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Ministry of Labor and Skills

Crop Production

Level-IV

Based on April, 2022, Version 1 Occupational Standard



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Introduction to the Module

This module covers the knowledge, skills and attitude required to participate in processes to assess soil-related factors for organic farming , assess soil health and fertility indicators, select and implement allowable techniques and inputs for organic farming , implement, monitor and evaluate organic farming activities ,maintain quality standard of the products of organic farming and document organic farming program

LG #18	LO #1Assess soil-related factors for organic farming

Instruction Sheet

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

- Introduction to the module
- Identifying nutritional requirements for selected crop types
- Selecting soil analysis and suitable testing facilities
- Conducting soil and plant tissue sample collection according to organisation procedures and requirements of testing facility.
- Analysing results of soil and tissue testing in relation to requirements of the farming system.
- Assessing soil condition for drainage, compaction, aeration, and water infiltration and moisture conservation techniques for desired crop growth
- Assessing soil biological activity by identifying and evaluating presence of organisms

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:

- Identify nutritional requirements for selected crop types
- Select soil analysis and suitable testing facilities
- Conduct soil and plant tissue sample collection according to organization procedures and requirements of testing facility.
- Analyze results of soil and tissue testing in relation to requirements of the farming system.
- Assess soil condition for drainage, compaction, aeration, and water infiltration and moisture conservation techniques for desired crop growth
- Assess soil biological activity by identifying and evaluating presence of organisms

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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 1

1.1.Identifying nutritional requirements for selected crop types

How to identify nutritional requirements of selected crop?

To identify the nutritional requirements for specific crop types, several steps can be taken, as:

- Understand the specific nutritional requirements for the crop you are growing.
- Perform a Soil Test: Conduct a soil test to assess the existing nutrient levels in the soil.
- Perform a Tissue Analysis: This involves analyzing the plant tissue to determine its nutrient content.
- Refer to Region-Specific Guidelines**:** Practical nutrient requirements for certain crops should come from regionally specific guidelines dependent on the crop and environmental factors such as soil type and weather conditions
- Understand Macronutrients and Micronutrients: Crops require macronutrients (e.g., nitrogen, phosphorus, potassium) and micronutrients (e.g., boron, zinc, iron) for optimal growth and development
- Utilize Soil and Plant Tissue Tests: These tests can assess the nutrient content of both the soil and the plant, helping to determine the specific nutrient needs of a given plant in a given soil. By following these steps and understanding the specific nutrient requirements for the crop being grown, farmers and agricultural professionals can ensure that the necessary nutrients are provided to support optimal plant growth and yield

Different crop types have specific nutritional requirements that must be met to achieve optimal growth and yield. The nutrients required by crops can be classified into

- ✓ Macronutrients

Macronutrients are required in larger amounts and include nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur

- ✓ Micronutrients.

Micronutrients are required in smaller amounts and include boron, zinc, manganese, iron, copper, molybdenum, and chlorine

The specific nutrient requirements for each crop type may vary depending on

- ✓ The region
- ✓ Soil type
- ✓ Weather conditions

Adequate amounts of these nutrients can be found in the soil and supplied to crops from chemical fertilizers, organic manures, plant residues, and biological nitrogen fixation

Soil and plant tissue tests can be used to assess the nutrient content of both the soil and plant, and to determine the nutrient need of a given plant in a given soil

Agricultural and food chemists play a crucial role in producing sufficient nutritious food and feed, delving into all aspects of crop and animal production, food safety, quality, nutrition, processing, packaging, and utilization of materials

1.2.Selecting soil analysis and suitable testing facilities

Selecting the appropriate soil analysis and testing facilities is crucial for accurate assessment of nutrient levels and soil conditions. Here are some steps to follow:

- Research local agricultural extension services: Many universities and government agencies offer soil testing services through their agricultural extension services. These services can provide detailed reports on
  - ✓ soil pH
  - ✓ nutrient levels
  - ✓ other essential factors for plant growth

.

