are different types of agricultural crops cultivating widely in the worlds. Those are

1. **Cereals:** Cereal crops provide essential nutrients and energy in the everyday human diet through direct human consumption and also via meat production.
   The term "cereals" refers to members of the Gramineae family and determines nine species: wheat (Triticum), rye (Secale), barley (Hordeum), oat (Avena), rice

(Oryza), millet (Pennisetum), corn (Zea), sorghum (Sorghum), and triticale, which is a hybrid of wheat and rye. The top cereals produced in the world in 2014, ranked on the basis of tonnage (in million tons), are corn (1253.6), rice (paddy, 949.7), wheat (854.9), barley (146.3), oat (23.2), and rye (15.8).

Cereal crops are mostly grasses cultivated for their edible seeds (actually a fruit called a caryopsis). Cereal grains are grown in greater quantities worldwide than any other type of crop and provide more food energy to the human race than any other crop.

The starchy carbohydrates which are provided by cereals are essential in human nutrition.

A. **Wheat (Triticum spp.):** is a grass cultivated worldwide. Wheat is usually ground to flour which is used to produce a wide range of products. The type of flour produced differs according to the rate of extraction. Wheat grain is a staple food used to make flour, livestock feed and for fermentation to make alcohol. Wheat can be fermented to make beer. The husk can be separated and ground into bran. Wheat is also planted as a forage crop for livestock and the straw can be used as a ruminant feed component or construction material.

B. **Maize (or corn, Zea mays):** is a cereal grain that was domesticated in Mesoamerica. It is called corn in the USA, Canada and Australia, but in other countries that term may refer to other cereal grains. Hybrid maize is favored by farmers over conventional varieties for its high grain yield. It may be processed to make many different ingredients (e.g. high fructose corn syrup which can be used as an alternative to sucrose derived from sugar cane and sugar beet) and food products. Its germ is rich in oil and can be refined to produce corn oil.

   Finally, maize is one of the first crops for which genetically modified varieties make up a significant proportion of the total harvest.

C. **Rice:** is a dietary staple of more than half of the world's human population (most of Asia and Latin America), making it the most consumed cereal grain. Rice cultivation is well suited to countries and regions with low labor costs and high rainfall, as it is very labor-intensive to cultivate and requires plenty of water for irrigation. However, it can be grown practically anywhere, even on steep hillsides.

Rice is the world's third largest crop, behind maize (corn) and wheat. Brown rice has its outer husk removed and white rice is milled and polished further to remove the bran and germ.

D. **Barley (Hordeum vulgare):** is a major food and animal feed crop, a member of the grass family. Barley is mainly sold as pearl barley, which is the whole grain with its husk removed. It is also used in bread (as flour) and ground as porridge in some countries. Barley is used mainly for malting. Malting is the process where the barley grain is germinated thus producing enzymes which convert its starch reserves to sugars, mainly maltose. In animal feed compositions based on barley grain, industrially derived lysine and threonine are added to obtain a balanced nutritional diet. However, the essential amino acids must be added at additional cost. Other non-essential amino acids, such as glutamine and proline, are present in excess in the major storage proteins and create a different problem. These amino acids, when digested by the animal, release non-utilizable nitrogen. This nitrogen is excreted in the urine, creating a significant environmental load, especially on and around pig farms. In, barley ranked fourth in area of cultivation of cereal crops in the world (570 000 km2).

E. **Oat (Avena sativa)**: is a species of cereal grain and the seeds of this plant. It is used for food for people and as fodder for animals, especially poultry and horses. Oat straw is used as animal bedding and sometimes as animal feed. Oat straw is also used in corn dolly making and it is the favorite filling for home-made lace pillows.

F. **Rye:** is also a crop that has declined in popularity and today is no longer grown on a substantial level. Previously grown as a poor alternative to wheat, its main function was as a fodder crop. The increased production of barley has reduced its importance. Rye contains a low amount of gluten, thus producing breads with low volume and a dense texture.

2. **Pulses:** Pulses are the edible seeds of plants in the legume family. Pulses grow in pods and come in a variety of shapes, sizes and colors.

Pulses are annual crops that yield between one and 12 grains or seeds. The term “pulses” is limited to crops harvested solely as dry grains, which differentiates them from other vegetable crops that are harvested while still green.

Pulses are healthy, nutritious and easy to cook with. Growing pulses also promotes sustainable agriculture, as pulse crops help decrease greenhouse gases, increase soil health, and use less water than other crops.

Pulses are the dried seeds of the legume plants. Hundreds of different varieties of pulses are grown around the globe.

Fig3. Common Pulses

3. **Oil crops:** Oil crops are plants that are grown primarily for the oil that they produce. The major oil crops are typically used to produce edible oils. They include soybeans, peanuts, sunflowers, and canola, which is a genetically engineered form of rapeseed, originally developed in Canada. Linseed oil, also known as flaxseed oil, was originally produced for industrial applications, such as the manufacture of paint, but has gained prominence in the United States as a nutritional supplement is eaten in countries in Europe.

   In addition to the well-known crops, a number of other plants are grown for use in oil production. Edible oil plants include a number of nuts, gourds, and fruits. Inedible oils can also come from almonds, papayas, and even tung beans, which create an oil used to seal wood.

4. **Vegetable crops**: The term vegetable is used to describe the tender edible shoot, leaves, fruits and root of plants and spices that are consumed whole or in part, raw or cooked as a supplement to starchy foods and meat.

Classification of vegetables

1. According to the part consumed (disposition)
2. According to season or area of production
3. According to their botanical or taxonomy
4. According to their frequency of cultivation
5. According to their maturity time, harvesting pattern and growth habit

1. **According to the part consumed**

Leafy vegetables: the leaves and succulent young shoots are picked for consumption. Examples are amaranthus, celosia, pumpkin, lettuce, cabbage, bitter leaf, water leaf, jews mallow and fluted pumpkin

Fruit vegetables: this comprises of young, immature unripe fruits or mature ripe fruits of plants grown as vegetables. Examples are cucumber, tomato, okra, pumpkin, eggplant, garden egg, water melon, sweet pepper and chilli pepper.

Seed vegetables: this group is important for the seed produced. Examples are Egusi melon and Ito melon.

Root vegetables: such as sweet potato, Irish potato, carrot and radish.

Spices: important for their flavor and color in foods such as chili pepper, onion, garlic and basil.

2. **According to Season/Climatic area/ area of cultivation**

Cool season vegetables: such as cabbage, garlic, onion, radish, spinach, lettuce, potato and carrot.

Warm season vegetables: such as tomato, pepper, cucumber, okra, eggplant, garden egg, melon, pumpkin, sweet potato.

3. **Botanical or Taxonomic Classification**

Vegetables are classified according to family, genera and species. It is the most important and acceptable form of classification.

4. **Frequency of Cultivation**

Regularly cultivated vegetables : Onion, Amaranthus, Celosia, Egusi melon,Okra; Eggplant, Tomato and Pepper

Occasionally/Wild vegetables such as: mushroom (Agaricus spp, Celosia triguna Ajefawo) Basella Rubra (White) Indian spinach Basella alba (Red) Crassocephallum biafrae Bologi, C. crepidoidis - Ebolo

5. **According to their maturity time, harvesting pattern and growth habit**

Vegetables with short growing period and harvested two or three times by topping or young leaf removal: This group consists of leafy vegetables such as Amaranthus spp and Celosia argentea.

Vegetables which can be harvested over several weeks or months: This group comprises of vegetables such as Corchorus spp, Solanum spp, Capsicum spp, Tomato, Okra, and Cucurbits.

Vegetables with climbing growth habit: these are vegetables which are trained along a stake and on house walls. Examples are snake gourd, fluted pumpkin, in to melon and basella spp. vegetables with Creeping stems: such as melon, cucumber and water melon.

1.3 Determining methods of planting

Two methods of planting

1. **Direct-seeding** - method of planting seeds directly in the garden plot. Characteristics of seeds and plants:
   - Big seeds
   - Seeds that grow fast
   - Seeds and plants that do not need extra care during the seedling stage.
   - seeds with delicate root system Examples of seeds: cucumber sitao squash okra kangkong radish melon beans watermelon carrot

1. Prepare garden plots.

- Ideal size is 2 to 3 feet.

2. Sterilize the garden plot.

- Burn hays on the surface of the garden plot

- Pour boiling water on the surface of the garden plot

3. Sow seeds on the ground and cover them with soil.

- The depth of the hole should be twice or four times the diameter of the seed.
- The spacing between the plants should be equal to the height of the plant when it reaches maturity.
- Plants which grow tall and slender like celery, green peas, bush lima and onions can be planted nearer while plants which grow broader like kangkong, broccoli and cabbage should be planted farther away each other.

4. Cover the soil with mulch. Mulch – any organic material like grasses, lawn clippings that you put on the surface of the soil to prevent water from evaporating. Cover the soil with mulch and not the plants.

5. Water the plants and the soil.

6. Remove some seedlings once the true leaves have come out to maintain at least 5 centimeter distance between plants.

7. Cover the garden bed with nylon net once the seedling start to grow to protect plants from too much heat of the sun and strong winds.

2. **Transplanting** - method of planting seed in a seed box and later, when the seedlings are big enough, (when they have two or four "true" leaves) they are transplanted from the seed box to the garden plot. Characteristics of seeds and plants

- Small seeds
- Plants that need extra care during their seedling stage Examples of seeds tomato Eggplant Mustard Peachy Pepper.

Steps in planting seeds in a seed box

1. Prepare the seed box using wooden box, plastic egg tray or metal cans.
2. Fill seed box with a good soil for sprouting seeds.
3. Sow the seeds and cover them with soil.

- The depth of the hole should be twice or four times the diameter of the seed.

4. Water the soil using a sprinkler.
5. Cover the seed box with a plastic cover to protect seeds from direct heat of the sun.
6. Transplant the seedling once the "true leaves" have emerged.

Considerations when transplanting

- Transplant seedlings in the afternoon to allow the roots recover from damage.
- Do not transplant during rainy weather.
- Bring the seed box near the garden plot. Steps in transplanting

1. Remove the seedling from the seed box as gently as possible by digging 2 to 3 inches beneath the root system.

- Pass a sharp knife or trowel in between the seedlings, much like cutting a cake into smaller pieces.

2. Transplant the seedling in the prepared garden plot.
3. Cover the seedling and gently tamp the soil up to the first leaves.
4. Water each seedling soon after you have transferred it. Do not wait until you have planted a row of seedling before watering.
5. Maintain at least 5-inch distance between seedlings.
6. Cover the seedling with saha to protect them from strong winds and too much heat of the sun

Self-Check – 1	**Written test**

Name…… ID…… Date…….

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

Teat I: Short Answer Questions

1. Mention the advantages of transplanting late afternoon
2. Discuss classification of vegetables in detail.
3. _____ taking the seeding from nursery to field.
4. Mention at least three examples of cereal crop.

Test II: say true or false

1. Seedling is transplanted more with the little care.
2. Watering is optional for newly transplanted seedlings.
3. Transplant seedlings in the afternoon to allow the roots recover from damage.
4. The spacing between the plants should be equal to the height of the plant when it reaches maturity.
5. Do not transplant during rainy weather.
6. Cabbage should be planted farther away each other.

Test III: choice

1. when transplanting
    A. Water each seedling soon after you have transferred it
    B. Cover the seedling with dry grass
    C. A and B
    D. None

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

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

Information Sheet 2- Assessing and calculating resources of planting operations

2.1 Introduction

Resources are materials, tools and equipment's used at the time of planting including humans participating on the activities.

2.2 Planting operation resources

- Personnel (these might be temporary, permanent, or contracted workers)
- Machinery and equipment
- Consumables and leasing arrangements.
- Seed
- Chemicals
  - ✓ Herbicide
  - ✓ Growth hormone
  - ✓ Insecticide etc.
- Planting equipment's
  - ✓ Rake
  - ✓ Shovel
  - ✓ String
  - ✓ Peg
  - ✓ Pole
  - ✓ Fertilizer
  - ✓ Hoe
  - ✓ Spade
  - ✓ Wheel barrow
  - ✓ Watering can etc.
- Contractual license arrangements, in which the landowner determines and largely undertakes all farming decision-making and operations, but licenses others to perform certain functions, often involving crop planting and harvesting.
- labor tenancies, in which laborers receive a token wage or share of output, together with usufruct rights to a small parcel of land for their own purposes (usually subsistence);
- Sharecropping and other similar arrangements, in which the expectation is that both landowner and tenant share the cost of inputs and receive a share of outputs. This may vary from arrangements which look very similar to contractual labor relationships, to those where the scale of the venture more closely resembles a full tenancy; and

- Tenancies, in which there is a fundamental separation between the interests of the landowner (leasing out land) and the tenant (leasing in land). The tenancy arrangement is significantly different than the other forms of arrangements, principally in that tenancy involves the transfer of certain property rights.
- Calculating seed requirements: The following formula can be used to calculate sowing rates, taking into account:
  - ✓ Target plant density
  - ✓ Germination percentage
  - ✓ Seed size
  - ✓ Establishment, usually 80%, unless sowing into adverse conditions.

$$\text{Seed rate} = \frac{\text{1000 seed weight (grams) X target plant population } (m^2) \text{ X 100}}{\text{Establishment \% X Germination \%}}$$

Self-Check – 2	**Written test**

Name…… ID…… Date…….

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

Test I: give short answer

1. Covering the seedling with plastic is not appropriate.
2. Mention tools for applying pesticide
3. If the seed used for maze is 25 kg per hectare calculate seed rate for 5000 m^2 area.
4. Mention resources required for planting

Test II: say true or false

1. Planting agricultural crop is not used labors.
2. Tenancy involves the transfer of certain property rights.
3. Labor tenancies, in which laborers receive a token wage or share of output.
4. In contractual license arrangements the landowner determines and largely undertakes all farming decision-making and operations.

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

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

Information Sheet 3- Setting the target dates of planting

3.1. Introduction

The sowing or planting date defines the environmental conditions to which the crop will be exposed in key moments of its developmental cycle critical periods for yield and quality components.

Selecting different sowing dates requires a coherent selection of plant density and genotype to maximize the use of environmental resources during the growing season.

3.2. Planting date

This refers to the period of the year at which a particular crop sown in order to produce well. It is usually after the First rainfall in the year for most crops except where irrigation is practiced.

However, planting date varies for different crops. This is due to types of the crops. For example, some grains and legumes require little rainfall for growth and production, and a dry period for the grains and pods to get dried, Vegetables, especially the leafy types require wet period for their growth and production.

Sowing planting dates depend on market dates, as well as geographical location, because of great variations in plant growth and bloom dates due to natural environmental conditions.

Adjustment in sowing or planting dates is a simple yet powerful tool for adapting to the effects of potential global warming.

Overall, sowing seeds planting with high vigour are essential to decrease the risk of bad seedling establishment in early sowings in high latitude environments where temperatures during the spring are often cold.

If you plant seeds in the morning, you can give them moisture throughout their first 12 hours in the garden bed. A constant level of humidity is important to seeds; they are very sensitive to lack of water. Morning planting also will delay exposure to rodents.

Seeds need warmth to germinate, temperatures between 65 and 75 degrees and sunlight works best. Seeds thrive on about 12 to 16 hours of sun each day. Only morning planting will allow seeds immediate substantial sunlight exposure.

Self-Check – 3	Written test

Name…… ID…… Date…….

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

Say true or false

1. Planting date is not the similar for similar verities at different places.
2. Planting date is highly nutrient sensitive.

3. Adjustment in sowing or planting dates is a simple yet powerful tool for adapting to the effects of potential global warming.
4. Sowing seeds planting with high vigor are essential to decrease the risk of bad seedling establishment in early sowings.
5. Only morning planting will allow seeds immediate substantial sunlight exposure.
6. Seeds need warmth to germinate, temperatures between 65 and 75 degrees and sunlight works best.
7. Seeds thrive on about 12 to 16 hours of sun each day.
8. A constant level of humidity is important to seeds.
9. Selecting different sowing dates requires a coherent selection of plant density and genotype to maximize the use of environmental resources during the growing season.

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

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

Information Sheet 4- Selecting and organizing chemical applications

4.1. Introduction

Agricultural chemicals are defined as chemicals such as pesticides, herbicides, fungicides, insecticides, and fertilizers used in agriculture to control pests and disease or control and promote growth.

The term agricultural chemical refers to any substance involved in the growth or utilization of any plant or animal of economic importance to humans. ... To the first group belong plant fertilizers and animal food supplements, and to the latter group belong pesticides, herbicides, animal vaccines, and antibiotics.

The Agricultural Chemicals Regulation Law defines “agricultural chemicals” as chemical agents such as fungicides and insecticides that are used to control crop-harming organisms (e.g., fungi, nematodes, mites, insects, and rodents) or viruses (hereinafter collectively referred to as "diseases and pests") (the "crop,” as used herein, shall include wood and agroforestry products and those used to promote or inhibit the physiology of agricultural and other products, such as plant growth regulators and germination inhibitors (Hereinafter referred to as "agricultural and other products). The chemical agents here include those manufactured using the above chemical agents as raw materials or ingredients that are intended to control the diseases and pests that are stipulated in the ordinances. The law also includes "natural enemies" and "microorganisms" that are used to control diseases and pests of agricultural and other products, as the agricultural chemicals

A. **Insecticide agents**: for controlling harmful insect pests that damage field crops.
B. **Fungicides gents:** for controlling diseases that damage field crops.
C. **Insect-fungicides agents**: that simultaneously controls harmful insect pests and diseases that damage field crops.
D. **Herbicides agents**: for controlling weeds
E. **Rodenticides agents** : for controlling rats and other rodents
F. **Plant growth regulators**: Agents to promote or inhibit the growth of field crops.
G. **Attractants agents**: that attracts mainly harmful insect pests by odor or other means.

H. **Repellents agents** : for having repellent action on harmful mammals and birds that damage field crops.

I. **Spreaders agents**: that is mixed with other agricultural chemicals to enhance the adherence of these chemicals.

4.2. Selecting chemicals

Depending on your crop rotation and tillage, as well soil types, pests and diseases, each farm has specific needs to address when developing a chemical plan.

Finding the right pest management and weed control programs for your farm can seem like a daunting task, but thinking of them holistically can help you to develop a plan that will protect the yield potential you planted.