- Choose a reputable testing facility: Select a facility that has a strong reputation for providing accurate and reliable soil analysis results. This can help ensure that the recommendations provided are based on accurate assessments of your soil's nutrient levels
- Consider the scope of services: Some facilities may offer a broader range of services, including
    - ✓ plant tissue analysis
    - ✓ soil pH testing
    - ✓ nutrient management plans
- Consider the specific needs of your farm or garden and choose a facility that can provide the services that will best support your agricultural goals.
- Check for customer reviews and testimonials: Look for reviews and testimonials from previous clients to assess the quality of the facility's services. This can give you a better understanding of the facility's expertise and success in providing accurate and helpful results
- Contact the facility: Reach out to the facility directly to discuss your specific needs and requirements. This can help you determine if they are the right fit for your project and ensure that they can provide the services you need

By following these steps, you can select a suitable soil analysis and testing facility that will provide accurate and reliable results to help you make informed decisions about your farm or garden's nutrient management.

A good soil analyses should be cheap, reproducible in different laboratories, and easily adapted to routine laboratory procedures.

The procedure should extract the element from the same labile nutrient element pool in the soil that plants do. Soil analyses procedure; however, is influenced by

- pH
- Temperature
- Water status
- Biological activity
- Past fertilization

- cropping practices,
- An extraction reagent**.**

Soil analyses can be grouped into several categories based on objective:

All these determinations can be performed via a number of laboratory procedures; the method selected is determined, in part, by the physical and chemical characteristics of the soil. Therefore, there is no such thing as a soil analyses, that is, a single method of laboratory analysis applicable to all soils. However, there are some general criteria that have guided the development of soil analyzing procedures; particularly the extraction procedures that are used to evaluate the nutrient element status of the soil.

Soil analyses Objectives

1. Water, salt, and buffer Soil reaction and lime requirement
2. Extractable elements
   Major elements
   (P, K, Ca, Mg, NO3, SO4)
   Nutrient element status
   Micronutrients
   (B, Cl, Cu, Fe, Mo, Mn, Zn)
   Other elements (Al, Na)
3. Trace elements and heavy metals
   (As, Cd, Co, Cr, Cu, Mn, Pb, and Ni) → Toxicity
4. Organic matter content → Physical and chemical characteristics
5. Mechanical analyses → Soil texture classification
6. **Soluble salts** → Total Salts in the soil solution

1.3.Conducting soil and plant tissue sample collection according to organization procedures and requirements of testing facility.

To conduct soil and plant tissue sample collection according to organization procedures and requirements of testing facilities, follow these steps:

- Determine the type of samples needed: Soil samples are used to assess
  - ✓ nutrient levels
  - ✓ soil pH
  - ✓ overall soil health while plant tissue samples are used to determine the nutrient content of the plant
- Choose the appropriate testing facility: Select a reputable testing facility that offers soil and plant tissue analysis services, such as the University Soil Testing Lab or the Agricultural Analytical Services Lab
- Prepare for soil sampling: Soil samples should be collected from different locations across the field, and at least three samples should be taken per area. Ensure that the samples are representative of the entire area to get an accurate assessment of the soil's nutrient levels.
- Prepare for plant tissue sampling: Plant tissue samples are typically collected from the leaves or stems of the plants, as these parts contain the highest concentration of nutrients

Make sure to collect samples from different plants and at different growth stages to get a comprehensive understanding of the plant's nutrient status.

- Follow the testing facility's guidelines: Each testing facility may have specific guidelines for sample collection and preparation. Make sure to follow their instructions to ensure accurate results
- Submit samples to the testing facility: Once the samples are collected and prepared, submit them to the chosen testing facility for analysis. The facility will analyze the samples for various nutrients, such as nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, zinc, manganese, copper, boron, and molybdenum
- Review the test results: After the samples have been analyzed, receive a detailed report on the nutrient levels, soil pH, and other relevant factors. Use these results to make informed decisions about fertilizer application, crop rotation, and other agricultural practices to

optimize plant growth and yield. By following these steps, you can ensure that your soil and plant tissue samples are collected and analyzed according to the organization's procedures and requirements, providing valuable insights into your crop's nutritional needs and overall health.

1.3.1. Importance of sampling

Soil sampling is the most vital step for any analysis. An individual sample should represent no more than 20 acres except when soils, past management, and cropping history are quite uniform. The most representative sample can be obtained from a large field by sampling smaller areas on the basis of soil type, cropping history, erosion, or past management.

In general Sampling activities may include:-

- Collecting
- Preparing
- Packaging and labeling soil samples for off-site testing and/or on-site testing and
- Analysis.

1.3.2. Soil sampling techniques

- Before sampling, study the history of the area,
- The sample must truly represent the field it belongs to.
- Afield can be treated as a single sampling unit if the area is less than 0.5 ha
- Collect soil samples (15-20) from each transect at least every 2-3 years
- Soil samples should be randomly selected avoiding fence lines, waterlines and animal matter.
- When collecting samples it is important that each sample is kept separate and stored in a clean container to reduce the chance of cross-contamination
- Collect samples at the same time each year
- Collect at least 10 soil cores for small areas and up to 30 cores for larger fields
- Take the soil cores randomly throughout the sampling area and place them in the bucket

Do not sample from:

- Back furrows or dead furrows
- Old fence rows
- Areas used for manure or hay storage and livestock feeding, and
- Areas where lime has been piled in the past.

Types of crop in relation to their root depth must be checked before sampling the soil of that farm i.e. sampling depth depend on root depth of a given crops as.

I. For cereals, vegetables and other seasonal crops, the sample should be drawn from 0 -15cm
II. For deep rooted crops like sugar cane or under dry farming condition sample should be drown from different depth based on individual situation
III. For plantation crops the sample must be drawn from 0-30, 30 -60 and60-90cm
IV. For saline and alkaline soils the sample must be drawn up to 15 cm depth

1.3.3. Conducting Tissue sampling

The two primary objectives for conducting a tissue test are to

- Identify quickly the nutritional status of the plant for verification of an apparent nutrient element insufficiency,
- Determine by evaluating the current nutrient-element status of the plant whether additional fertilizer is needed to ensure that the desired yield goal is obtained.

Factors that distinguish a tissue test from a plant analysis are

- ✓ a tissue test is conducted in the field rather than on collected tissue that is sent to a laboratory for analysis
- ✓ A tissue test is conducted on extracted sap, whereas a plant analysis is the determination of the total elemental content or determinations are made by extraction on oven-dried, ground plant tissue.

In general, a tissue test is conducted using chemically treated papers or test strips, test tubes or vials, and specially prepared reagents. The development of a color and its intensity are used to identify the presence of an element (normally its ion) and its concentration, respectively, or by a

change in color with the addition (by drop count or pipette volume) of a reagent for concentration determination.

1.3.4. Tissue sampling Techniques

To conduct most tissue tests successfully, a sufficient quantity of cell sap must be obtained to conduct the test. What are commonly selected are conductive tissues, such as leaf petioles, leaf midribs, or the plant stalk itself. It is from the recently mature leaves that the petiole or midrib tissues are collected. When the plant stalk is the test tissue, the stalk section at the base of the plant or the midsection is the portion of the stalk selected. The time of sampling is determined by the purpose for the tissue test. For diagnostic evaluation when dealing with a suspected nutrient element insufficiency, the time would be when the first symptoms of stress are visually evident. For determining nutrient-element status, when the need for supplemental fertilization is to be determined. The time of sampling is based on a specific development period in the life cycle of the plant.

Here are some general instructions to be followed when collecting plant tissue for testing:

- ✓ Collect tissue between 8:00A.M.And 5:00P.M.
- ✓ Do not collect tissue immediately after a rain.
- ✓ Collect tissue from a range of plants, young plants to those near maturity.
- ✓ Do not collect tissue from plants during drought or when the plants are under some stress condition.

1.4.Analyzing results of soil and tissue testing in relation to requirements of the farming system.

A. Soil color result

Soil color	Attributes and conditions
Brown to dark black	It has high organic matter content, which is well humified. Fertile soils. Developed under humid grassland. Organic matter content is around 7%
Black (subsurface horizon)	It indicates Manganese accumulation. Very hard when it is dry. Slowly permeable for water and roots. Usually the subsoil is rich in clay content. Frequently sodic or alkali soil.
Dark grey, bluish	It contains reduced Iron (Fe_2^+). They normally poorly drained soils. Its permeability is very low, which causes anaerobe conditions in the soil. It frequently waterlogged.
White to grey	Accumulation of salts. Developed under conditions, when the evapo-transpiration is higher than precipitation. There is an upward movement of water and soluble salts in the soil.
Dark red	Iron and aluminium accumulation. Feral and Ferro soils
Yellow to reddish	Rich in oxidized Iron (Fe_3^+). They are well aerated soils.