Like all input decisions, deciding exactly what chemicals to purchase is a bit of a balancing act, figuring out what active ingredients your plan needs and when, and measuring that plan against the ease of ordering, delivery timing and cost (or in some cases, what it could cost you not to buy).

Here are a few things to consider as you start to create your chemical selection:

- **Know your cropping plan:** Crops have diverse needs and tolerate weed, insect and disease pressures differently. And plant back intervals vary between crops, sometimes even for the same product. That's why it's important to know what you're planting—so you don't restrict yourself with a herbicide that has a plantback interval that may be too long to work.
- **Rotate your modes of action**: It would be easy to just do what's worked before, but we all know that eventually, any pest management program can lose its effectiveness. By making sure you're utilizing multiple modes of action, you'll be able to fight weeds in multiple growth stages and prevent any resistance issues that have become prevalent on farms across the country.
- **Consider your tillage practices**: Be sure to take tillage into account as you're creating your chemical plan. No-till, reduced till, minimum till, ridge-till and full tillage may each require a different herbicide program. For example, are you planning to till your soil before planting? If that's the case, then you may not need to use a burndown herbicide because any weeds will be pushed under from rotating soil.

- **Know your field history**: Knowing what weeds, insects and diseases you dealt with in previous years can help you select the products you will need this year to combat any threats that carried over.
- **Think long term:** Take into consideration the weeds and insects you may see in corn versus soybeans, as well as any other crop you may consider planting a cover crop or specialty crop, for example. Don't let a pest linger that will be a danger to the next crop in your rotation, or in planting something new down the road.

4.3. Organizing chemical application

Application of chemicals is organized by concerned persons that are directly related to chemical applicators.

Adequate pre-preparation will help make sure that the actual spraying is carried out under the safe conditions and accurate spray timing will ensure that the product is applied with optimum effect.

Employers and operators must make sure that all safety equipment and clothing is clean and in a good state of repair.

The knapsack spray operator when using a forward-held hand lance is usually walking through a treated crop. As the crop grows, operator contamination increases so it is essential to make sure the operator has adequate body protection. Holding the hand-lance forward and to the down-wind side of the operator will help reduce contamination, but the use of a "tail-boom" should also be considered where appropriate.

Self-Check – 4	Written test

Name…… ID…… Date…….

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

Test I: Short answer questions

1 List agro chemical types?

2 Why PPE is worn during chemical applications

Test II: say true or false

1. Fungicide is recommended for rodents.
2. Weed is always used for feeding animals.
3. Each and every farmer have skill to apply herbicides.
4. Holding the hand-lance forward and to the down-wind side of the operator will help reduce contamination.
5. Employers and operators must make sure that all safety equipment and clothing is clean and in a good state of repair.
6. Don't let a pest linger that will be a danger to the next crop in your rotation.

Test III: choice

1. Agricultural chemicals for controlling weeds
   - A. Pesticide
   - B. Insecticide
   - C. Fungicide
   - D. Herbicide
2. Agricultural chemicals for controlling rodents
   - A. Insecticide
   - B. Repellents
   - C. Rodenticide
   - D. Fungicide

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

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

Information Sheet 5- Preparing plan of environmental impacts

5.1. Introduction

Agricultural inputs broadly refer to the materials used or added in the process of agricultural production and include biological inputs, chemical inputs, and agricultural facilities and equipment. In particular, agricultural chemical inputs denote the different types of chemical applications in agricultural production, such as pesticides (including natural and biological pesticides), chemical fertilizers, veterinary drugs and feed additives, among others.

5.2. Reducing environmental impacts

- Wind erosion,
- Removal of topsoil,
- The development of acid sulphate soils,
- Increased water run-off speeds.

Would be avoided by suitable planning and appropriate decisions will avoid, or minimize impacts of such problems.

- Appropriate farming practices,
- Reducing removal of top soil through proper farming system
- Appropriate fertilizer use
- Appropriate pesticide application
- Storage and disposal are key considerations to overcome environmental degradation or impacts.
- Lay out hedges transversely to the slope. The division of a 200 m long, erosive slope into two 100 m-long slopes reduces the soil loss by a third.
- Lay out wide grass verges alongside streams as buffer zones, ideally with trees and bushes. A number of countries offer corresponding funding programs.
- Where possible, cultivate transversely to the slope.
- Avoid the cultivation of crops with wide row spacing (e. g. maize) or requiring frequent soil cultivation (e. g. field vegetables) on erosion endangered fields.
- Cover the soil with catch crops and nurse crops.

Self-Check – 5	Written test

Name…… ID…… Date…….

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

Test I: Short answer questions

1. What is the impact of pesticide on ground water?
2. List chemical use health hazards?

Test II: true or false

1. Storage and disposal are key considerations to overcome environmental degradation or impacts.
2. Appropriate farming practices are not used to minimize farming environmental impacts.
3. Cultivate transversely to the slope reduces erosion impacts to the environments.
4. Cover the soil with catch crops and nurse crops increases removal of topsoil.
5. Appropriate pesticide application is not minimize pesticide environment impacts.

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

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

Information Sheet 6- Identifying and assessing OHS hazards

6.1. Introduction

This code of practice is intended to raise awareness of the hazards and risks associated with agriculture and promote their effective management and control; to help prevent occupational accidents and diseases and improve the working environment in practice; to encourage governments, employers, workers and other stakeholders to cooperate to prevent accidents and diseases; to promote more positive attitudes and behavior towards occupational safety and health (OSH) in agriculture throughout the sector; ensure that good workplace health and safety practices are applied to all workers in the workplace regardless of age or gender.

6.2. Identifying OHS hazards

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP).

When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS Guidelines are designed to be used together with the General EHS Guidelines document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors.

Environmental issues in crop production primarily include the following:

- Soil conservation and management
- Nutrient management
- Crop residue and solid waste management
- Water management
- Pest management
- Use and management of pesticides
- Fertilizers
- Biodiversity and ecosystems
- Genetically modified crops (GM crops)
- Energy use

- Air quality
- Greenhouse gas (GHG) emissions
- The operation of other machinery and vehicles,
- Excessive noise
- Organic and other dusts
- Hazards associated with storing and handling bulk grain and other seeds, pulses, pasture seed and billets and
- Hazards associated with storing handling,
- Transporting hazardous substances.

Self-Check – 6	Written test

Name…… ID…… Date…….

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

Test I: Short answer questions

1. Mention OHS hazards?
2. Discuss chemical and environmental interactions?
3. List chemical use health hazards?

Test II: true or false

1. In crop production transporting hazardous substances is not risky task.
2. Gases formed during crop storage can be toxic and may pose a risk to workers in confined spaces.
3. Fertilizers that are a toxic hazard for workers can cause skin irritation and potentially serious respiratory effects through the inhalation of gaseous forms of anhydrous ammonia.
4. Noise is a serious occupational hazard to those who work in agriculture.
5. Agriculture involves the use of a wide variety of hazardous machinery and processes.
6. Agricultural production involves the generation of a variety of dusts and biological exposures that present potential hazards to the health of workers.
7. Dusts are generated in the production of various grains, legumes and other field crops.

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

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

Information Sheet 7- Identifying and obtaining approvals of planting operations

7.1. introduction

Subordinate legislation sits under the Environment Protection Act 1970. This allows EPA to regulate pollution and waste that impacts human health and the environment.

7.2. Planting operation approvals

Subordinate legislation aims to protect air, water and land. It also covers noise, waste and serious chemical hazards. It includes:

- State Environment Protection Policies (SEPPs)
- Waste Management Policies (WMPs)
- Regulations
- Notifiable Chemical Orders (NCOs).

PA regulates industry's greenhouse gas emissions as part of protecting air quality. When we make a works approval or licensing decision, we look at industry's potential to impact climate change.

EPA must also uphold certain legislation. This includes laws that deal with:

- Disability in the workplace
- Freedom of information
- Gifts, benefits and hospitality
- Privacy, including privacy on our website and on the interaction portal
- Workplace conduct and public interest disclosures.

The risks associated with any plant or equipment undergoing inspection, maintenance, cleaning, repair or construction should be assessed and appropriate control measures put in place.

Before work commences the plant should be stopped, appropriately isolated/locked and danger tagged, and any stored energy should be dissipated.

Isolation procedure:

- Shut down the machinery and equipment
- Identify all energy sources and other hazards
- Identify all isolation points

- Isolate all energy source
- OHS legislation,
- Site regulations and procedures,
- Ethiopian standards, manufacturer’s specifications and recommendations
- Statutory requirements

Self-Check – 7	Written test

Name…… ID…… Date…….

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

Test I: Short answer questions

1. List the duty of EPE?
2. What are approvals of planting operations?

Test II: true or false

1. The employer should not permit the use of any unsafe or faulty equipment.
2. Unauthorized persons should not be allowed to operate machinery.
3. The employer should ensure that tools are kept in an efficient state, in good repair and in good working order.
4. The employer should ensure that all agricultural equipment undergoing servicing.
5. The employer should not permit the use of any unsafe or faulty equipment.
6. The employer should ensure that workers are trained to operate equipment before they are directed to do so.
7. Tools with broken or cracked handles, chisels and punches with mushroom heads, and bent or broken implements should be replaced.
8. Workers should never operate equipment while under the influence of alcohol or other substances which might affect their operating ability.

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

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

Information Sheet 8- Determining measurable indicators, specifications and targets

8.1. Introduction

We defined a measurable indicator as an observable trait that is an objective measure of some other phenomenon difficult to estimate directly.

8.2. Measurable indicator and specifications

Seed quality describes the potential performance of a seed lot. Trueness to variety; the presence of inert matter, seed of other crops, or weed seed; germination percentage; vigor; appearance; and freedom from disease are important aspects of seed quality.

- **Measurable indicator of infertile (poor or bad) soils**
  - ✓ Presence and occurrence of sandy soils
  - ✓ Presence of soils which dry fast
  - ✓ Light color and red soils
  - ✓ Occurrence of soils with low soil moisture retention capacity.
  - ✓ Presence/growth of drought resistant trees
  - ✓ Low and sparse plant population
  - ✓ Presence of specific and peculiar plants
  - ✓ Low crop yields
  - ✓ Presence of rocks and stones
  - ✓ Occurrence of shallow soils
- **Measurable indicator of seed quality**
  - ✓ Trueness to variety;
  - ✓ The presence of inert matter, seed of other crops, or weed seed;
  - ✓ Germination percentage;
  - ✓ Vigor;
  - ✓ Appearance; and
  - ✓ Freedom from disease
- **Observing the plants**

The cultivated plant is always the best indicator plant. If it thrives well and healthily over the years, the result will be a satisfying, high-quality yield. If such a result is achieved without the use of nitrogen fertilizers or chemical pesticides, we may assume high soil

fertility. The strength of soil fertility becomes apparent particularly with unfavorable weather conditions over the whole year. Associated plants, such as thistles or chamomile, allow damage or signs of deficiency, such as compactions, to be revealed.

- **Interpreting the soil surface**

The soil surface already gives indications of the state of the underlying soil. If it is protected by a vegetation cover, a surface crumbling emerges; the so-called biological engineering of soil crumbs. It can be recognized by its round soil crumbs, which also prevent excessive capping/siltation and erosion of the soil. This is why capping/siltation and erosion are indicators of a bad state of the soil. With increasing organic matter content, capping/ siltation and erosion decrease.

- **Observing the soil life**

The activity of earthworms and even smaller species, such as springtails, can be recognized by their exit holes on the soil surface. They can mainly be observed in springtime when organic mass has been lying on the soil surface ready for consumption by soil organisms. At that time, many small 'drill holes', as well as a few bigger ones can be spotted. With a cut of the spade, the channels can also be made visible in the topsoil crumb. Earthworm faces on the soil surface, too, can indicate a high activity of this particular soil worker.

An indirect indicator of soil fertility is the speed at which plant residue decomposes. The easiest way is to observe straw decomposition. If during a vegetation period straw remains unaltered on the ground, it shows sparsely active soil life.

- **Smelling the soil**

A fertile soil smells nice, not repellent. You can compare it with the smell of forest soil or field margins. If the soil smells of rot, something is wrong. Roots also have an inherent odor which derives from root excretions (exudates). Leguminous plants have a pleasant smell. Earthworms can often be found in the surrounding area.

Self-Check – 8	Written test

Name…… ID…… Date…….

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

Test I: Short answer questions

1. List measurable indicators of fertile soil.
2. List measurable indicators of good quality seed.

Test II: true or false

1. A fertile soil smells nice, not repellent.
2. An indirect indicator of soil fertility is the speed at which plant residue decomposes.
3. The activity of earthworms and even smaller species, such as springtails, can be recognized by their exit holes on the soil surface.
4. The soil surface already gives indications of the state of the underlying soil.
5. The cultivated plant is always the best indicator plant.
6. The strength of soil fertility becomes apparent particularly with unfavorable weather conditions over the whole year.

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

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

Operation Sheet 1- planting seeds in a seed box

Tools and equipment's

- Seed box
- Peg
- String
- Meter
- plastic egg tray or metal can
- seed

Procedures

1. Prepare the seed box using wooden box, plastic egg tray or metal cans.
2. Fill seed box with a good soil for sprouting seeds.
3. Sow the seeds and cover them with soil.
4. Water the soil using a sprinkler.
5. Cover the seed box with a plastic cover

LAP TEST	Selecting PPE

Name…… ID……..

Date……

Time started: _____ Time finished: _____

Instructions: planting the seed in seed box.

LG #44	LO#3- Determine scheduling and key responsibilities

Instruction sheet

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

- Determining scheduling for planting
- Determining Key responsibilities and specific preparatory *processes*
- Determining Key responsibilities for specific implementation processes
- Determining record keeping requirements and procedures
- Documenting plan
- Requiring plan

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

- Scheduling for planting determine taking the range of geographic and resourcing factors into consideration, as well as operations that will be occurring at the same time as the planting
- Key responsibilities for specific preparatory processes that require before planting determine
- Key responsibilities for specific implementation processes determine
- Recordkeeping requirements determine and procedures put in place to ensure compliance with the range of applicable regulations
- The plan, including scheduling and key responsibilities clearly document
- The plan includes the type, format, frequency and detail of any reporting require by both managers and operators

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.

5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Determining scheduling of planting

1.1 Introduction

Scheduling is the process of arranging, controlling and optimizing work and workloads in a production process. Companies use backward and forward scheduling to allocate plant and machinery resources, plan human resources, plan production processes and purchase materials.

1.2 Planting schedule

Sowing or planting schedules cannot be determined on a national scale. Conditions vary from year to year even in one location with early springs and rainy spells upsetting schedules. At best, a schedule can only estimate the time and events between sowing or planting and marketing.

The planting schedule also depends on whether plants are to be sold green or in bloom. If the market will tolerate green plants, considerable greenhouse time can be saved in producing them. Attempts should be made to educate consumers of the desirability of using green plants, the major advantage being less transplant shock due to overgrown or interlaced roots at transplanting. Although there are significant advantages in marketing a green crop, most bedding plants are marketed in flower, and it is the instant color that sells the crop.

Temperature is one factor that can be controlled that will influence scheduling. Each species has an ideal medium temperature for germination and early seedling growth. Variations in temperature will delay germination, which in turn delays flowering.

Note that by temperature, we mean temperature in the medium, not the air in the greenhouse. A thermostat placed at eye level will be easy to read but will not be an accurate indicator of temperature in the flat. Soil thermometers are needed to monitor temperatures and to maximize germination percentages.

Self-Check – 1	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Show activities included under planting plan schedule.
2. What is planting schedule?

Test II: say true or false

1. Sowing or planting schedules cannot be determined on a national scale.
2. Scheduling is the process of arranging, controlling and optimizing work and workloads in a production process.
3. Temperature is one factor that can be controlled.
4. Variations in temperature will delay germination, which in turn delays flowering.
5. Soil thermometers are needed to monitor temperatures.
6. There are significant advantages in marketing a green crop.
7. Most bedding plants are marketed in flower.

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

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

Information Sheet 2- Determining key responsibilities of preparatory processes

2.1 Introduction

Pre-planting operations are a series of operations carried out in a farm management system prior to planting the seed or planting material. They are those operations carry out before sowing the seeds. Pre-planting activities are very important; they are the foundation on which builds the success and survival of the crop

2.2 Pre-planting operations

These are the operations carried out in the farm before sowing. They include;

- Choosing of site
- Clearing
- Stumping
- Plotting
- Tillage practices
- Ploughing
- Harrowing
- Ridging

Choice of site

The choice of a farm site is a part of the activities before planting. This is guarded by;

The nature of the land (Topography): This is, whether the land is hilly or level. A fairly level land should be chosen to reduce the cost of the land preparation and erosion control problem.

The type of soil: This should be considered in the choice of farm site or location. This is because soil is the medium for plants growth and poor soil will produce poor yield.

Availability of inputs such as labour and planting materials: The workers to be employed that will work in the farm must be available in the area where the farm is to be located. Crop planting materials should also be available. The ease of transporting farm produce and sale also guard the choice of a farm site.

Clearing of site

The farm site is cleared by means of hand tools such as the cutlass or mechanical equipment such as bulldozer. The equipment used depends on the vegetation in the area. In the rain forest belt, cutlass may be required for brushing the under growth while axe, motor saw or chain saw and cutlass are used to fell the trees. The trees are chopped into pieces. On large scale, bulldozer may be used to remove forest vegetation. Burning can be carried out on cut undergrowth and plants, especially in the rain forest area. This helps to add ash which contains lime and potassium which make the soil alkaline. Alkalinity of the soil leads to increase in nitrification process. The remains of burnt plants are packed and re-burnt. The larger trunks are left to decay in case of small holdings, but bulldozers may be used to push them off in the case of mechanized farming.

Stumping

This is the removal of plant stumps and roots from the soil. It is a tedious operation. The practice is usually avoided in small scale private farms. Where crop rotation system is practiced, stumping is done.

Plotting or laying out

The act of dividing the farm land into sections is called plotting or laying out. This is usually based on the report of soil survey. Soil survey shows the nature of the land (Topography), Soil types, and nutrient status. Soil and water conservation methods to be used on the land. It also shows where to locate the various farm steads. Plotting can be done by using the 3-4-5 method.