B. Coarse fragment

Shape	Size in mm	Definition
Rounded, Sub-rounded, Sub-angular, Angular	2-5	Fine gravely
	5-20	Medium gravely
	20-75	Coarse gravely
	75-250	Cobbly
	250-600	Stony
	>600	Bouldery
Flat	2-150	Channery
	150-380	Flaggy
	380-600	Stony
	>600	Bouldery

✓ **Soil texture**

Texture		Bulk Density (g/cm^3)	Porosity (%)	Field capacity (%)	Available water (Volume %)	Available water (cm H_2O/30cm soil)
Sand	Coarse	1.6	40	17	8	2.5
Loam	Medium	1.2	55	24	13	3.8
Clay	Fine	1.05	60	36	16	5

✓ **PH result**

The pH value measures the ratio of H+ ions to OH- base ions in the soil. If the soil solution has more H+, the soil is acidic. If the OH dominates, the soil is alkaline. The equal balance between them is neutral and its value 7.0. The soil pH value interacts with the mineral nutrients. Availability is determined by the soil pH and varies for each nutrient. High or low pH causes toxicity and decreases microbiological life in the soil. Sodium raises pH and destroys soil structure.

High pH makes elements such iron zinc and manganese less soluble. Low pH leads to continuous acidification in the soil. Acidification can be the result of the excessive use of fertilizer, or it cans also occur naturally.

Categories	pH value
Extremely acidic	<4.0
Strongly acidic	4.5 – 5.5
Acidic	5.5 - 6.5
Slightly acidic to neutral	6.5 – 7.2
Alkaline	7.3 – 7.8
Strongly alkaline	7.8 – 8.5
Extremely alkaline	>8.5

✓ **Tissue test result**

The type of tests to be conducted and the methods selected will determine to a considerable degree what procedure will be used to assay the collected tissue; therefore, only general instructions can be specified. For analyzing tissue tests follow;-

A. Use tissue test results along with all other available information soil tests, past history, visual observations, current fertilizer use, etc. to determine adequacy or inadequacy of nutrient element supplies.

B. Look for the one factor that is most limiting plant growth. Be careful it may not be N, P, or K.

C. Use tissue tests to increase knowledge of plant nutrition.

D. Remember that the plant is a dynamic biological system, and that the nutrient elements (particularly NO3–N and K) can be present in adequate amounts today only to be short a month from now because the soil could not supply them fast enough.

1.5.Assessing soil condition for drainage, compaction, aeration, and water infiltration and moisture conservation techniques for crop growth

1.5.1. Assessing soil drainage condition

Assessing your soil's drainage is recommended before you get into planting plants. Most plants require a well-drained soil; otherwise their survival is at stake. Fortunately, there are solutions if you are dealing with poorly draining soil.

Solutions to drainage problems

If you are dealing with poorly drained soil, you can take one of these measures: Choose plants suited to your growing conditions

Dig a hole of at least 30 cm deep and wide; Fill it with water and allow it to drain; the next day, refill the hole with water, then time how long it takes to drain completely; if the hole drains quickly, you have good drainage.

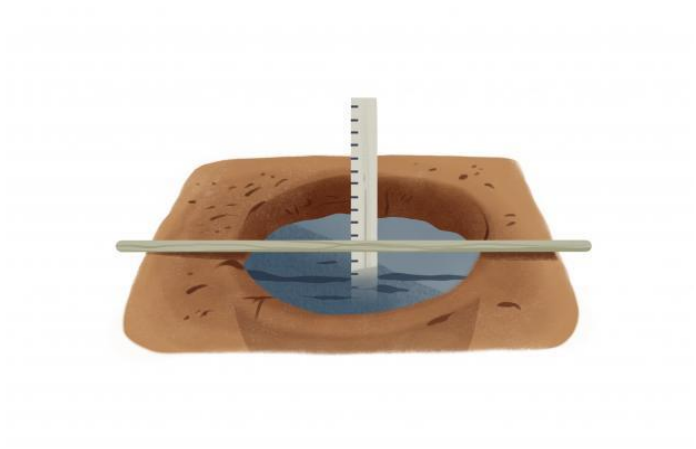


Figure. Drainage

1.5.2. Assessing soil compaction

Physical process that reflects the increase in pressures brought upon sediments as a result of deeper and deeper burial. As the individual particles of sediment are packed closer and closer together, pore space is reduced.

Soil Compaction destroys the quality of the soil because it restricts rooting depth and decreases pore size. The effects are more water-filled pores less able to absorb water, increasing runoff and erosion, and lower soil temperatures.

To reduce compaction:

- Add organic matter
- Practice reduced-till or no-till systems and
- harvest when soils are not wet

Compaction*:* This soil carries a risk of compaction by animals and machinery. Compaction also happens in open land with granular soil that has been subjected to shallow cultivation.

Soils may be only a third to half solid material, with the remaining pore space occupied by water or air. The pore space includes very fine pores of micron-sized up to millimeter-sized spaces between soil aggregates. The range of pore sizes influences the retention and drainage of water and the ease by which air can circulate to roots. A predominance of very fine pores will provide good water storage but a significant proportion of water will be so tightly trapped in fine pores that it is too hard for roots to suck it out. Predominance of coarse pores will provide less storage but good drainage of excess water.

Saturation by water reduces the supply of air through pores in the soil. After a period of time microbes that use oxygen exhaust the available supply and the soil becomes ‘anaerobic’. This affects the roots of many plants and initiates a number of chemical changes in the soil. One chemical change is experienced by iron that occurs naturally in mineral soil. Iron is an element responsible for the brown to red colors of soil and remains as an insoluble coloring agent in the presence of oxygen. Anaerobic conditions cause some of the iron to become soluble and to migrate. It moves towards areas of relatively high oxygen content where it concentrates into rust colored patches or spots (mottles).

1.5.3. Assessing soil aeration condition

The aeration status of a soil can vary over a wide range of values with a continual change in the physical, chemical and biological properties. In a well-aerated soil, the O_2 content is high with a large percentage of the soil pore spaces filled with air. However, when soil pore spaces are filled with water, anoxia exists. It is impossible because of limited techniques to measure the degree or extent of anoxia in a soil profile. Anoxia involves more than mere absence of O_2 in the soil. Many other redox systems are involved in determining the biological and chemical activities of a soil, and these redox systems are usually not affected until O_2 has been depleted. Also, difficulties arise from the fact that whereas physical methods can predict the degree of O_2 supply, it requires biochemical assays to determine the degree of demand.

However, by studying results of certain measuring techniques and considering responses and products of organisms and plants, one can make value judgements about the soil environment. Many different methods have been devised which when coupled by appropriate statistical analyses, can be used to evaluate either qualitatively or quantitatively the aeration status of a soil. A review of these methods is presented in this report.

1.5.4. Assessing soil condition for infiltration

The infiltration capacity is the maximum rate at which water can enter a particular soil. Different soil types have different infiltration capacities; for example, sandy soils are more freely draining than clays, resulting in higher infiltration capacities. High infiltration capacities will reduce run-off and risks of water logging; however, very high infiltration capacities, such as are often found in sands, may mean the nutrients are lost from the root zone through leaching into deeper parts of the soil profile. Infiltration capacities can be altered by soil management practices. As infiltration is related to soil structure, any practice that degrades the structure of the soil will have an adverse effect on infiltration. Therefore, monitoring infiltration rates under different soil management regimes is a good indicator of how the practice will influence the rate at which water can move into the soil.

There are several different ways of measuring infiltration which vary in their accuracy and complexity. A relatively simple and accurate approach is the ring infiltrometer method. A metal 'infiltration ring' is pushed into the soil. Water is poured into the ring, and the rate at which the water soaks into the soil is measured.