Tillage practices

Land tillage is the operation that follows after the land area has been cleared, stumped, and plotted. Tillage involves the opening up of the soil for seed planting. This could be done by means of simple farm implements such as hoe in a small scale farm. Mechanical devices such as the tractor and its coupled implements like ploughs, harrows or ridgers could be used in tilling the land. This is used mostly under large scale farming. The purpose of tillage is the same whether hand tools or mechanical equipment are used

Ploughing: This involves the tillage or turning of the soil upside down. It can be done with a hoe, a spade or a tractor driven disc plough in the tropical regions or mouldboard

plough used mostly in the temperate regions. Animals could be used to drag the plough during tilling. It is usually the first equipment to be use on cleared farmland. The plough cuts and inverts large lumps of soil. Weed seeds are then buried below cultivated seeds. The disc plough is more suitable for use in heavy, sticky and dry tropical soils than the mouldboard plough.

Harrowing: The harrow is the next equipment used after the land has been ploughed. It is used to further breakdown the large lumps of soil cut by the plough into smaller pieces. This is called pulverization of soil. The disc harrows are more suitable for use in tropical environment. After harrowing it may be possible to grow crops such as rice which do not required seed beds or ridges for other crops such as yam, tomato and groundnut after harrowing. This will necessitate the next operation which is ridging.

Ridging: This is the last stage in land preparation for planting of seeds or seedlings. It can be done by means of Indian hoes or tractor driven disc ridger or mouldboard ridger. Animals could be used to drag ridger for ridge making. Ridging is done normally across the slope of the land to prevent it from being washed away by erosion. It is spaced 1m apart. This is measured from the top or crest of one ridger to the other. The length of the ridger depends on the availability of land and choice of the farmer. A standard ridger should be 25m long. It has a conically shaped top or crest or triangular shape. The trench between two ridges is called furrow. Tie-ridges can be constructed at intervals between two ridges. Ridging increases the depth of surface soil for better crop growth.

Self-Check – 2	**Written test**

Name…… ID…… Date…….

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

Short Answer Questions

1. List all activities under taken before planting.
2. Discuss harrowing.

True or false

1. The choice of a farm site is a part of the activities before planting.
2. Pre-planting operations are a series of operations carried out in a farm management system prior to planting the seed or planting material.
3. A fairly level land should be chosen to reduce the cost of the land preparation and erosion control problem.
4. The farm site is cleared by means of hand tools such as the cutlass or mechanical equipment such as bulldozer.
5. Ridging is done normally across the slope of the land to prevent it from being washed away by erosion.
6. The disc plough is more suitable for use in heavy, sticky and dry tropical soils than the mouldboard plough.

Choice

1. The last stage in land preparation for planting of seeds or seedlings.
   A. Harrowing
   B. Ridging
   C. Ploughing
   D. Clearing
2. The large lumps of soil cut by the plough into smaller pieces is called _____
   A. Pulverization
   B. Harrowing
   C. Ploughing
   D. Ridging

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

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

Information Sheet 3 - Determining key responsibilities of implementation processes

3.1. Introduction

These are the activities carried out during planting. It is a deliberate establishment of seeds or seedlings in the soil, for proper germination to take place.

3.2. Planting implementation process

These are activities done during planting. They are:

a. Planting

b. Transplanting

c. Nursery practices

- **Planting**

This is probably the most critical phase in the establishment of a new plant. Mistakes at this point may lead to a poor survival rate of offshoots or tissue culture derived plants, regardless of the efforts put in during the preparation phases. The aim is to assist the crop grower to execute the planting operation in a way that will ensure a high transplanting survival rate in the newly established farm.

- **Transplanting**

Transplanting is the process of moving a fully germinated seedling (or mature plant) and replanting it in a permanent location for the growing season

- **Nursery practices**

These include preparation of nursery beds, soil management, planting procedures, control of seedling density, use of fertilizers, irrigation, and pest control. Sometimes they also may include root pruning and inoculation with mycorrhizal fungi.

Self-Check – 3	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Mention all activities done during or at planting.
2. Discuss all planting process.
3. Write nursery practice.
4. _____is the process of moving a fully germinated seedling (or mature plant) and replanting it in a permanent location for the growing season.

Test II: say true or false

1. Nursery work is not activities doing at time of planting.
2. Planting is skill task.

Test III: Choice

1. _____is the process of moving a fully germinated seedling (or mature plant) and replanting it in a permanent location for the growing season.

   A. Transplanting
   B. Sowing
   C. Planting
   D. Seeding

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

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

Information Sheet 4 - Determining record keeping requirements and procedures

4.1. Introduction

Management system which includes crop records increases returns by improving nutrient and pesticide-use efficiency. This Field File provides an organized place for storing information on each crop-producing field.

4.2. Record keeping procedures

Having a good process for holding and storing health and safety documentation is not only good practice but in some instances is a legal requirement.

When a government inspector or an internal/third party auditor arrives on site it is beneficial to have documentation held in a structured format.

This procedure gives guidance on a good system for record keeping. It indicates what records need to be held and suggests a period of retention.

There are two main objectives of this procedure:

1. To formalise how documents are held on a site, and
2. To show the retention period for each record.

Self-Check – 4	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. List all record keeping procedures.
2. Why record keeping is important for crop production?
3. Mention all record keeping elements.

Test II: say true or false

1. Record keeping is optional during planting plan.
2. Recording all planting details is very crucial.

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

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

Information Sheet 5- Documenting plan

5.1. Introduction

Documentation Plan - is a document written by technical writers (usually, team leads or project leaders) to shape up the details of the work to be done. It helps structure all the processes within the team, and grant everyone access to the essential information

5.2. Plan documentation

A documentation plan can include varied elements. These are the things that get included to such plans by most companies:

- Project name
- Scope and objectives
- Detailed content Plan
- Time estimates
- Responsible persons
- Workflow
- Resources (software, style guides, websites)
- Publishing details (formats, ways of delivery to end users

Activity documentation

Use this form to record all types of farm or ranch activities and make notes about observations. Include details about crops and/or livestock at a given location: planting, input applications, mowing, irrigation, pest monitoring, weather, etc. Records may be kept in any type of notebook or format.

Farm/Location: Year:

Date	Activities

Self-Check – 5	Written test

Name…… ID…… Date…….

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

Short Answer Questions

1. List all documenting activities during planting.
2. What is documentation plan?
3. Why documentation is highly important for crop production.

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

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

Information Sheet 6- Requiring plan

6.1. introduction

The practical steps listed below are of general application. In practice however, one must study the feasibility of possible course of action at each stage.

Although it precedes actual planning and is, therefore not strictly a part of the planning process, an awareness of opportunities in the external environment as well as within the organization is the real starting point for planning. All managers should take a preliminary look at possible future opportunities and see them clearly and completely know where they stand in light of their strengths and weaknesses, understand what problems they wish to solve and why and know what they expect to gain. Setting realistic objectives depends on this awareness. Planning requires a realistic diagnosis of the opportunity situation.

6.2. Establishing Objectives

The second step in planning is to establish objectives for the entire enterprise and then for each subordinate work unit. This is to be done for the long term as well as for the short term. Objectives specify the expected results and indicate the end points of what is to be done., where the primary emphasis is to be placed, and what is to be accomplished by the network of strategies, policies, procedures, rules, budgets and programs.

Enterprise objectives give direction to the major plans, which by reflecting these objectives define the objective of every major department. Major department objectives, in turn, control the objectives of subordinate departments, and so on down the line in other words, objectives from a hierarchy.

6.3. Establishing circulate, and obtaining agreement

The third logical step in planning is to establish circulate, and obtain agreement to utilize critical planning premises such as forecast, applicable basic policies, and existing company plans. They are assumptions about the environment in which the plan is to be carried out. It is important for all the managers involved in planning to agree on the premises.

6.4. Determining Alternative Courses:

The fourth step in planning is to search for and examine alternative courses of action, especially those not immediately apparent. There is seldom a plan for which reasonable, alternatives do not exist and quite often an alternative that is not obvious proves to be the best.

6.5. Evaluating Alternative Courses:

After seeking out alternative courses and examining their strong and weak points, the next step is to evaluate the alternatives by weighing them in the light of premises and goals. One course may appear to be the most profitable but it may require a large cash outlay and have a slow payback; another may look less profitable but may involve less risk; still another may better suit the company's long range objectives

6.6. Selecting a course

After seeking out alternative courses and examining their strong and weak points, the next step is to evaluate the alternatives by weighing them in the light of premises and goals. One course may appear to be the most profitable but it may require a large cash outlay and have a slow payback; another may look less profitable but may involve less risk; still another may better suit the company's long range objectives

6.7. Numbering Plans by budgeting:

After decisions are made and plans are set, the final step in giving them meaning, as was indicated in the discussion of types of plans is to number them by converting them into budgets. The overall budgets of an enterprise represent the sum total of income and expenses, with resultant profit or surplus, and the budgets of major balance sheet items such as cash and capital expenditures. Each department or programs of a business or some other enterprise can have its own budgets, usually of expenses and capital expenditures which tie into the overall budget.

Self-Check – 6	Written test

Name…… ID…… Date…….

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

Short Answer Questions

1. What is documenting in terms of crop production.
2. What is documentation plan?
3. Why documentation is highly important for crop production.
4. Explain all documentation process.

True or false

1. After seeking out alternative courses and examining their strong and weak points, the next step is evaluating the alternatives by weighing them in the light of premises and goals.
2. The overall budgets of an enterprise represent the sum total of income and expenses.
3. The overall budgets of an enterprise represent the sum total of income and expenses.
4. The second step in planning is establish objectives for the entire enterprise and then for each subordinate work unit.
5. The fourth step in planning is to search for and examine alternative courses of action
6. . Planning requires a realistic diagnosis of the opportunity situation.

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

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

Operation sheet 1– implementation process

Tools and materials

- Peg
- String
- Meter tape
- Wheelbarrow
- Peg
- Spade
- Shovel
- Rake
- Watering can etc.

Procedures

1. Planting
2. Transplanting
3. Nursery practices

Lap Test	Demonstration

Name…… ID……..

Date……

Time started: _____ Time finished: _____

Instructions: Demonstrate planting process

LG #45	LO#4 - Monitor and adjust the planting plan

Instruction sheet

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

- Outlining monitoring points
- Observing and following checks for the OHS requirements
- Observing and following checks for the site environmental requirement
- Communicating with operational staff and contractors
- Making follow up for documentation
- Initiating and taking corrective action or amendment for the planting plan

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

- Monitoring points outline in the implementation plan adhere to
- Checks made to ensure that the OHS requirements being observe and follow
- Checks made to ensure that the site environmental requirement being observe and follow
- Operational staff and any contractors communicate with regularly to ensure smooth operation and progress
- Follow up make to ensure that the documentation require by the organization, or other regulating bodies complete clearly and accurately during the progress of the planting process
- Where any corrective action or amendment to the planting plan require the action initiate and take

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.

4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6.If you earned a satisfactory evaluation proceed to “Operation sheets
7.Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8.If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- outlining monitoring points

1.1. Introductions

Monitoring is designed to measure progress towards the strategic plan's goals. When you start to implement your strategic plan to manage the urban the planting plant, you should also start to monitor outcomes. As you implement planned actions and assess results, you will be able to see if progress is being made. You will assess if standards are being met.

In the case of a small site, the monitoring plan might simply be the expansion of the Implementation Matrix with columns for who is responsible for monitoring, when to collect data, and what data to collect.

1.2. Monitoring points

- Pre planting operations
  - ✓ Choosing of site
  - ✓ Clearing
  - ✓ Stumping
  - ✓ Plotting
  - ✓ Tillage practices
  - ✓ Ploughing
  - ✓ Harrowing
  - ✓ Ridging
- Planting operations
  - ✓ Planting
  - ✓ Transplanting
  - ✓ Nursery practice
- Post planting operations

These are the operations carried out after planting. They include

- ✓ Thinning,
- ✓ Supplying water,
- ✓ Mulching,
- ✓ Manure/fertilizer application,

- ✓ Weeding,
- ✓ Control of pests and diseases,
- ✓ Harvesting,
- ✓ Processing,
- ✓ Storing and
- ✓ Marketing.

- Resources used
  - ✓ Seed
  - ✓ Fertilizer
  - ✓ Labour etc.

Self-Check – 1	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. List resources required during planting.
2. Mention planting, pre planting and post planting activities.
3. List all monitoring points.

Test II: say true or false

1. Pre planting activities is not important for wheat production.
2. For crop production the crucial resource is land.
3. Monitoring is designed to measure progress towards the strategic plan's goals
4. In the case of a small site, the monitoring plan might simply be the expansion of the Implementation.

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

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

Information Sheet 2- Observing and following checks of OHS

2.1 Introduction

Occupational health and safety is concerned with protecting the safety, health and welfare of people engaged in work or employment. Regardless of the nature of their work, workers should be able to carry out their responsibilities in a safe and secure working environment, free from hazards.

2.2 Observing checks of OHS

Agricultural and plantation works are associated with a variety of unique occupational health hazards in the form of physical factors like extreme weather conditions, sunrays, etc.; chemical toxicological hazards in the form of pesticides/fertilisers, etc., including different forms of biological and mechanical hazards.

Farming situations present several respiratory hazards to farm workers. Exposure to these hazards has been linked to excessive coughing and congestion in 20 to 90 percent of farm workers and families.

- Noise
- Skin disorders
- Cancers
- Chemical hazards
- Heat stress
- The operation of other machinery and vehicles,
- Excessive noise
- Organic and other dusts
- Hazards associated with storing and handling bulk grain and other seeds, pulses, pasture seed and billets and the
- Hazards associated with storing handling,
- Transporting hazardous substances.

Self-Check – 2	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. List all OHS hazards during planting.
2. Define OHS.

Test II: say true or false

1. In crop production activities OHS is not limiting factor.
2. Agricultural and plantation works are associated with a variety of unique occupational health hazards.
3. There are no chemical hazards in crop production.
4. Dusts are generated in the production of various grains, legumes and other field crops.
5. The employer should ensure adequate cleaning of the workplace.

Test III: choice

1. Dusts may include components :
   - A. Straw,
   - B. Bagasse,
   - C. Husks of grain,
   - D. All
2. Sources of noise on farms
   - A. Tractors,
   - B. Chainsaws,
   - C. Grain dryers
   - D. All

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

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

Information Sheet 3 - Observing and following checks of site

3.1. Introduction

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in crop production areas by existing technology at reasonable costs.

Application of the EHS guidelines to existing farming systems may involve the establishment of site-specific targets, with an appropriate timetable for achieving them.

3.2. Observing site environmental requirement

Environmental issues in annual crop production primarily include the following:

- Soil conservation and management
- Nutrient management
- Crop residue and solid waste management
- Water management
- Pest management
- Use and management of pesticides
- Fertilizers
- Biodiversity and ecosystems
- Genetically modified crops (GM Crops)
- Energy use
- Air quality

3.3. Nutrient management and the environment

In addition to the global warming potential of N_2O, nutrient applications (from mineral and organic sources) can impact the environment in the following ways:

- Acid deposition from anthropogenic emissions of Sulphur dioxide (SO_2), nitrogen oxides (NO) and ammonia (NH_3);
- Eutrophication of aquatic (and terrestrial) systems by increasing N and P flows from agricultural land to these systems;
- Stratospheric ozone depletion by N_2O emissions;
- Particulate matter formation following NH_3 emissions;
- Nitrate (NO_3 -) accumulation in groundwater.

Self-Check – 3	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. What is site environmental requirement?
2. Discuss EHS requirements in crop production.
3. Explain nutrient management and environment.
4. Explain pesticide use and site requirements.

Test II: say true or false

1. Wrong fertilizer application is not considered under EHS.
2. Wrong fertilizer use affects the crop production sites.
3. Nitrate (NO3-) accumulation in groundwater is the result of wrong nutrient use.
4. Avoid N applications on waterlogged soils, have the potential to minimize N losses in the form of N_2O.
5. Use slow- or controlled-release fertilizers or fertilizers stabilized with nitrification inhibitors), have the potential to minimize N losses in the form of N_2O while improving overall N use efficiency and effectiveness.

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

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

Information Sheet 4 - Communicating operational staff and contractors

4.1. Introduction

We have all been there, where we are given a task or leave a meeting and have no idea what to do next. It's quite common. According to the statistics, 57% of employees report not being given clear directions and 69% of managers are not comfortable communicating with the employees in general. From the statistics, it is clear that there is a need to improve communication in the workplace. But first things first .

4.2. Communicating with farm staff and contractors

Spring can quickly lead into summer, and farm jobs will move from calving, lambing and animal husbandry to grass management and making silage, hay and straw.

With lots of activity and different tasks to be completed, farmers often rely on farmworkers and contractors to undertake and complete key jobs on the farm.

During this busy time, communication is critical. Good communication includes giving clear instructions and requests that the person receiving them understands, actively listening, asking questions and relaying information with ease.

It also includes avoiding misunderstandings or being unclear. Farmers must prepare themselves and practice good communication skills when managing new or returning farm staff.

Firstly, it is the farmer's responsibility to have an introductory conversation with new farm staff and contractors. They should do this before they start any jobs. Depending on the role and duties of the person, the farmer must outline essential information.

During this conversation, list the tasks you expect them to do and point out safety information and the farm's general rules.

A farmer should also do a farm walk and demonstrate the workings of machinery if necessary.

We recommend that farmers take time in advance to think of key points and essential information about the farm or the task at hand. Write them out on paper, on a whiteboard or in a message for reference.

It is also important to listen and answer any questions that a farm worker or contractor may have. Encourage them to raise any concerns at this initial stage as it will benefit both parties in the long run.

It also gives the farm worker or contractor a chance to clarify an expectation set by the farmer. This is important as it will save time going forward.

Self-Check – 4	Written test

Name…… ID…… Date…….

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

Test I: say true or false

1. The basis for estimating costs of production for cropping enterprises begins with an accounting of variable input requirements and prices for items.
2. Farmers must prepare themselves and practice good communication skills when managing new or returning farm staff.
3. Firstly, it is the farmer's responsibility to have an introductory conversation with new farm staff and contractors.
4. The farm worker or contractor a chance to clarify an expectation set by the farmer.
5. We recommend that farmers take time in advance to think of key points and essential information about the farm or the task at hand.
6. A farmer should also do a farm walk and demonstrate the workings of machinery if necessary.
7. Good communication includes actively listening, asking questions and relaying information with ease.