Limitations of this method Although this method has the advantage of being easy to use and easy to interpret, it does have its disadvantages, the main one being that the water inside the infiltration ring flows horizontally through the soil as well as vertically, thus giving results greater than would be achieved if the flow was confined only to downward movement through the soil profile. There are ways to correct for this, but for comparative purposes they are not necessary. It must just be assumed that the proportion of the water which moves sideways is always similar. As only a small area is used, this technique is very sensitive to worm and root holes, and other cracks in the soil. Any crack in the soil surface will result in much faster flow than would otherwise be achieved. As these cracks are often not visible at the surface it is not always

Resources

- You will need 150mm deep metal rings. Commercial products may be available, or metal rings can be cut from clean empty 20 litre oil drums (380mm inside diameter).
- Sharpen one edge of the ring so that it is easier to push into the soil.
- Draw a line with a water-resistant marking pen on the outside of the ring 50mm up from the sharp edge to mark the depth to push the ring into the soil. On the inside of the ring accurately draw two lines at 90mm and 100mm from the sharpened edge to mark the depth of water once the ring is installed in the soil. Other items that you will need are:
- A piece of flat board or plank about 2cm thick and long enough to span the diameter of the ring.
- Hessian bags.
- Garden clippers.
- Three 5 litre buckets with a small (2mm diameter) hole in the base.
- Metal or plastic rule (mm/cm scale).

- Shovel.
- About 50 litres of rain water or clean water suitable for irrigation.
- Stopwatch.
- Recording sheet and pen.ays possible to avoid them when choosing a site

Timing

This measurement is best performed in spring or autumn when the soil is moist and not dry, hard or cracked. Where to monitor Measures of infiltration can be taken under the vine-row or in the inter-row area depending on the information you want to collect. Often the soil in the inter-row is more compacted and has a different infiltration rate to soil underneath vines. Ideally, you should measure the infiltration rates on different soil types in your vineyard and perhaps in locations of different elevation if you are on a sloping site. It is a good idea to set up about three infiltration rings on the same types of soil in the areas being measured to account for soil micro-variation at each monitoring point. You can use these groups of rings as your 'defined measurement unit' for a given soil type and calculate an average of the monitoring results from each of these (as long as they do not differ too greatly, in which case your infiltration rings may actually be sited on soils with different characteristics, despite surface appearances). It is not a good idea to try to measure infiltration on cracking clay soils or in freshly cultivated paddocks because results will not be representative of that soil's behaviour at all times. On stony and very hard soils, it may be difficult to push the ring into the soil.

Method: 1 preparation

I. At each location, clip any plants on the site down to ground level, being careful not to disturb the soil. If the area is covered with a mulch or compost, clear it away to expose the soil surface. Avoid trampling on the area where the measurement is to be made.
II. Place wet hessian bags on the soil surface at each measurement site, fill the holed bucket with rainwater and place it on the bag allowing the water to slowly drain onto the bag overnight and gently wet the soil.
III. The next day remove the bucket and bag and insert the metal ring, sharp edge first, by gently pushing down on the middle of the ring with the flat board until the line marked on the outside

is level with the soil surface all around the ring. If it will not push in by hand, the soil may not have wet deeply enough and you should gently remove the ring, replace the bag, refill the bucket and try again the next day.

IV. Seal any large gaps along the edges of the ring with 'putty' made from moist, reworked soil rolled out to the thickness of a pencil (subsoil is best). Take care not to disturb the surface of the soil inside the ring once the site is prepared with the ring in place, the actual infiltration test can be done.

Method 2: measurement

All measurements should be recorded in units of milimetres (mm) and minutes (min.) for the purposes of the following calculations:

- Gently fill the ring with water, being careful not to stir up the soil; until the level is just on the upper line drawn on the inside of the ring (the water should be 50mm deep).
- Using the rule and stopwatch, measure how far the water level drops in 6 minutes and record as 'depth'. If the level drops by more than 10mm in 6 minutes, record the number of minutes taken for the 10mm drop to occur record as 'time').
- Refill the ring with water and repeat the measurements several times until the times or the depths are similar to within one minute or 1mm.
- Calculate an average of the most recent, similar values in your measurements.

Calculations

The water intake rate in mm per hour is calculated as follows:

Infiltration rate = depth (mm) x 10

If you were able to take the measurements in 6 minute intervals

OR

Infiltration rate = 600/time (min).

If the water level dropped by more than 1cm in 6 minutes. Interpreting results the mm/hour value obtained can be interpreted from the information in the table below.

Note:

These criteria cannot be applied to cracking clay soils.