Note*:* Satisfactory rating - 20 points Unsatisfactory - below 20 points

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

Information Sheet 5- Making follow up of documentation

5.1. Introduction

The production plan should provide a basis for projecting future operational activities and alternative enterprises. While changes will occur, the production plan serves to document historical performance and project the future direction of the business. Crop production plans should include the estimated acreage and yield for each crop. Estimated production levels can then be combined with anticipated prices to generate some of the figures needed for the financial component.

5.2. Following up documentation

For crop farms, the production plan should include the estimated acreage for each crop for each year (crop rotation) and an estimated yield for each crop. Other items that should be documented include: historical yields, government payment information, variable costs of production, insurance coverage, and production practice considerations.

The basis for estimating costs of production for cropping enterprises begins with an accounting of variable input requirements and prices for items such as seed, fertilizer, herbicide, irrigation fuel, and harvesting.

Planting and Harvest Record

Use this form to record crop acreage and location (for documentation of crop rotation), planting and harvest dates, yield, and sales (for production verification audit).

Location	Crop /variety	Transplant / Seeding Date	Harvest Date(s)	Harvest Quantity / Yield	Buyer / Price

Self-Check – 5	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Write follow up of documentation plan activities
2. List items needed during planting and hovering records.

Test II: say true or false

1. The production plan should provide a basis for projecting future operational activities and alternative enterprises
2. The production plan serves to document historical performance and project the future direction of the business.

N*ote:* Satisfactory rating - 20 points Unsatisfactory - below 20 points

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

Information Sheet 6 - Initiating and taking corrective action or amendment

6.1. Introduction

A corrective action plan outlines a set of specific steps used in quality management to eliminate process discrepancies and prevent root cause recurrence. Enforcing corrective actions in the workplace means performing systematic changes by assigned personnel to address work-related issues and improve business operations.

6.2. Taking corrective action or amendment

A strong corrective action plan doesn't depend on uncertain variables which could make the corrective action plan weak. a weak corrective action plan depends on current workplace processes and employee training.

Examples of enforcing employee training and policies are:

- Staff conducting double checks
- Staff retraining
- Creating new work procedures

A corrective action plan is a detailed document that records exactly what should be done and what was actually done to rectify any non-conformance. It should be S.M.A.R.T. (Specific, Measurable, Attainable, Relevant, Time bound) and includes timeframes, costs, and signatories. Corrective action plans should be used when identified problems could negatively impact the quality management system (QMS) of an organization.

Example of a corrective action

Briefly describe the problem
What will be done? (Action steps, description)
Why will it be done? (Justification, reason)
Where will it be done? (Location, area)
When will it be done? (Time, dates, deadlines)

Self-Check – 6	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Explain the crop production task that needs corrective action measures.
2. Write uses of corrective action plan.

Test II: say true or false

1. Corrective actions in the workplace means performing systematic changes by assigned personnel to address work-related issues and improve business operations.
2. Corrective action plans should be used when identified problems could negatively impact the quality management system (QMS) of an organization.
3. Corrective action plan outlines a set of specific steps used in quality management.
4. A corrective action plan used to eliminate process discrepancies and prevent root cause recurrence.

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

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

Operation sheet 1 – OHS Site requirements

Tools and materials

- Not book
- Pen
- PPE etc.

OHS Site requirements

- Soil conservation and management
- Nutrient management
- Crop residue and solid waste management
- Water management
- Pest management
- Use and management of pesticides
- Fertilizers etc.

Lap Test	Demonstration

Name…… ID……..

Date……

Time started: _____ Time finished: _____

Instructions: Observe OHS site requirements.

LG #46	LO # 5 - Determine condition of agricultural crops

Instruction sheet

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

- Undertaking measurement and assessment of soil moisture
- Calculating water requirements
- Assessing nutrient requirements for crops and identifying deficiencies.
- Identifying crop production potential factors
- Implementing Sustainable land management

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

- Measurement and assessment of soil moisture undertake to calculate soil water percentage.
- Water requirements calculate according to soil analysis data, standing crop, and forecast weather conditions.
- Nutrient requirements for crops assess and deficiencies identify
- Factors affecting crop production potential identify.
- Sustainable land management implement according to enterprise requirements and environmental standards.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

6.If you earned a satisfactory evaluation proceed to “Operation sheets

7.Perform “the Learning activity performance test” which is placed following “Operation sheets” ,

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

9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information sheet 1- Undertaking measurement and assessment of soil moisture

1.1. Introduction

It is common landscape practice to supplement rainfall with the use of an irrigation system to keep plants looking their best. Many systems are automatic: the more complex units are connected to a climate-based electronic controller and run when weather and evapotranspiration data dictate; the simpler ones run a set schedule linked only to a time clock. Either of these systems may apply more water than is necessary to maintain a healthy landscape. For a clear picture of when and how much to water plantings, agricultural managers have long relied on soil moisture measurements; landscape professionals can do the same to maximize irrigation efficiency in landscape and turf plantings.

Soil moisture terminology

Soil water content is a measurement of the amount of water in a known amount of soil; it can be expressed as % water by weight or volume of soil, or inches of water per foot of soil.

Soil water potential or **soil moisture tension** is a measurement of how tightly water clings to the soil and is expressed in units of pressure called bars (one bar is equal in strength to the pressure of one atmosphere). Generally the drier the soil, the greater the soil water potential and the harder a plant must work to draw water from the soil.

Plant available water (PAW) is the amount of water in the soil between the soil's field capacity (soil water content after gravity has removed any freely draining, excess water) and its **permanent wilting point** (soil water content at which most plants cannot recover from wilting). It is expressed as inches of available water per foot of soil.

This figure is important because it is within this range (between field capacity and wilting point) that irrigation should occur, based on the amount of PAW that can be depleted in the soil without harming plant growth and development. Plants with shallow roots and low root densities should be watered before the soil moisture level comes too close to the

permanent wilting point since they will be less able to absorb all available water than plants with deeper roots and higher root densities.

A useful tool for estimating PAW in different soil types is a hydraulic properties calculator, which is readily available online. The calculator is straightforward, but requires the user to know the percentages of sand and clay in his or her soil. This kind of soil textural analysis can be requested in a soil test from the soil and plant tissue testing laboratory.

1.2. Calculating soil moisture percentage

A wide range of tools are available for determining soil moisture, and the devices mentioned here are typically used for irrigation management purposes. They are not much more expensive than simple soil probes (but are much more accurate), and are straightforward to operate.

- **Tensiometers** are devices that measure soil moisture tension. They are sealed, water-filled tubes with a porous ceramic tip at the bottom and a vacuum gauge at the top. They are inserted in the soil to plants' root zone depth. Water moves between the tensiometer tip and surrounding soil until equilibrium is reached, and moisture tension registers on the gauge at the top of the unit. Readings indicate water availability in the soil. Tensiometers operate best at soil moisture tensions near field capacity and need to be serviced before reuse if they dry out. Average cost for a tensiometer is $50-$100 (and generally more than one is installed at a location.
- **Electrical resistance blocks**, also known as **gypsum blocks**, measure soil water tension. They consist of two electrodes embedded in a block of porous material, usually gypsum; the electrodes are connected to lead wires that extend to the soil surface for reading by a portable meter. As water moves in or out of the porous block in equilibrium with the surrounding soil, changes in the electrical resistance between the two electrodes occur. Resistance meter readings are converted to water tension using a calibration curve. Gypsum blocks operate over a wider range of soil moisture tensions than tensiometers, but tend to deteriorate over time and may even need to be replaced yearly. Individual blocks can cost as little as $1.25 each and the meter is around $300. **Granular matrix sensors** are newer devices that are similar to

gypsum blocks but are less susceptible to degradation. The sensors are more expensive than gypsum blocks, in the $30 range.

- **Time Domain Reflectometry (TDR)** is a newer tool that sends an electrical signal through steel rods placed in the soil and measures the signal return to estimate soil water content. Wet soil returns the signal more slowly than dry soil. This type of sensor gives fast, accurate readings of soil water content, and requires little to no maintenance. However, it does require more work in interpreting data, and may require special calibration depending on soil characteristics. The cost ranges from $100 to $500.

The soil moisture calculations in percentages on a weight basis have been commonly used, but this does not give a true picture of soil-moisture relationships. Two soils may have similar moisture content on a weight basis but not on a volume basis.

Calculations on a volume basis are more meaningful and practical because water is retained in the soil within a given volume and plant roots also absorb moisture from a volume of soil.

To change percentage soil moisture on a weight basis to percentage soil moisture on a volume basis, the following calculation is given:

% moisture by volume = % moisture by weight Ã— bulk density of the soil.

When calculated for a depth of 12 inches, this value indicates water in inches per foot depth. On an acre or hectare basis, this value is written as acre or hectare inches per acre or hectare foot of soil.

Problem 1:

Calculate

(a) The total water presently contained in the top 30 cm,

(b) The depth to which 27.5 mm (1.1 inch) of irrigation would wet this uniform soil and

(c) The available water the soil contains in the top 30 cm when the soil is at field capacity.

The measurement of the soil is as follows:

Present water content â€“ 18%

Water content at field capacity â€“ 23%

Permanent wilting percentage â€“ 9%

Bulk density of 0-30 cm depth surface soil â€“ 1.3 g/c.c.

Solution:

(a) Depth of water (dw)

= 1.3 Ã—18/100 Ã— 30 cm

= **7.0 cm**

So, the depth of total water present in the top 30 cm of soil is 7.0 cm.

(b) To calculate the depth of wetting by a 27.5 mm (1.1 inch) irrigation, the following equation is substituted.

or, 27.5 mm = 1.3 Ã—23 â€“ 18/100 Ã— ds

or, 27.5 mm = 1.3 Ã—5/100 Ã— ds

or, ds = 27.5mm Ã— 100/1.3 Ã— 5

= 42.3 mm

So 42.3 mm depth of soil will be wetted.

(c) To calculate the total possible plant available water in the top 30 cm, when the soil is wetted equals field capacity minus permanent wilting percentage. So the plant available water (dw) is

dw= 1.3 Ã—23 â€“ 9/100 Ã— 30 cm

= 1.3 Ã— 14/100Ã— 30 cm

= 1.3 Ã— 0.14 Ã— 30 cm

= **5.46 cm**.

So the top 30 cm of soil contains 5.46 cm of available water.

Problem 2:

A soil sample taken from a field is placed in the aluminum box, weighed, dried in an oven at 105Â°C (221Â°F) and reweighed.

The measurements are as follows:

Weight of moist soil plus aluminum box = 159 g

Weight of oven dried soil plus aluminum box = 134 g

Weight of empty aluminum box = 41 g

Calculate the moisture content of the soil.

Solution:

Weight of moist soil only = (159 â€” 41) g

= 118g

Weight of oven dried soil only = (134 – 41) g

= 93 g

$$\text{Therefore, moisture percentage} = \frac{\text{weight of moist soil} - \text{weight of oven dried soil}}{\text{weight of oven dried soil}} \times 100$$

= 118 â€“ 93/93 Ã— 100

= **26.9**

Self-Check – 1	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. List soil moisture testing tools.
2. Define those terminology
   - Soil water content
   - Soil water potential or soil moisture tension
   - Plant available water (PAW)
   - Permanent wilting point

Test II: say true or false

1. Soil water content is a measurement of the amount of water in a known amount of soil.
2. Irrigation is applied between field capacity and wilting point.
3. Plants with shallow roots and low root densities should be watered before the soil moisture level comes too close to the permanent wilting point.
4. Landscape professionals can do the same to maximize irrigation efficiency in landscape and turf plantings.
5. The soil moisture calculations in percentages on a weight basis have been commonly used, but this does not give a true picture of soil-moisture relationships.
6. Wet soil returns the signal more slowly than dry soil.
7. Tensiometers operate best at soil moisture tensions near field capacity.
8. Gypsum blocks operate over a wider range of soil moisture tensions than tensiometers.

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

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

Information sheet 2 - Calculating water requirements

2.1. Introduction

Crop water requirements (CWR) are defined as the depth of water [mm] needed to meet the water consumed through evapotranspiration (ETc) by a disease-free crop, growing in large fields under non-restricting soil conditions including soil water and fertility, and achieving full production potential under the given growing environment. Defining crop evapotranspiration (ETc) as the rate of evapotranspiration [mm d−1] of a given crop as influenced by its growth stages, environmental conditions and crop management to achieve the potential crop production, then the CWR is the sum of ETc for the entire crop growth period. When management or environmental conditions deviate from the optimal, then that rate of evapotranspiration has to be adjusted to the prevailing conditions and is called adjusted or actual crop evapotranspiration (ETc). Both CWR and ETc concepts apply to either irrigate or rain fed crops.

2.2. Calculating crop water requirements /CWR/

Research focusing on water-saving agriculture has recently emphasized the use of crop water requirement", (CWR) aiming at supplying a precise amount of water to a crop based on crop needs. CWR refers to the amount of water required to compensate for ET losses from a crop field during a specified period of time. CWR can be expressed in millimeters per day, per month, or per season; these can be used for management purposes in estimating irrigation water requirements, irrigation scheduling, and water delivery scheduling. In crop management practices, CWR can be used as a guide to determine the balance between the amount of extractable soil water available for the crop and the amount of water needed to be supplied at a particular growth stage. In a wet soil, the water has a high potential energy, is relatively free to move and is easily taken up by plant roots. In a dry soil, however, the water is bound by capillary and absorptive forces to the soil matrix, and is less easily extracted by crop plants. When the potential energy of the soil water decreases to a threshold value (usually, the lower limit of plant extractable soil water), the crop is unable to extract the water from the soil and becomes water stressed. Thus, the CWR of a particular crop at a particular growth stage can be estimated by multiplying the crop coefficient with the crop reference ET, as follows:

CWR = Ks Kc ETo

where CWR is under water stress, Ks describes the effect of water stress on crop transpiration (Ks is <1 under soil water-limiting conditions, with evaporation from soil not a large component of ET), Kc is the crop coefficient which can be estimated using a "crop coefficient curve" developed for different crop species, and ETo is the crop reference ET calculated using Eqn (2.1) above.

The amount of irrigation water needed by a crop is roughly the difference between CWR and precipitation on a weekly or monthly basis.

IW=CWR – Pr

Where **IW** is irrigation water required and **Pr** is precipitation during the given period (weekly or monthly).

Self-Check – 2	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. _____depth of water [mm] needed to meet the water consumed through evapotranspiration (ETc).
2. _____. the rate of evapotranspiration [mm d−1] of a given crop as influenced by its growth stages, environmental conditions and crop management to achieve the potential crop production.

Test II: say true or false

1. The amount of irrigation water needed by a crop is roughly the difference between CWR and precipitation on a weekly or monthly basis.
2. Research focusing on water-saving agriculture has recently emphasized the use of crop water requirement", (CWR).
3. CWR can be expressed in millimetres per day, per month, or per season.
4. The amount of irrigation water needed by a crop is the precipitation on a weekly or monthly basis.
5. The simplest equipment for soil-moisture sampling is the hand auger.
6. Tensiometers are affected by temperature.
7. The temperature gradients between the porous point of the tensiometer and the soil may cause variations in the tension readings.

Note*:* Satisfactory rating - 20 points Unsatisfactory - below 20 points

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

Information sheet 3 - Assessing nutrient requirements of crops and identifying deficiencies

3.1. Introduction

Nutrient management is critical in order to increase or maintain crop yields on a single parcel of agricultural land. To meet crop needs throughout growing season soil fertility must be consistently high. There are fourteen nutrients that are supplied to crops from soil and fertilizer sources. Six (6) are generally considered macronutrients, while the rest are micronutrients. Macronutrients are used in relatively larger amounts by the plant, however micronutrient deficiencies can be equally damaging to yield and profitability.

3.2. Determining nutrient needs

Soil testing is a critical component in determining those nutrients that are already available and those that may be in limited supply. Deficiencies will impact crop quality or yield and knowing these will assist in determining the amount and type of fertilizer required. Soil testing, however, is highly dependent on appropriate soil sampling on an individual field basis.

Plant tissue analysis may also be used as a method for measuring nutrient levels of a plant during their growth. This analysis is a useful tool for growers looking to understand the effectiveness of their fertilization practices. Tissue analysis may also be appropriate for diagnosing certain production problems. Similar to soil testing, however, plant tissue analysis is only as good as the samples that are submitted.

3.3. Identifying crop nutrients

Nitrogen (N), phosphorous (P), and potassium (K) are the three main nutrients that are conventionally supplied by inorganic fertilizers. Nutrients may also be supplied by other products and processes such as organic manures, plants residues, and biological nitrogen fixation. Practical nutrient requirements for certain crops should come from regionally specific guidelines dependent on the crop, environmental factors such as soil type and weather conditions, and the nutrient being applied.

Nitrogen: Nitrogen is an essential macronutrient for plant growth and is one of the most abundant elements in the earth's atmosphere and surface. Nitrogen deficiency, however,

is one of the most prevalent crop nutrient problems around the world. The reason for widespread shortages is that most of the N in the atmosphere and in the earth's crust is not available for immediate uptake by plants. Most organic forms of N, such as the N found in plant residue, soil organic matter, or bacteria, are not available to plants. However, many spoil microorganisms are able to convert organic N into a plant available inorganic form, a process referred to as **mineralization**. Although not directly available for plant uptake, organic N is an important factor in soil health because it is relatively stable within the system, and can provide plants with a long-term slow release of N. Mineral N in the inorganic forms ammonium (NH_4^+) and nitrate (NO_3^-) are plant available forms, however NO_3^- is also quite susceptible to being lost from the system because it is water soluble and does not interact with soil particles.

Phosphorous: Phosphorous is an essential macronutrient for plant reproduction, which may significantly impact grain or fruit yield. P deficiency is a common problem causing crop stunting or discoloration in the field. One of the major contributing sources of P for crops comes from soil organic matter. This soil organic matter will generally contain a range of organic P compounds, which must be converted into inorganic phosphate by soil microorganisms in order to be taken up by plants. Soil organic matter can be an excellent source of stable organic P compounds that can be released over time, however the P available to plants is only found dissolved in the soil solution. Soluble P is a small fraction of the total P in the soils. Even much of the P added to a system through compost, manure, or fertilizer is immobilized in soil. For this reason the efficiency of P fertilizer may be low.

Potassium: Soil potassium is an essential macronutrient for crops and can generally be found in three forms in an agricultural system. The K immediately usable by plants is found within the soil solution. Though this form is most significant for plant uptake, it is only a small fraction of the total K in the soil. Exchangeable K and mineral forms of K are far more prevalent within the soil. Mineral K is the most stable form and is generally tightly held within the soil itself. The availability of this form of the nutrient is fairly low for crop uptake. Exchangeable K, on the other hand, is an important pool of the K available for

crop growths. This form of K is a positively charged ion that is loosely attracted to the negatively charged surfaces of soil particles.

Secondary Nutrients: Calcium (Ca), magnesium (Mg), and sulfur (S), are considered secondary macronutrients, or secondary nutrients, because they are required in amounts smaller than typically needed for N, P, or K. These elements, however, are equally important for plant growth and nutrition. Often, adequate amounts of these nutrients can be found in the soil and supplied to crops from chemical weathering or atmospheric deposition.

Micronutrients: Micronutrients are essential nutrients for plant growth that are used in relatively small amounts by crops. Boron (B), zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), molybdenum (Mo), nickel (Ni), and chlorine (Cl) will only make up a small proportion of a plant; however, a deficiency in any of these elements has the potential to cause a decrease in crop quality or yield. In contrast, excess availability may cause toxicity. The availability of each of these micronutrients will depend on environmental and soil conditions. While visual clues may point a grower in the right direction towards identifying deficiencies, the most common method for determining deficiencies is through soil testing or plant tissue analysis. The most common method for ensuring proper micronutrient content within the soil is through increasing and enhancing the soil organic matter, which can be seen as a reservoir for holding stable forms of nutrients. In many cases, micronutrients can also be supplied with foliar sprays.

3.4. Identifying nutrient deficiencies in crops

The elements used by plants for growth and development are often referred to as nutrients. Nutrients that are required in great amounts are called **macronutrients**

There are nine macronutrients. Carbon, hydrogen, and oxygen are not considered in a fertility program because they are part of the air around the plant. Nitrogen (N), phosphorus (P), and potassium (K) are considered to be primary nutrients because they are used by plants in large amounts.

Nitrogen deficiency symptoms: plants are light green, older leaves yellow (chlorosis); yellowing begins at leaf tip and extends along midribs in corn and sorghum, and slow or dwarfed growth.

Phosphorus deficiency symptoms: plants dark green with purple cast to leaves and stems, and stunted leaves and plants.

Potassium deficiency symptoms: yellow/brown discoloration and scorching along outer margin of older leaves that begins at leaf tip in corn and sorghum.

Secondary macronutrients are needed in moderate amounts. Calcium (Ca), magnesium (Mg) and sulfur (S) are the secondary macronutrients.

Calcium deficiency symptoms: Emergence of the primary leaves delayed, terminal buds deteriorate, young leaves at growing points die back, short branched roots, leaf tips may be stuck together in corn.

Magnesium deficiency symptoms: Loss of green leaf color starting with bottom leaves; older leaves have yellow discoloration between veins, reddish-purple from edge inward.

Sulfur deficiency symptoms: Young leaves light green with veins being lighter.

Micronutrients or trace elements are required in small amounts. Boron (B), copper (Cu), chlorine (Cl), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn).

Boron deficiency symptoms: Young leaves yellow and thick, growth buds appear as white or light brown dead tissue.

Copper deficiency symptoms: Young leaves uniformly pale yellow, may wilt and wither without chlorosis, heads to not form or may be grain-less on small grains.

Chlorine deficiency symptoms: Wilting of upper leaves, then chlorosis.

Iron deficiency symptoms: Leaves yellow to almost white, veins remain green, interveinal chlorosis to leaf tip.

Manganese deficiency symptoms: Leaves yellowish-gray or reddish-gray with green veins.

Molybdenum deficiency symptoms: Older leaves yellow, stunted growth, young leaves wilt and die along margins.

Zinc deficiency symptoms: Older leaves yellow, stunted growth, broad white to yellow bands appear on the leave so each side of the midrib, shortened internodes

Fig 2. **Top left** corn ear with boron deficiency. **Top right** wheat with manganese deficiency. **Bottom left** potato leaf with potassium deficiency. **Bottom right** soybean with zinc deficiency. (Courtesy, Potash and Phosphate Institute)

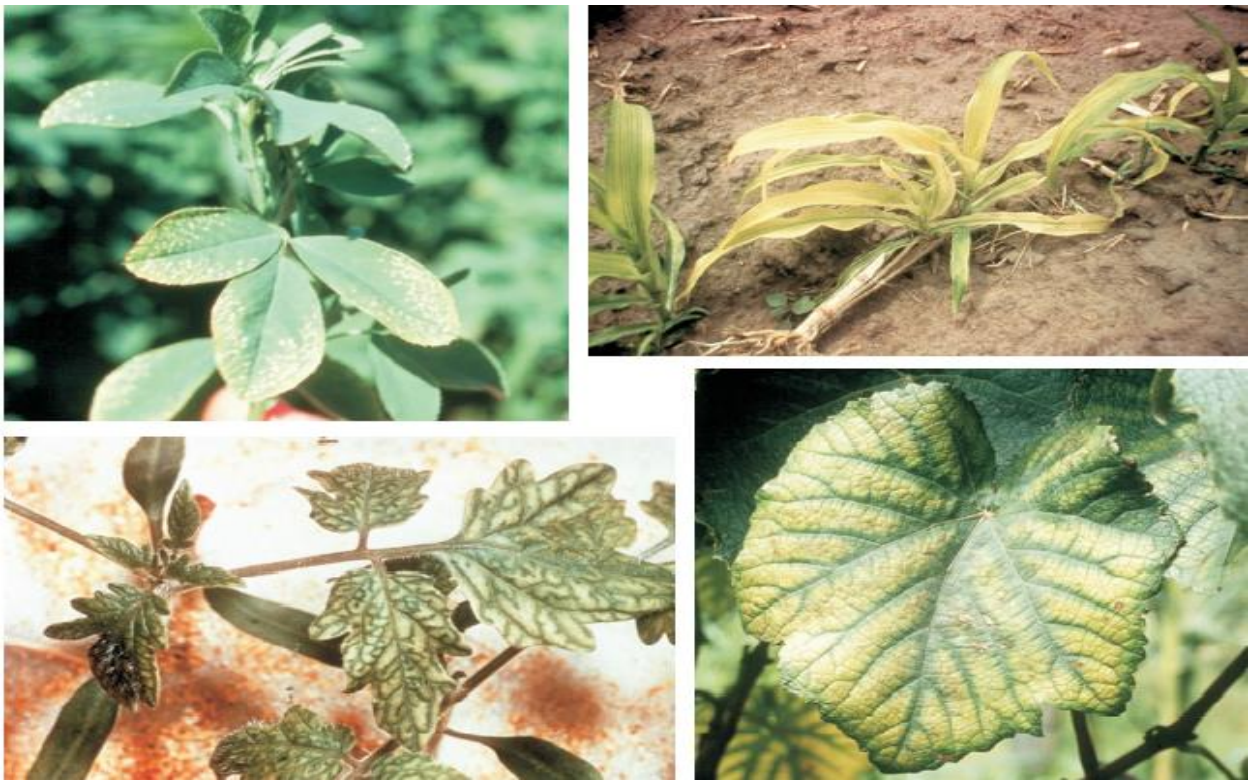


Fig 3. Top left potassium deficiency in alfalfa. Top right nitrogen deficiency in corn. Bottom left iron deficiency in a tomato plant. Bottom right magnesium deficiency in a grape plant. (Courtesy, Potash and Phosphate Institute, Norcross, Georgia)

Self-Check – 3	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Write Nitrogen deficiency symptoms.
2. Write potassium deficiency symptoms.
3. Write calcium deficiency symptoms.

Test II: say true or false

1. Manganese deficiency symptom shows leaves yellowish-gray or reddish-gray with green veins.
2. Molybdenum deficiency symptom shows older leaves yellow, stunted growth, young leaves wilt and dies along margins.

Test III: choice

1. Zinc deficiency symptoms

A. Older leaves yellow, stunted growth, broad white to yellow
B. Young leaves wilt and die along margins
C. Terminal buds deteriorate
D. Young leaves at growing points die back

2. Nitrogen deficiency symptoms:
   A. Plants are light green, older leaves yellow (chlorosis);
   B. Terminal buds deteriorate
   C. Young leaves at growing points die back
   D. Veins remain green
3. Phosphorus deficiency symptoms:
   A. Plants dark green with purple cast to leaves and stems
   B. Terminal buds deteriorate
   C. Young leaves at growing points die back
   D. Veins remain green

4. Potassium deficiency symptoms:
   A. Yellow/brown discoloration and scorching along outer margin of older leaves
   B. Terminal buds deteriorate
   C. Young leaves at growing points die back
   D. Veins remain green
5. Sulfur deficiency symptoms:
   A. Young leaves light green with veins being lighter
   B. Terminal buds deteriorate
   C. Young leaves at growing points die back
   D. Veins remain green

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

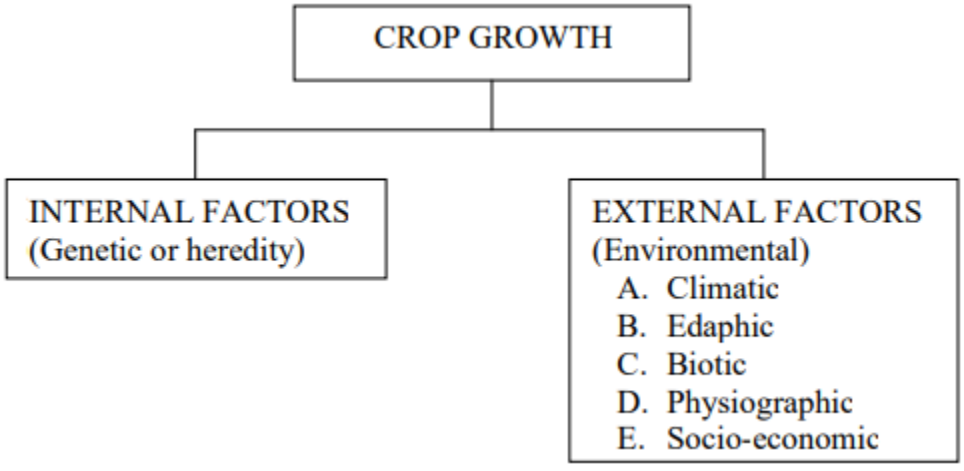
You can ask you teacher for the copy of the correct answers.

Information Sheet 4- Identifying crop production potential factors

4.1. Introduction

Factors if what will be done**? (**Action steps**,** description**)** facing crop production are:

- Climatic
- Edaphic
- Biotic-
- Physiographic and socio economic factors



4.2. Identifying crop production potential factors

1. **Internal factors**

- **Genetic factors**

The increase in crop yields and other desirable characters are related to Genetic make-up of plants.

- ✓ High yielding ability
- ✓ Early maturity
- ✓ Resistance to lodging
- ✓ Drought flood and salinity tolerance
- ✓ Tolerance to insect pests and diseases
- ✓ Chemical composition of grains (oil content, protein content)
- ✓ Quality of grains (fineness, coarseness)
- ✓ Quality of straw (sweetness, juiciness)

The above characters are less influenced by environmental factors since they are governed by genetic make-up of crop.

2. **External factors**

A. Climatic

B. Edaphic

C. Biotic

D. Physiographic

E. Socio-economic

A. Climatic factors

Nearly 50 % of yield is attributed to the influence of climatic factors. The following are the atmospheric weather variables which influences the crop production.

1. Precipitation
2. Temperature
3. Atmospheric humidity
4. Solar radiation
5. Wind velocity
6. Atmospheric gases

1. Precipitation

- Precipitation includes all water which falls from atmosphere such as rainfall, snow, hail, fog and dew.
- Rainfall one of the most important factor influences the vegetation of a place.
- Total precipitation in amount and distribution greatly affects the choice of a cultivated species in a place.
- In heavy and evenly distributed rainfall areas, crops like rice in plains and tea, coffee and rubber in Western Ghats are grown.
- Low and uneven distribution of rainfall is common in dryland farming where drought resistance crops like pearl millet, sorghum and minor millets are grown.
- In desert areas grasses and shrubs are common where hot desert climate exists
- Though the rainfall has major influence on yield of crops, yields are not always directly proportional to the amount of Precipitation as excess above optimum reduces the yields
- Distribution of rainfall is more important than total rainfall to have longer growing period especially in drylands

2. Temperature

- Temperature is a measure of intensity of heat energy. The range of temperature for maximum growth of most of the agricultural plants is between 15 and 40ºC.
- The temperature of a place is largely determined by its distance from the equator (latitude) and altitude.
- It influences distribution of crop plants and vegetation.
- Germination, growth and development of crops are highly influenced by temperature.
- Affects leaf production, expansion and flowering.
- Physical and chemical processes within the plants are governed by air temperature.
- Diffusion rates of gases and liquids changes with temperature.
- Solubility of different substances in plant is dependent on temperature.
- The minimum, maximum (above which crop growth ceases) and optimum temperature of individual's plant is called as cardinal temperature.

Crops	Minimum temperature ºC	Optimum temperature ºC	Maximum temperature ºC
Rice	10	32	36-38
wheat	4.5	20	30-32
Maize	8-10	20	40-43
Sorghum	12-13	25	40
Tobacco	12-14	29	35

3. Atmospheric Humidity (Relative Humidity - RH)

- Water is present in the atmosphere in the form of invisible water vapour, normally known as humidity. Relative humidity is ratio between the amount of moisture present in the air to the saturation capacity of the air at a particular temperature.
- If relative humidity is 100% it means that the entire space is filled with water and there is no soil evaporation and plant transpiration.
- Relative humidity influences the water requirement of crops
- Relative humidity of 40-60% is suitable for most of the crop plants.
- Very few crops can perform well when relative humidity is 80% and above.
- When relative humidity is high there is chance for the outbreak of pest and disease.

4. Solar radiation (without which life will not exist)

- From germination to harvest and even post-harvest crops are affected by solar radiation.
- Biomass production by photosynthetic processes requires light.
- All physical process taking place in the soil, plant and environment are dependent on light
- Solar radiation controls distribution of temperature and there by distribution of crops in a region.
- Visible radiation is very important in photosynthetic mechanism of plants. Photosynthetically Active Radiation (PAR - 0.4 – 0.7µ) is essential for production of carbohydrates and ultimately biomass.

0.4 to 0.5 µ - Blue – violet – Active

0.5 to 0.6 µ - Orange – red - Active

0.5 to 0.6 µ - Green –yellow – low active

Photoperiodism: is a response of plant to day length

Short day: Day length is <12 hours (Rice, Sunflower and cotton),

Long day: Day length is > 12 hours (Barley, oat, carrot and cabbage),

Day neutral: There is no or less influence on day length (Tomato and maize).

Phototropism: Response of plants to light direction. Eg. Sunflower

Photosensitive: Season bound varieties depends on quantity of light received

5. Wind velocity

- The basic function of wind is to carry moisture (precipitation) and heat.
- The moving wind not only supplies moisture and heat, also supplies fresh CO2 for the photosynthesis.
- Wind movement for 4 – 6 km/hour is suitable for more crops.
- When wind speed is enormous then there is mechanical damage of the crops (i.e.) it removes leaves and twigs and damages crops like banana, sugarcane
- Wind dispersal of pollen and seeds is natural and necessary for certain crops.
- Causes soil erosion.
- Helps in cleaning produce to farmers.
- Increases evaporation.
- Spread of pest and diseases.

6. Atmospheric gases on plant growth

- CO2 – 0.03%, O2 - 20.95%, N2 - 78.09%, Argon - 0.93%, Others - 0.02%.
- CO2 is important for Photosynthesis, CO2 taken by the plants by diffusion process from leaves through stomata
- CO2 is returned to atmosphere during decomposition of organic materials, all farm wastes and by respiration
- O2 is important for respiration of both plants and animals while it is released by plants during Photosynthesis
- Nitrogen is one of the important major plant nutrient, Atmospheric N is fixed in the soil by lightning, rainfall and N fixing microbes in pulses crops and available to plants
- Certain gases like SO2, CO, CH4, HF released to atmosphere are toxic to plants

B. Edaphic factors (soil)

Plants grown in land completely depend on soil on which they grow. The soil factors that affect crop growth are:

1. Soil moisture
2. Soil air
3. Soil temperature
4. Soil mineral matter
5. Soil organic matter
6. Soil organisms
7. Soil reactions

- **Soil moisture**
  - ✓ Water is a principal constituent of growing plant which it extracts from soil
  - ✓ Water is essential for photosynthesis
  - ✓ The moisture range between field capacity and permanent wilting point is available to plants.
  - ✓ Available moisture will be more in clay soil than sandy soil
  - ✓ Soil water helps in chemical and biological activities of soil including mineralization
  - ✓ It influences the soil environment Eg. it moderates the soil temperature from extremes
  - ✓ Nutrient availability and mobility increases with increase in soil moisture content.
- **Soil air**
  - ✓ Aeration of soil is absolutely essential for the absorption of water by roots
  - ✓ Germination is inhibited in the absence of oxygen
  - ✓ O2 is required for respiration of roots and micro organisms.
  - ✓ Soil air is essential for nutrient availability of the soil by breaking down insoluble
  - ✓ mineral to soluble salts
  - ✓ For proper decomposition of organic matter
  - ✓ Potato, tobacco, cotton linseed, tea and legumes need higher O2 in soil air
  - ✓ Rice requires low level of O2 and can tolerate water logged (absence of O2) condition.
- **Soil temperature**

- ✓ It affects the physical and chemical processes going on in the soil.
- ✓ It influences the rate of absorption of water and solutes (nutrients)
- ✓ It affects the germination of seeds and growth rate of underground portions of the crops like tapioca, sweet potato.
- ✓ Soil temperature controls the microbial activity and processes involved in the nutrient availability.
- ✓ Cold soils are not conducive for rapid growth of most of agricultural crops

- **Soil mineral matter**
  - ✓ The mineral content of soil is derived from the weathering of rocks and minerals as particles of different sizes.
  - ✓ These are the sources of plant nutrients
    eg; Ca, Mg, S, Mn, Fe, K etc.
- **Soil Organic matter**
  - ✓ It supplies all the major, minor and micro nutrients to crops
  - ✓ It improves the texture of the soil
  - ✓ It increases the water holding capacity of the soil,
  - ✓ It is a source of food for most microorganisms
  - ✓ Organic acids released during decomposition of organic matter enables mineralization process thus releasing unavailable plant nutrients
- **Soil organisms**
  - ✓ The raw organic matter in the soil is decomposed by different microorganisms which in turn releases the plant nutrients.
  - ✓ Atmospheric nitrogen is fixed by microbes in the soil and is available to crop plants through symbiotic (Rhizobium) or non-symbiotic (Azospirillum) association
- **Soil reaction (pH)**
  - ✓ Soil reaction is the pH (hydrogen ion concentration) of the soil.
  - ✓ Soil pH affects crop growth and neutral soils with pH 7.0 are best for growth of most of the crops
  - ✓ Soils may be acidic (<7.0), neutral (=7.0), saline and alkaline (>7.0)
  - ✓ Soils with low pH are injurious to plants due high toxicity of Fe and Al.
  - ✓ Low pH also interferes with availability of other plant nutrients

Self-Check – 4	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Discuss soil factors that affect crop growth.
2. Write internal factors of crop production.
3. List all external factors of crop production.

Test II: say true or false

1. Relative humidity influences the water requirement of crops.
2. Soil temperature controls the microbial activity and processes involved in the nutrient availability.
3. Aeration of soil is absolutely essential for the absorption of water by roots
4. The raw organic matter in the soil is decomposed by different microorganisms which in turn releases the plant nutrients.
5. Soil pH affects crop growth and neutral soils with pH 7.0 are best for growth of most of the crops
6. Soils with low pH are injurious to plants due high toxicity of Fe and Al.
7. Cold soils are not conducive for rapid growth of most of agricultural crops

8. Water is essential for photosynthesis.

Note*:* Satisfactory rating - 20 points Unsatisfactory - below 20 points

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

Information Sheet 5- Implementing sustainable land management

5.1. introduction

One out of every three people on earth is in some way affected by land degradation. Latest estimates indicate that nearly 2 billion ha of land worldwide an area twice the size of China is already seriously degraded, some irreversibly. This includes large areas of cropland, grassland, woodland and forest areas whose degradation reduces productivity, disrupts vital ecosystem functions, negatively affects biodiversity and water resources, and increases vulnerability to climate change.

5.2. Sustainable land management practice

Sustainable land management (SLM) is crucial to minimizing land degradation, rehabilitating degraded areas and ensuring the optimal use of land resources for the benefit of present and future generations. SLM is based on four common principles:

- land-user-driven and participatory approaches;
- Integrated use of natural resources at ecosystem and farming systems levels;
- Multilevel and multi stake holder involvement; and
- Targeted policy and institutional support, including development of incentive mechanisms for SLM adoption and income generation at the local level. Its application requires collaboration and partnership at all levels land users, technical experts and policy-makers to ensure that the causes of the degradation and corrective measures

are properly identified, and that the policy and regulatory environment enables the adoption of the most appropriate management measures.

The causes of land degradation are complex and vary from place to place. The major drivers of land degradation are generally grouped into two: proximate and underlying causes.

The proximate causes are more or less natural factors such as biophysical conditions, topographic and climatic conditions, and inappropriate land management practices, whereas the underlying factors are mostly anthropogenic, which include population growth, land tenure, and other socioeconomic and policy related factors.

The major drivers of land degradation in Ethiopia include land shortage and lack of alternative livelihoods (induced by high population growth), forest clearance and high removal of vegetation cover, unsustainable cultivation practices, and overgrazing.

Soil erosion and deforestation are the two more severe forms of land degradation that contribute to the poor performance of subsistence agriculture sector in Ethiopia.

Sustainable land management has, therefore, utmost importance to Ethiopia in which about 80% of its population is directly supported by the agriculture sector. It addresses land degradations and enhances the productive capacity of the natural resources base. In addition, in the absence of effective sustainable land management (SLM) practice, it is less likely to eradicate poverty.

Self-Check – 5	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Write importance of sustainable land management (SLM).
2. Write the major drivers of land degradation in Ethiopia.
3. List proximate causes of land degradation.
4. Mention the two more severe forms of land degradation.

Test II: say true or false

1. Sustainable land management (SLM) is crucial to minimizing land degradation.
2. Ethiopia has not sustainable land management policy.
3. The causes of land degradation are complex and vary from place to place.
4. inappropriate land management practices are grouped under proximate causes of land degradation

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

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

Operation sheet 1 – Calculate the moisture content of the soil

Tools and equipment

- auger
- aluminum box
- Not book
- Pen
- Oven dry
- Sensitive balance etc.

Procedures:

1. A soil sample taken from a field is placed in the aluminium box,
2. weighed, dried in an oven at 105Â°C (221Â°F) and
3. Weight of moist soil plus aluminium box
4. Weight of oven dried soil plus aluminium box
5. Weight of empty aluminium box
6. Calculate the moisture content of the soil.

Lap Test	Demonstration

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: perform soil moisture test.

LG #47	LO # 6 - Determine pest and disease control

Instruction sheet

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

- Assessing evidence of pests and disease and determining control measures
- Availing chemicals, spraying equipment's and Safety measures
- Locating areas of weed infestation and identifying species
- Selecting pests and weed control methods
- Scheduling control methods
- Maintaining severity of infestations and records of treatments

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

- Evidence of pests and disease assess and effective control measures appropriate to type and species of infestation determine.
- The require chemicals, spraying equipment's and Safety measures avail
- Areas of weed infestation, which may be reduce or eradicate locate and species identify.
- Control methods selecte to control pests and weeds without building up a resistance to chemicals.

- Control methods schedule at the optimum time with minimal damage to the crop and environmental pollution.
- Severity of infestations and records of treatments maintain to provide essential data for future management programs.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information sheet 1 - Assessing evidence of pests and disease and determining control measures

1.1. Introduction

The damage to plants caused by competition from weeds and by other pests including viruses, bacteria, fungi, and insects greatly impairs their productivity and in some instances can totally destroy a crop. Today, dependable crop yields are obtained by using disease-resistant varieties, biological control practices, and by applying pesticides to control plant diseases, insects, weeds, and other pests.

1.2. Assessing evidence of pests and disease

A sign of plant disease is physical evidence of the pathogen. For example, fungal fruiting bodies are a sign of disease. When you look at powdery mildew on a lilac leaf, you're actually looking at the parasitic fungal disease organism itself (Microsphaera alni).

1. Aphids

Aphids have infested this scabiosa plant. Spraying with a jet of water and/or insecticidal soap gets rid of the problem. Repeated sprayings will probably be necessary

2. Cabbage Worms

Holes in cabbage leaves are a telltale sign of cabbage worm feeding. Hand-remove adults and look for eggs on the undersides of the leaves.

3. Spider Mites

This boxwood suffered a severe spider mite infestation, causing the leaves to dry out and die. Spraying with horticultural soap controls spider mites.

4. Squash Bugs

Squash bug eggs are hatching into nymphs on the undersides of these leaves. Remove any affected leaves and scout for adults.

5. Tomato Hornworms

The tomato hornworm is the larval stage of the five-spotted hawk moth. Both stages of this insect are formidable to see, but the hornworm is not a welcome sight in the vegetable garden. Hornworms favor the leaves of tomato and pepper plants. Since the hornworms blend in so well with the foliage, you might not notice them until you start to see the damage. Because the hornworm is so large (about the size of a pinkie finger), the easiest way to get rid of it is to simply remove it from the plant and dispose of it.

6. Whiteflies

Whiteflies feed off plants by sucking the plant's juices. They can cause wilting, stunting, and death. As with their relatives the aphids, mealybugs, and scale, a whitefly population can grow quickly. The best way to control whiteflies is to constantly monitor for them and use a combination of techniques to keep their population down. Check to be sure any new plant you buy is not infested; just moving the plant will cause them to flutter around. If you discover a small infestation in your garden, wash it off with a blast of water from the hose or by sinking the plant into a bucket of water. Sprays containing pyrethrum or neem offer some control to existing whitefly infestations. Coat both the upper and lower surfaces of leaves. Repeat applications will likely need to be made.

7. Wireworms

Wireworms are very common in most types of soil and can be found year-round. If wireworms feed on the roots of plants, the plants will grow slowly and will be weak. Since wireworms are so common, they are extremely hard to control. However, if you suspect

wireworms are present, here are a few techniques you can try to limit their destructiveness:

- Cultivate your soil in May and June when they hatch, to expose them to hungry birds.
- Use chunks of potato or sweet potato as a decoy trap. Skewer a piece of raw potato and bury it near the problem area and dig after about a week and check for the presence of wireworms. Dispose of the potato piece, wireworms and all.
- Remove and destroy infected crops after harvesting to limit overwintering.

8. Cucumber Beetles

Cucumber beetles eat roots, leaves, and flowers and transmit bacterial wilt disease along the way. The damage usually isn't enough to kill the plants, but the loss of flowers means a loss of fruits. The spread of bacterial wilt can be deadly and quick. It starts with one leaf wilting and spreads. A telltale sign of bacterial wilt is the sticky, white sap-like substance that oozes from snapped stems. Bacterial wilt is a serious disease of cucumbers and muskmelons. It affects squash, too, but to a much lesser extent.

Control the damage done by cucumber beetles by buying wilt-resistant plants and keeping plants off the ground by using a trellis. If an infestation still occurs, use a pesticide such as Rotenone or Pyrethrum on your plants.

9. Plant Viruses

Mottled yellow leaves usually indicate a mosaic virus. Remove and destroy any affected plants as soon as possible to limit the spread of the virus.

10. Gray Mold on Peony Leaves

Botrytis, or gray mold, is a fungus that frequently affects peony plants. Remove and destroy any affected leaves. Give the plants plenty of room for airflow, and cut back and remove foliage in the fall to lessen overwintering spores.

11. Powdery Mildew

Powdery mildew has formed on the leaves of this rudbeckia. If you see it on any of your plants, use a fungicide to control the problem

12. Leaf Spot

The lower leaves of this tomato plant are infected with leaf spot. A fungicide can be used and the leaves can be removed from the lower part of the plant to prevent spores from splashing up onto the foliage.

Self-Check – 1	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. List causes for crop damage.
2. Mention diseases causing agents.
3. _____ Physical evidence of the pathogen.

Test II: say true or false

1. A sign of plant disease is physical evidence of the pathogen.
2. Mottled yellow leaves usually indicate a mosaic virus
3. Cucumber beetles eat roots, leaves, and flowers.
4. Mottled yellow leaves usually indicate a aphids.
5. Cucumber beetles transmit bacterial wilt disease along the way.
6. If wireworms feed on the roots of plants, the plants will grow slowly and will be weak.

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

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

Information sheet 2- Availing chemicals, spraying equipment's and safety measures

2.1. Introductions

Sprayer is often used to apply different spray materials, such as pre-emergent and post emergence herbicides, insecticides and fungicides. A change of nozzles may be required, which can affect spray volume and pressure. The type and size of pump required is determined by the chemical used, recommended pressure and nozzle delivery rate. A pump must have sufficient capacity to operate a hydraulic agitation system, as well as supply the necessary volume of the nozzles.

Pumps must be resistant to corrosion from the chemicals. The materials used in pump housings and seals should be resistant to chemical used, including organic solvents. Other things to consider are initial pump cost, pressure and volume requirements, ease of priming and power source available.

2.2. Agro chemicals

Agrochemicals are pesticides, herbicides, or fertilizers used for the management of ecosystems in agricultural sectors. Rudimentary variations on agrochemicals have been used for millennia to improve crop yields and control the populations of agricultural pests.

Types of agrochemicals

There is a concerted effort to actively and conscientiously implement a broad range of agrochemicals to safely maintain and control the global food supply to ensure consistently high quality for widespread consumption. Types of agrochemicals include:

Pesticides or chemicals engineered to destroy insects and other organisms, weeds, and funguses that could spoil crop yields;

Synthetic fertilizers, for example ammonium nitrate (NH_4NO_3), which is designed to encourage crop growth by saturating, soils with nutrients;

Acidifiers and liming agents, engineered to alter the pH levels of soils to suit the planting properties of given crops;

Soil conditioners, for example gypsum ($CaSO_4 \cdot 2H_2O$), which is designed to condition soils with high sodium (Na) contents to improve planting conditions;

Growth hormones or synthetic chemicals designed to increase growth rates in animals and crops.

New and emerging agrochemical methods include the engineering of crops that are synthetically-resistant to herbicides, or that produce their own insecticides.

2.3. Spraying equipment's

A sprayer is a device used to spray a liquid, where sprayers are commonly used for projection of water, weed killers, crop performance materials, pest maintenance chemicals, as well as manufacturing and production line ingredients.

Various types of sprayers suitable for small to large lands are available.

1. Knapsack sprayer.
2. Portable power sprayer.
3. Knapsack power sprayer.
4. Mist dust sprayer.
5. HTP sprayers.
6. Orchard sprayers.

Spray Equipment

- Pump and flow controls.
- Centrifugal pumps and controls.
- Roller pumps and controls.
- Spray system pressure.
- Sprayer tanks.
- Tank agitators.
- Strainers.
- Sprayer distribution system.
- Nozzles. Functions. Flow rate. ...
- Other pesticide application equipment. Wiper applicators.

Type	Appearance	Comments on use
Knapsack		This is the equipment of choice of the small holder farmer. It is affordable, available and reasonably effective for low growing crops, particularly vegetables. Lance extensions are available to facilitate spraying tall crops but use for spraying fully grown trees is not advisable. Pesticides are applied as water based solutions and an Operating pressure is 1 – 3 bars, and a range of droplet sizes, (course – fine), is possible depending on nozzle type and aperture
Motorized knapsack		Also in use in the small farmer sector. The equipment is more expensive, needs more maintenance and is very heavy to use. Pesticides are applied as water based solutions but at an Operating pressure that is higher than for the manual knapsack gives greater penetration of the crop canopy. A range of droplet sizes is possible (course fine), depending on nozzle type and aperture. This together with the higher operating pressure gives better coverage with the spray mix and greater penetration of the crop canopy
Trolley mounted Sprayer		Found in use in most commercial greenhouse operations in Ethiopia. This equipment typically comprises a 250 -1000Lit tank and motorized pump mounted on a small trolley and usually fitted to a long hose with a multi nozzle claw lance or a wheeled vertical boom.

Tractor mounted boom sprayer		Used for large scale field (horizontal boom) and orchard (angled or vertical boom) The size and complexity of these pieces of equipment varies and you should refer to the operating manual for instruction for calibration, operation and maintenance.
ULV (Ultra Low volume) **applicators**		These applicators may be hand held or tractor mounted motorized devices used for application of low volumes of oil based pesticide products. ULV application involves the use of very fine droplets … microns, which drift through the crop canopy. This is particularly useful for vertical crops e.g. Cotton and trees. Crop coverage can be very good but the small droplet size and drift means that this method is quite high risk for operators, local communities and the environment

Self-Check – 2	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. List crop production sprayers.
2. Mention agro chemicals found at work place.

Test II: say true or false

1. Sprayer is often used to apply different spray materials.
2. Agrochemicals are pesticides, herbicides, or fertilizers used for the management of ecosystems in agricultural sectors
3. ULV application involves the use of very fine droplets.

Test III: choice

1. choice of the small holder farmer
   - A. Motorized knapsack
   - B. Knapsack
   - C. ULV (Ultra Low volume)
   - D. Mist dust sprayer
2. Use in most commercial greenhouse operations in Ethiopia.
   - A. Knapsack
   - B. Mist dust sprayer
   - C. ULV (Ultra Low volume)
   - D. Trolley mounted Sprayer

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

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

Information sheet 3- Locating areas of weed infestation and identifying species

3.1. Introduction

A weed is a plant considered undesirable in a particular situation, "a plant in the wrong place". Examples commonly are plants unwanted in human-controlled settings, such as farm fields, gardens, lawns, and parks.

3.2. classifications of weeds

There are many ways in which weeds can be classified. Two of the most common ways are by gross morphological features, and by their lifecycle. When classified by their gross morphological features, weeds are broken into three major categories: grasses, sedges, and broadleaf weeds. When classified by their life cycle, they are broken into annual, biennial, and perennial. The latter classification method can have a profound impact on the effectiveness of control measures.

Life cycle classification

Annual weeds complete their life cycle in one year or less. During that time, they germinate, complete their growth cycle, flower, produce seeds, and dia. Some develop prostrate stems or adventitious roots. If the stems are cut, they may develop into new plants.

Biennial weeds have life cycles that span two years (i.e. two growing seasons). During the first year, biennials germinate, and the plant focuses on growth. The plant overwinters, and then during the second year or growing season, it flowers, produces seeds, and dies.

Perennial weeds have life cycles that span more than two years. They reproduce from seeds or vegetative parts of the plant like rhizomes, bulbs, tubers, and stolon. Like annuals, perennial weeds can be classified into cool-season perennial weeds and warm-season perennials based on the time of year when they grow.

3.3. weed population and quantitative evaluation

For accurate estimation of loss caused by weeds and selection of right method of weed control for a given environment, it is essential to evaluate the weed cover in the field.

Objectives

1. To determine the weed population in the field.
2. To estimate the loss caused by weeds.
3. To obtain quantitative data about weed density, frequency, dominance and biomass.

- Materials
  - ✓ Quadrat,
  - ✓ Cloth bags,
  - ✓ Measuring scale,
  - ✓ Thread etc.

Procedure

Quadrat sampling is the most common method for obtaining various types of data on weed cover. In fact, quadrat is a sampling unit which has an area of definite size which may be circular, rectangular or square in shape. In general a square quadrat measuring 1m x 1m is sufficient to represent the composition of an agricultural field. In general, more the sampling units (quadrat), greater is the precision.

1. Select a field or sample area for study of weed flora.
2. Randomly put the quadrat in different plots and note down the observations as mentioned in Table 1.

Table 1. Quantitative study of weed flora through quadrat sampling

Plant Species	No. of plants in given quadrat (number)					Total No. of plants	No. of quadrat of occurrence	Total No. of quadrat studied
	1	2	3	4	5			
Cyperus rotundus	10	-	5	-	7	22	3	5
Amaranthus viridis	8	5	3	2	1	19	5	5
Trianthema monogyna	1	2	-	-	10	13	3	5
Grand total	-	-	-	-	-	**54**	-	-

Formula for estimation of quantitative parameters

Weed density: Count the number of individuals of particular weed species per unit area and determine the relative density.

$$\text{Density (D)} = \frac{\text{Total number of weeds in all quadrats}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Relative Density (RDe)} = \frac{\text{Number of individuals of a given weed species}}{\text{Total number of individuals of all the weed species}} \times 100$$

Weed frequency: This parameter determines the degree of dispersion of a given weed species in an area.

$$\text{Frequency (F)} = \frac{\text{Number of quadrats of occurrence of a species}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency of given weed species}}{\text{Sum of frequency of all weed species}} \times 100$$

3.4. Identify species of weed

1. Bindweed (Convolvulus arvensis) ...
2. Quackgrass (Elytrigia repens) ...
3. Canada Thistle (Cirsium arvense) ...
4. Nutsedge (Cyperus spp.) ...
5. Buckhorn Plantain (Plantago lanceolata) ...
6. Purslane (Portulaca oleracea) ...
7. Crabgrass (Digitaria spp.)

Self-Check – 3	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. .write procedures of quadrant method of weed samplings.
2. _____ a plant in the wrong place,

Test II: say true or false

1. Biennial weeds have life cycles that span two years.
2. Perennial weeds have life cycles that span more than two years.
3. Quadrat sampling is the most common method for obtaining various types of data on weed cover.
4. A square quadrat measuring 1m x 1m is sufficient to represent the composition of an agricultural field.

Test III: choice

1. Complete their life cycle in one year or less.
   A. Perennial weeds
   B. Annual weeds
   C. Biennial weeds
   D. Quadrat weeds

2. Parameter determines the degree of dispersion of a given weed species in an area.
   A. Weed frequency
   B. Weed density
   C. Relative weed
   D. Weed sampling

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

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

Information Sheet 4- Selecting pests and weed control methods

4.1. Introduction

Pest is defined as a living organism, either a plant, fungus, or animal that is harmful to humans, human concerns, crops, and livestock and threatens their existence. Weed, on the other hand, is a plant that grows where it is not needed when it's not needed.

4.2. Methods of pest and weed control

An integrated approach for disease, pests and weed management incorporates a range of management decisions and resources to reduce disease, pest, weed outbreaks and reduce the reliance on herbicide and insecticide inputs.

Four main categories of pest controls form IPM's foundation:

1. Cultural,
2. Biological,
3. Mechanical/physical and,
4. Pesticide controls.

The four works hand in hand to provide targeted, effective, long-term pest management, and each category plays a special role.

4.3. Selection of optimal pest control tactics

Bottom line: Options for minimizing economic, health and environmental risks.

- Easy to carry out safely and effectively/least hazardous
- Most cost-effective in the short and long term
- Opportunities to integrate with other strategies
- How the control option fit into the total management system
- Impact of selected strategy on other pests & natural enemies.
- Appropriate to the weather, soils, water, and the energy resources of the site.
- No single strategy has all these attributes
- Hence the need to integrate various strategies in an IPM approach

Self-Check – 4	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Define IPM.
2. Write IPM tactics.
3. _____ a living organism, either a plant, fungus, or animal that is harmful to humans, human concerns, crops, and livestock and threatens their existence.

Test II: say true or false

1. An integrated approach for disease, pests and weed management incorporates a range of management decisions and resources.
2. Chemical control measure is not included under IPM approaches.
3. The philosophy behind the IPM approach is to create unfavorable conditions for pest buildup by enhancing crop vigor and by protecting natural enemies that aid in controlling pest populations.
4. PM may result in reduced pesticide use by employing preventive pest management and nonchemical pest controls.
5. Beneficial organisms can help control weeds, diseases, and insects in crop fields.
6. Natural controls often work more slowly than pesticides, but they can be effective, environmentally friendly, and economically sustainable.
7. Adjusting planting, tillage, and harvest dates can sometimes help crops avoid pests.

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

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

Information Sheet 5- Scheduling control methods

5.1. Introduction

A schedule or a timetable, as a basic time-management tool, consists of a list of times at which possible tasks, events, or actions are intended to take place, or of a sequence of events in the chronological order in which such things are intended to take place.

5.2. Scheduling pest control methods

A pest control schedule helps pest control contractors keep an accurate record of pest control treatments administered at a client's property. This document helps the pest control company effectively control or eliminate harmful pests.

A pest control schedule includes:

1. Name of the authorized pest control service
2. Date of initial pest control treatments
3. Listing pest types
4. Dates of subsequent pest control treatments

Table 1 Pesticide-use schedule

Applicator name	Day M/D/Y	Crop	Pest controlled	No of areas	Chemical brand name and formulation	Name of manufacture	EPA registration NO	Rate /ha	Total amount applied

Self-Check – 5	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. List all pest scheduling records.

Test II: say true or false

1. A schedule or a timetable, as a basic time-management tool, consists of a list of times at which possible tasks, events, or actions are intended to take place.
2. Crop rotation is one of the oldest and most effective methods of pest control. C

Test III: choice

1. _____ is a labor-intensive but effective way to control insects large enough to be seen.
   A. Hand Removal
   B. Trapping
   C. Sanitation
   D. Crop Rotation
2. _____expresses the possibility to perform a certain activity in a given environment.
   A. Workability
   B. farm equipment a
   C. labor
   D. wealth

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

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

Information Sheet 6 - Maintaining severity of infestations and records of treatments

6.1. Introduction

Complete biological control of crop pests and subsequent elimination of pesticide use has not always been achieved in agroecosystems. In multipest systems, successful biological control of individual species often requires development of integrated pest management (IPM) programs to control those pest species not adequately checked by natural enemies

6.2. Maintaining severity of infestations

Pest infestations are measured in incidence (percent of all crops) and severity (percent of an individual plant). A large percentage of the leaves on this plant are affected by aphids this means that the severity for this plant is high. If 70% or more of crops have high severity, then it might be worth restarting a new crop cycle

6.3. Recording of treatment measures

Pest control operators (PCOs) must keep records for every pesticide application for every job.

The PCO that applies the pesticide must record the following details for every pesticide application:

- Trade name of pesticide
- Batch number of pesticide
- Specific precautions to be observed including the re-entry period
- Date of application
- Start and finish times of application
- The pests treated location of the pesticide application (including street address of property, if applicable)
- Specific location of the pesticide application within the property (i.e areas within a property where the product was applied)
- Pests treated method of application (spray or bait)
- Quantity of pesticide applied
- Rate of application or sufficient information to allow the rate of pesticide application to be determined (as expressed on the product label)

- If applied outdoors, the ambient temperature, wind direction and speed at the time of application (and any other relevant weather conditions).
- Name and licence number of the person supervising the application (if applicable for example, where the pesticide is applied by a trainee licence holder)
- Trading name, address and phone number of the business employing, engaging or owned by the person applying the pesticide.
- Name, phone number and address of the person for whom the application was carried out signature of the person completing the record.

All records must be kept at the business address for a minimum of 3 years. They should be accurate, up to date, clear, consistent and in English.

Self-Check – 6	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Write all PCO pest controllers detail data.
2. List all record keeping avtivities.

Test II: say true or false

1. Complete biological control of crop pests and subsequent elimination of pesticide use has not always been achieved in agroecosystems.
2. Pest control operators (PCOs) must keep records for every pesticide application for every job.
3. Rate of application or sufficient information to allow the rate of pesticide application to be determined (as expressed on the product label)
4. Name, phone number and address of the person for whom the application was carried out signature of the person completing the record.
5. Trading name, address and phone number of the business employing, engaging or owned by the person applying the pesticide.
6. If applied outdoors, the ambient temperature, wind direction and speed at the time of application (and any other relevant weather conditions).
7. All records must be kept at the business address for a minimum of 3 years.

Note*:* Satisfactory rating - 20 points Unsatisfactory - below 20 points

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

Operation sheet 1– Quadrat sampling of weed

Objectives:

- To identify weed species
- To determine the weed population in the field.
- To estimate the loss caused by weeds

Tools and equipment's

- Quadrants
- Not book
- Pen etc.

Procedures:

1. Select a field or sample area for study of weed flora.
2. Randomly put the quadrat in different plots and note down the observations
3. Calculate weed density.

Lap Test	Demonstration

Name…… ID……..

Date……

Time started: _____ Time finished: _____

Instructions: sample weed and calculate their density.

LG #48	LO #7 - Manage crop health

Instruction sheet

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

- Planning and monitoring cropping
- Monitoring weed and pest levels
- Performing crop cultivating practices
- Assessing fertilization methods
- Monitoring cropping programs
- Documenting data

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

- Cropping plan and monitor to maintain water and nutritional requirements for optimal production.
- Weed and pest levels monitor and the control program modify as require.
- Crop cultivating practices perform
- Benefits from fertilization methods assess and document for analysis in future management programs.
- Cropping programs monitor for efficiency and effectiveness, and document for future best practice.
- Relevant data document for continual analysis and effective crop management.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.

5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Planning and monitoring cropping

1.1 Introduction

The term cropping system refers to the crops, crop sequences and management techniques used on a particular agricultural field over a period of years. It includes all spatial and temporal aspects of managing an agricultural system.

Intensive cropping is the process of growing a number of crops on the same piece of land during the given period of time.

Cropping pattern refers to the proportion of land under cultivation of various crops at different points of your time. This indicates the time and arrangement of crops during a particular hectare. Change in space sequence and time of crops.

1.2 Cropping system

Cropping system: cropping patterns used on a farm and their interactions with farm makeup. Individual crops are the components of a given cropping pattern/system.

There are three types of intensive cropping:-

1. **Multiple Cropping**

Growing two or more crops on the same field in one year. The intensification of cropping is in temporal and spatial dimensions. Double, triple and quadruple cropping refers to growing two, three and four crops respectively, on the same land in a year in sequence.

Sequential cropping - Multiple cropping may be of the following types growing two or more crops in sequence (in succession) on the same field in an year. The succeeding crop is planted

after the proceeding crop has been harvested. The crop intensification is only in time dimension.

e.g., Rice-Rice-Cotton, Ragi-Cotton-Sorghum.

(b) Relay cropping - It refers to planting of the succeeding crop before harvesting the preceding crop. e.g.,

(i) Rice–Black gram (rice fallow pulse),

(ii) Rice–Lathyrus, (iii) Rice–Lucerne,

(iv) Rice–Berseem and

(v) Cotton–Berseem. Here the seeds of black gram, lathyrus, lucerne or berseem are broadcasted in standing rice or cotton crop just before they are ready for harvesting. Thus the field is never left fallow or there is no gap at all between two successive crops.

(c) Ratoon cropping or ratooning - It refers to raising a crop with regrowth coming out of roots or stalks after harvest of the crop although not necessarily for grain. e.g., Sugarcane, Banana,Sorghum.

(d) Overlapping system of cropping - In this system the crop is harvested in phases and the vacated area is sown by next crop. e.g., forage crops, part of the crop is harvested for feeding to the cattle and vacated area is sown with alternate crops like berseem or lucerne

2. Intercropping

Growing two or more crops simultaneously on the same field. The crop intensification is in both temporal and spatial dimensions. There is intercrop competition all or part of crop growth (as opposed to intercropping, sole cropping is growing one crop alone in pure stand at normal density)

Principles of Intercropping

- The associating crop should be complimentary to the main crop.
- The subsidiary crop should be of shorter duration and of faster growing habits, to utilize early slow growing period of main crop.
- The component crops should require similar agronomic practices.
- Erect growing crops should be intercropped with cover crop.
- Erosion permitting crop should be intercropped with erosion resisting crop.
- The component crops should have different rooting pattern and depth of rooting.

Types of intercropping based on Interactions

1. **Parallel cropping** - Under this two crops are selected which have different growth habits and have a zero competition between each other and both of them express their full yield potential.

e.g., black gram with maize, soybean with cotton.

2. **Companion cropping** - Usually a short duration crop is grown along with a long duration crop as a companion crop i.e., the base crop gets the company of another crop for a certain period.

e.g. Cotton + black gram/Green gram.

3. **Synergistic cropping** - Here the yield of crops, grown together is found to be higher than the yield of their pure crops on unit area basis. e.g., Sugarcane and potato

Advantages of Intercropping

- It offers similar benefits to that from rotational cropping.
- The total biomass production/unit area/unit time is increased because of the fullest use of land as the inter row spaces are utilized which otherwise would have been used for weed growth.
- The fodder value in terms of quantity and quality becomes higher when a non-legume is intercropped with legume. e.g., Napier + desmanthus, sorghum + cowpea..
- It provides crop yields in different times, which reduces the marketing risks.
- It offers more employment and better utilization of laborers, machine and power throughout the year.
- It is an insurance against drought.

Based on crop arrangements

(a) **Mixed Intercropping (mixed cropping) -** Growing two or more crops simultaneously with no distinct row arrangement.

(b) Row Intercropping (intercropping) - Growing two or more crops simultaneously where one or more crops are planted in rows.

3. Multistoried Cropping

Growing crops of different heights in the same field at the same time. It is practiced in orchards and plantation crops for maximum use of solar energy even under normal planting density. e.g. Sugarcane, potato and onion, coconut, pepper, cocoa and pineapple.

Crop rotation: a process of growing different crops in succession on a piece of land in a specific period of time with an object to get maximum profit from minimum investment without impairing the soil fertility.

Principles of crop rotation

- The crops with tap roots (deep rooted) should be followed by those, which have fibrous (shallow) root system. This helps in proper and uniform use of nutrients from the soil.
- The leguminous crops should be grown before non-leguminous crops because legumes fix atmospheric N into soil and add more organic matter to the soil.
- More exhaustive crops should be followed by less exhaustive crops because crops like potato, sugarcane, maize etc., need more inputs such as better tillage, more fertilizers, greater number of irrigations etc.
- Selection of the crop should be demand based.
- The crop of the same family should not be grown in succession because they act as alternate hosts for insect pests and diseases.
- An ideal crop rotation is one, which provides maximum employment to the farm family and labor and permits efficient use of machines and equipment's and ensures timely agricultural operations simultaneously maintaining soil productivity.
- The selection of the crops should be problem based i.e.
  - ✓ One sloppy land, which are prone to erosion, an alternate cropping of erosion promoting and erosion resisting crops like legumes should be adopted.
  - ✓ In low-lying and flood prone area, the crops, which can tolerate water stagnation, should be selected.
  - ✓ Under dry farming the crops, which can tolerate the drought, should be selected.
  - ✓ The selection of crops should suit farmer's financial conditions.
  - ✓ The crop selected should also suit the soil and climatic conditions

Advantages of Crop Rotation

- Crop rotation helps in maintaining of soil fertility, organic matter content and recycling of plant nutrients. All crops do not require the plant nutrients in the same proportion. If different crops are grown in rotation, the fertility of land is utilized more evenly and effectively.
- Restorative crops like heavy foliage crops and green manure crops included in rotation increase the nitrogen and organic matter content of the soil.

- Helps in control of specific weeds like bermuda grass, cyprus (sedges) and Trianthema portulacastrum.
- Avoids accumulation of toxins and maintains physical properties of soil.
- Controls certain soil borne pests and disease.
- Reduces the pressure of work due to different farm operations in a stipulated period of time.

Self-Check – 1	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. List advantages of crop rotation
2. Discuss principles of crop rotations.
3. What are principles of intercropping?
4. _____ growing two or more crops simultaneously with no distinct row arrangement.

Test II: say true or false

1. The term cropping system refers to the crops, crop sequences and management techniques used on a particular agricultural field over a period of years.
2. Reduces the pressure of work due to different farm operations in a stipulated period of time.
3. Crop rotation helps in maintaining of soil fertility, organic matter content and recycling of plant nutrients.
4. Growing two or more crops simultaneously with no distinct row arrangement.

Test III: choice

1. Growing two or more crops simultaneously with no distinct row arrangement.
   A. Multistoried Cropping
   B. mixed cropping
   C. Crop rotation
   D. Intercropping
2. Growing two or more crops on the same field in one year
   A. Multiple Cropping
   B. Intercropping
   C. Crop rotation
   D. mixed cropping

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

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

Information Sheet 2- Monitoring weed and pest levels

2.1. Introduction

Effective weed and pest management begins with monitoring to assess current or potential threats to crop production, and to determine best methods and timing for control measures. Regular monitoring of each field allows the farmer to:

- Spot critical stages of crop and weed development for timely cultivation or other intervention.
- Identify the *weed flora* (species composition), which helps determine best short- and long-term management strategies.
- Detect new invasive or aggressive weed species while the infestation is still localized and possible to eradicate

2.2. Monitoring /scouting/ pest

Once a pest manager has taken precautions to prevent pest infestations, it is important to watch regularly for the appearance of insects, weeds, diseases, and other pests. This is called **monitoring**.

The primary goals are to locate, identify, and rank the severity of pest infestations. These data may also be used to project future populations through pest management models. In addition to giving solid data for making a management decision, regular monitoring works well for checking the success or failure of a control strategy. Pest populations vary from field to field, building to building, and year to year. Managing pests requires flexibility and an absolute commitment to pest monitoring. Pest monitoring is site-, crop-, and pest-specific. Each situation will require specialized knowledge and tools.

Regular checking of a crop field, garden, greenhouse, warehouse, school, bakery, restaurant, golf course, athletic field, or other areas and early detection of pests function together as an early warning system for pests, helping to prevent or minimize a pest outbreak.

Proper identification of pests is an extremely important prerequisite to handling problems effectively. For example, the brown-banded and German cockroach can be easily confused with each other. Identification is important because certain management

practices may control only one species and not the other. Correct identification enables you to manage the real source of the problem and avoid merely treating the symptoms (or controlling organisms that are not pests). Some pests cause similar damage. Unless the pest is identified, the control program may have the wrong pest as its target. Identification enables you to target the pest problem and avoid injury to beneficial organisms.

2.3. Monitoring tools and techniques

The IPM Scout or technician is the most important part of a professional monitoring program. The scout works in a variety of situations, each requiring specific knowledge and tools. However, diligent growers, golf course superintendents, structural pest control managers, etc. can also monitor successfully for pests.

- Flashlight
- Black light (detect rodent urine)
- Video camera
- Screw driver
- Putty knife
- Spatula
- Tracking patches or powders
- Double-sided transparent tape (tree and shrub insects)
- Shovel or spade

2.4. Determining economic thresholds level of weeds

Current field scouting protocols for many insect pests and some crop diseases compare observed pest levels with research-based economic thresholds (ETs) to determine whether control measures are needed. The ET is the pest population density or level of visible crop damage at which treatment is needed to prevent a net economic loss a decrease in marketable yield of greater dollar value than the cost of the treatment. The use of ETs to determine whether and when control measures are needed can save money and reduce adverse environmental impacts.

Self-Check – 2	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. List all pest monitoring tools and equipment's
2. What is the difference between injury and economic threshold levels?
3. The pest infestation level at which it pays to take remedial action is known as_____.

Test II: say true or false

1. Effective weed and pest management begins with monitoring to assess current or potential threats to crop production.
2. Proper identification of pests is an extremely important prerequisite to handling problems effectively.
3. Timely scouting can alert you to pest problems before they exceed economic thresholds.
4. The economic threshold for most pests problems is just below the economic injury level.
5. Economic thresholds are set below the economic injury level to allow for the time lag between pest detection and the application of control measures.
6. Herbicide rates can be reduced by using a combination of cultural and mechanical practices.
7. Tillage is the primary nonchemical weed management tool used by crop growers.

Note*:* Satisfactory rating - 20 points Unsatisfactory - below 20 points

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

Information Sheet 3- Performing crop cultivating practices

3.1. Introduction

Inter cultivation is a process involving operations in the rows of standing crops. Weeding, tiling and cultivating are the examples for the same.

Though traditional practices exist even today, they have lots of drawbacks. Such practices depend on bullocks and are also labor intensive which results in many practical hassles. Nowadays lots of machineries are available to facilitate inter cultivation and thus increase.

3.2. Crop cultivating practices

Cultivation: loosening and breaking up (tilling) of the soil. The soil around existing plants is cultivated (by hand using a hoe, or by machine using a cultivator) to destroy weeds and promote growth by increasing soil aeration and water infiltration.

Soil being prepared for the planting of a crop is cultivated by a harrow or plow. Cultivating improves moisture penetration and thus helps with water retention. As more water is retained there is obviously a reduced need for supplemental watering. Last but not least, a cultivated garden with minimal weeds looks attractive and fresh. Soil must only be loosened a couple of inches deep when you cultivate.

Self-Check – 3	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Write importance of cultivating.
2. _____ loosening and breaking up (tilling) of the soil.
3. _____ is a process involving operations in the rows of standing crops.

Test II: say true or false

1. Cultivating practices is always done during dry season.
2. Cultivating improves moisture penetration.
3. The soil around existing plants is cultivated (by hand using a hoe, or by machine using a cultivator).
4. Soil being prepared for the planting of a crop is cultivated by a harrow or plow.
5. Soil must only be loosened a couple of inches deep when you cultivate.

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

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

Information Sheet 4- Assessing fertilization methods

4.1. Introduction

Fertilizers are synthetic (commercially manufactured) or naturally occurring chemical compounds either

dry solid or liquid that added to the soil to supply one or more plant nutrients for crop growth

4.2. Classification

the fertilizers are classified based on whether the fertilizer supplies a single or more than one nutrient, their chemical nature and commercial mode of supply as straight, compound, complex and mixed.

Straight Fertilizers

When a fertilizer contains and is used for supplying a single nutrient, it is called a straight fertilizer.

This is further classified as nitrogenous, phosphatic and potassic fertilizers depending on the specific macro nutrient present in the fertilizer.

A. **Nitrogenous fertilizers**

N fertilizers are those fertilizers containing N as major nutrient. It may be either a nitrate or ammonium or amide fertilizer depending on the form of nitrogen present.

B. **Phosphate fertilizers**

They are classified into three groups, based on the solubility of phosphate contained in the fertilize

(i) Water soluble phosphate (Mono calcium phosphate) Ca (H2PO4)2

- Single super phosphate 16% Ca(H2PO4)2, H2O
- Double super phosphate 32% 2Ca (H2PO4)2, H2O
- Triple super phosphate 48% 3Ca (H2PO4)2, H2O

(ii) Citric acid soluble phosphate (Di-calcium phosphate) Ca(H2 PO4)2

- Basic slag (CaO)3 P2O5SiO2 14-18% (by-product from steel industry)
- Di-Calcium Phosphate Ca2 (H2PO4)2 34-39%

(iii) Insoluble phosphate (Tri-calcium phosphate)Ca3(PO4)2

- Rock phosphate 20-40% Ca3(PO4)2 CaF2

- Raw bone meal 20-25% Ca (PO4)3 CaF2 (2–4% N)
- Steamed bone meal 22%–30%

(IV) Potassic fertilizers Muriate of potash (KCI) 60%

- Sulphate of potash (K2SO4) 48–52%
- Potassium nitrate (KNO3) 48% (N-13%)
- Schoenite (K2SO4MgSO4) 6H2O 22–24%

Compound Fertilizers Compound fertilizers are the commercial fertilizers in which two or more primary nutrients are chemically combined. For example: DAP. DAP contains 18% N and 46% P2O5.

Complex fertilizers are the commercial fertilizers containing at least two or more of the primary essential nutrients at higher concentration in one compound. The nutrients in complex fertilizers are physically mixed.

4.3. Time of Fertilizer application

Time of fertilizer application depends on the type of crop cultivated, its growth stage, nutrient requirements, soil conditions and nature of fertilizer.

1. Application before sowing: Amendments should be applied well in advance to sowing. Some of the water insoluble P fertilizer such as rock phosphate and basic slag should be applied about 2-4 weeks before sowing. This enables conversion of water insoluble form of P to soluble form for efficient crop utilization.

2. Application at sowing: Application of fertilizers at the time of sowing or just before sowing is called “basal application.” Mostly phosphatic and potash fertilizers are basally applied. A part of recommended N is also applied as basal dose. Micronutrient fertilizers should be applied at the time of sowing on the soil and should not be incorporated into the soil.

3. Application after sowing: Application of fertilizers after the crop establishment is called top dressing. Usually a portion of N is applied as top dressing depending on the stage of the crop. In light textured soils, potash is also recommended for top dressing.

4. Split application of N: split applications increase the nitrogen use efficiency by supplying nitrogen at the critical stages when the crop requirement is high. This also avoids large amounts of basally applied N being subjected to various losses. It is the most

convenient and easily adaptable technique. Factors such as total amount of nitrogen to be applied, soil texture, crop duration, critical stages of growth, crop season and water management practices largely govern the number of splits. In irrigated crops N is generally applied in 2-3 splits. In dry land condition, the entire N is applied at sowing as it is difficult to apply N at later stages in the absence of adequate soil moisture. N application is recommended at tillering and panicle initiation stages for rice. Basal application is sufficient for pulses. Split application of N at 30, 60 and 90 days after planting are recommended for sugarcane.

4.4. Method of fertilizer application

1. Broadcasting: Fertilizers are applied on the open field at the time of sowing or spread in the standing crop. Broadcasting is mostly done manually or with fertilizer spreaders. Broadcast fertilizers should be incorporated into the soil. Fertilizers that are applied in large quantities are normally broadcast applied.

2. Placement: Whenever small quantity fertilizers are applied, placement is practiced. This method is practiced in wide spaced crops and the soils having low fertility. Placement of fertilizer is done in different ways: drilling band application and spot placement.

Drilling: is one of the methods to place fertilizers simultaneously at the time of sowing by the use of seed cum fertilizer drill.

Band application: is generally practiced in the standing crops. If the fertilizer is placed in bands to one or either sides of crop rows, it is called side dressing. Fertilizer application to fruit trees is adopted by circular band (ring placement) away from the base of plants. Application of fertilizer nearer to each plant is called as spot placement. This method is practiced for vegetable crops. Urea super granules are deep placed in lowland rice.

3. Foliar application: Fertilizer nutrient that are soluble in water are applied on the foliage as a solution or suspension. Low concentration (less than 1-2 %) is prepared to supply one plant nutrient or combination of nutrients. In general, N and micronutrients are applied as foliar sprays. Among the N fertilizers, Urea is suitable for foliar application. DAP spraying is recommended for pulses and cotton. Of late, water-soluble specialty fertilizers have come into the market. These are highly suitable for foliar application since they do not leave any residues on dissolution.

Compatible insecticide also be mixed with the fertilizers and applied as foliar spray. Micronutrients are applied in small quantities and hence foliar spray is an effective method. Soluble inorganic salts are used for foliar spray. Generally high volume sprayers are used for foliar application.

4. Fertigation: the application of fertilizers with the irrigation water.

Advantages

(1) Frequent supply of nutrients reduces fluctuation of nutrient concentration in soil;

(2) There is efficient utilization and precise application of nutrients according to the nutritional requirements of the crop;

(3 fertilizers applied throughout the irrigated soil volume;

(4) Nutrients can be applied to the soil when soil or crop conditions would otherwise prohibit entry into the field with conventional equipment.

Self-Check – 4	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. _____.is the application of fertilizers with the irrigation water.
2. Application of fertilizer nearer to each plant is called_____
3. _____ Fertilizers are applied on the open field at the time of sowing or spread in the standing crop.

Test II: say true or false

1. Split application is recommended for Nitrogenous fertilizers.
2. DAP spraying is recommended for pulses and cotton.
3. Band application: is generally practiced in the standing crops.
4. In general, N and micronutrients are applied as foliar sprays.
5. N fertilizers are those fertilizers containing N as major nutrient.

Test III: choice

1. _____ Fertilizers are applied on the open field at the time of sowing or spread in the standing crop.
   A. Broadcasting
   B. Placement
   C. Fertigation
   D. Foliar
2. _____is the application of fertilizers with the irrigation water.
   A. Fertigation
   B. Foliar
   C. Drilling
   D. Placement

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

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

Information Sheet 5- Monitoring cropping programs

5.1. Introduction

Cropping pattern is a basic element of cropping system. For the better management of cropping systems, up-to-date information on present cropping pattern and changes in cropping pattern is essential.

In the recent past, cropping systems approach has gained importance in agriculture and related enterprises. A system consists of several components, which are closely related and interacting among them. In agriculture, management practices are usually formulated for individual crops. However, farmers are cultivating different crops in different seasons based on their adaptability to a particular season, domestic needs and profitability. Therefore, production technology or management practices should be developed keeping in view all the crops grown in a year or more than one year if any sequence or rotation extends beyond one year. Such a package of management practices for all the crops leads to efficient use of costly inputs, presides reduction in production cost. For instance, residual effect of manures and fertilizers applied and nitrogen fixed by legumes can considerably bring down the production cost if all the crops are considered than individual crops. In this context, cropping systems approach is gaining importune.

5.2. Cropping system

It is an important component of a farming system and it represents the cropping pattern used on a farm and their interactions with farm resources other farm enterprises and available technology which determine their makeup.

- **Cropping Pattern**

Cropping pattern means the proportion of area under various crops at a point of time in an unit area. If cropping pattern indicates the yearly sequence and spatial arrangement of crops and fallow on a given area.

- **Crop Rotation**

Crop rotation refers to recurrent succession of crops on the same piece of land either in a year or over a long period of time. Component crops are so chosen so that soil health is not impaired or Crop rotation refers to growing different crops in succession on a piece of land in a specific period of time with an objective to get maximum profit from least investment without impairing the soil fertility. This may also be defined as the repetitive

cultivation of an ordered succession of crops (or crops and fallow) on the same land and one cycle may take one or more years to complete.

There are certain principles, which should be adhered to, to make a rotation successful. These principles are as follows:

- Crops with top roots should be followed by those, which have fibrous root system. This helps in proper and uniform use of nutrients and water from the soil and the roots do not compete with each other.
- Leguminous crops should be grown after non-leguminous crops because legumes fix atmospheric–N into the soil and add more organic matter to the soil. Actually, non-legumes are fertility depleting crops.
- More exhaustive crops should be followed by less exhaustive crops. For example, potato, sugarcane, maize, etc. need more inputs than oilseeds and pulses.
- Selection of the crops should be demand based. The crops, which are needed by the people of the area, can be easily sold at a higher price.
- Selection of crop should be problem based. For instance:
  - ✓ On sloping lands which are prone to soil erosion, an alternate cropping of erosion-promoting crops e.g., millets and other row crops and erosion resisting crops, e.g., legumes should be adopted.
  - ✓ Under dry land farming or partially irrigated areas, the selection of crops should be such, which can tolerate the drought spell. Similarly in low lying and flood prone areas the crops should be such, which can tolerate water stagnation e.g., paddy, jute, etc.
  - ✓ Selection of crops should suit the financial condition of the farmers.
  - ✓ Crops selected should also suit the soil and climatic conditions.
- Crops of the same family should not be grown in succession because they act like alternate hosts for insects/pests and disease pathogens. Apart from this, different types of weeds are found associated with various crops, therefore, selection of the same type of crops in rotation encourages weed problems in the field.

- An ideal crop rotation is one, which provides maximum employment to the family and farm laborer. Some common crop rotations followed in various parts of the country are given below:

Rotation	Duration
Paddy–Wheat	1 Year
Maize–wheat	1 Year
Maize–potato	1 Year
Soybean–wheat	1 Year
Maize–potato–sugarcane	2 year
Paddy–sugarcane–wheat	2 yea

The major advantages of following proper crop rotation principles are:

- Agricultural operations can be done timely for all the crops because of less competition.
- Soil fertility is maintained by legumes through fixing of atmospheric nitrogen encouraging microbial activity and maintaining physicochemical properties of the soil. The soil is also protected from erosion, salinity and acidity.
- An ideal crop rotation helps in controlling insect pests and diseases. It also controls the weeds in the fields.
- Proper utilization of all the resources and inputs could be made. Farmers get better price for their produce because of its higher demand in the locality or in the market.

5.3. Monitoring cropping

Monitoring is the regular and careful inspection of crops throughout the growing season. When monitoring crops, a farmer walks through crops to look for crop problems. Crop monitoring is designed to make easy farming activities, while at the same time ensuring the best user experience and get a good yield.

Self-Check – 5	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Why crop monitoring is important.
2. _____ is the regular and careful inspection of crops throughout the growing season.
3. Why leguminous crops should be grown after non-leguminous crops?

Test II: say true or false

1. Monitoring is the regular and careful inspection of crops throughout the growing season.
2. In crop production monitoring is optional.
3. Crops of the same family should not be grown in succession because they act like alternate hosts for insects/pests and disease pathogens.
4. An ideal crop rotation is one, which provides maximum employment to the family and farm laborer.
5. Crops with top roots should be followed by those, which have fibrous root system.
6. Leguminous crops should be grown after non-leguminous crops because legumes fix atmospheric–N into the soil and add more organic matter to the soil.
7. More exhaustive crops should be followed by less exhaustive crops.

Note*:* Satisfactory rating - 20 points Unsatisfactory - below 20 points

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

Information Sheet 6- Documenting data

6.1. Introduction

Documentation means capturing the work that you do in a way that enables others to understand what you did so they can duplicate the process. To do this, your documentation must include information about what was done, how it was done, why it was done, when it was performed, where it was performed, and who performed the work.

6.2. Documenting crop production data

Crop production depends on the availability of arable land and is affected in particular by yields, macroeconomic uncertainty, as well as consumption patterns; it also has a great incidence on agricultural commodities' prices. The importance of crop production is related to harvested areas, returns per hectare (yields) and quantities produced. Crop yields are the harvested production per unit of harvested area for crop products. In most of the cases yield data are not recorded, but are obtained by dividing the production data by the data on area harvested. The actual yield that is captured on farm depends on several factors such as the crop's genetic potential, the amount of sunlight, water and nutrients absorbed by the crop, the presence of weeds and pests.

6.3. crop production record keeping system

Management system which includes crop records increases returns by improving nutrient and pesticide-use efficiency. This field file provides an organized place for storing information on each crop-producing field.

Table 2. Crop planning

Table 1 is a record of current cropping information. This table can be used to evaluate how cultural management practices influence crop yields. Yield goals can also be compared to actual crop yields to determine how realistic you've made the yield goals

crop	Year	variety	Yield goal	Actual yield	Planting date	Pop planted	Actual pop	planter	Management practices	Harvest date

Table 3. soil test summary

Table 2 provides a brief history of a field's soil fertility. This table helps evaluate how your crop and nutrient management program is influencing the nutrient status of each field.

Date of test	Name of soil testing lab	sample	index	Soil test result						Lime Reco		Organic matter%	CEC	Others
				N	P	P	ca	Mg	S	tes	NO			

Table 4. fertilizer planning

year	Crop	Yield goal	Fertilizer recommendation			manureapplication				Recommendation		
			N	K2O	P2O							

Table 5. Nutrient Applications

The source of nutrients, actual application dates, and rate for the field are recorded on.

year	crop	Yield goal	Fertilizer recommendation								
			N	P2O	K20	Ca	Mg	S			

Self-Check – 6	Written test

Name…… ID…… Date…….

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

Test I: give short answer

1. Write all record details.
2. What is documentation?
3. Fill all documentation formats.
4. How cultural management practices influence crop yields?

Test II: say true or false

1. Documentation means capturing the work that you do in a way that enables others to understand what you did.
2. Management system which includes crop records increases returns by improving nutrient and pesticide-use efficiency.
3. Yields are the harvested production per unit of harvested area for crop products.
4. Documentation means capturing the work that you do in a way that enables others to understand what you did so they can duplicate the process.

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

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

Operation sheet 1 – Method of fertilizer application

Tools and equipment

- Fertilizers
- Meter ape
- Rope
- Not book
- Pen
- Sensitive balance
- Hoe
- Spade
- Shovel
- Rake
- Watering can etc.

Methods:

- Broadcasting
- Placement
  - ✓ Drilling
  - ✓ Band application
- Foliar application
- fertigation

Lap Test	Demonstration

Name…… ID……..

Date……

Time started: _____ Time finished: _____

Instructions: Demonstrate fertilizer application methods.

Reference Materials

Book:

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