Table1. Soil structural assessment based on water infiltration rate After Geeves et al. 1995

Rate of water entry (mm/h)	Soil structural assessment
0-10	Very poor structure
10-30	Poor structure
30-70	Moderate structure
> 70	Good structure

1.5.5. Assessing moisture conservation techniques

Soils normally contain a finite amount of water, which can be expressed as the "soil moisture content." This moisture exists within the pore spaces in between soil aggregates (inter-aggregate pore space) and within soil aggregates (intra-aggregate pore space) (Figure 1**).** Normally this pore space is occupied by air and/or water. If all the pores are occupied by air, the soil is completely dry. If all the pores are filled with water, the soil is said to be saturated.

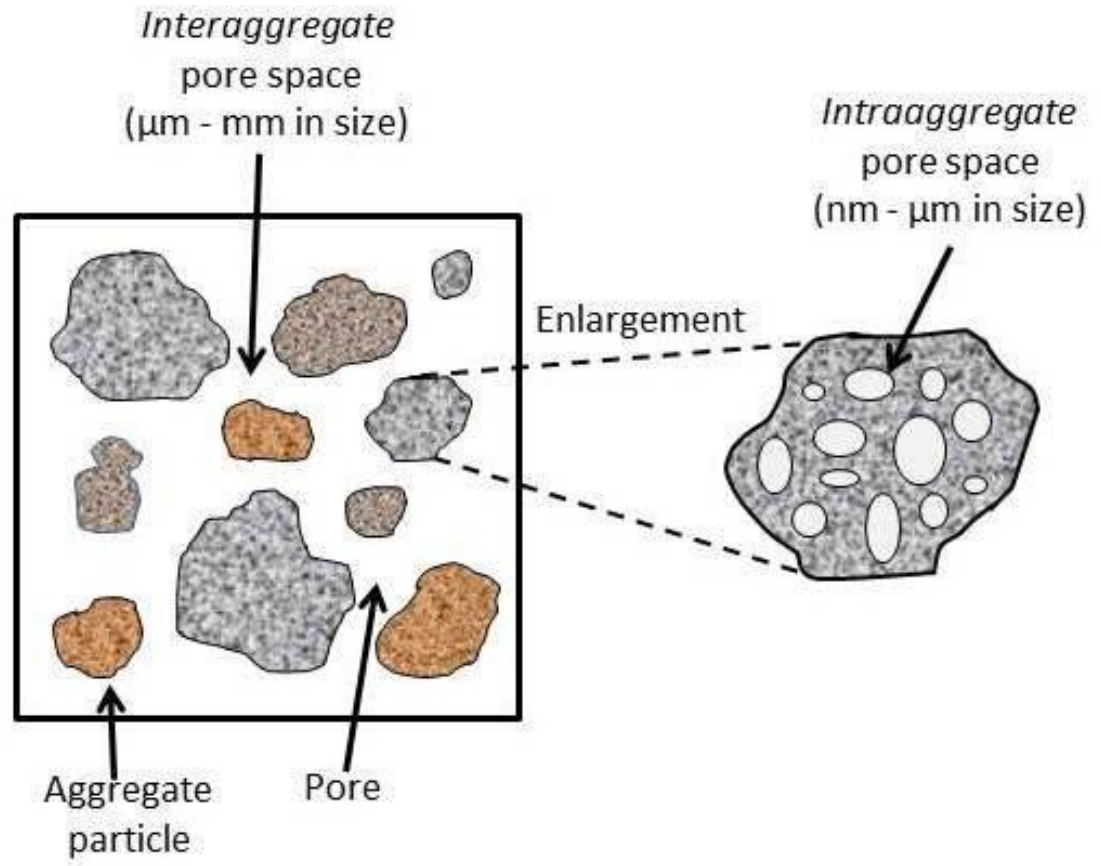


Figure 2. Pore space in soil.

Principles

In outdoor natural environments, water is added to soil via rainfall or deliberate irrigation of plants. In either case, soil moisture increases as more pores become filled with water at the expense of air. If all the pores become filled with water, excess water will now leach downward (Figure 2**)** through continuous soil pores, until the rain or irrigation ceases. Leaching will continue until the water films within the pores are held by the surface tension of soil colloids against the force of gravity. Such a situation is referred to as the soil being at "field capacity" with respect to soil moisture. A soil at field capacity has pores partially filled with air, surrounded by soil moisture films. Normally a soil at field capacity is optimal for plant growth and aerobic soil microorganisms, since both air and water are available. In contrast, a saturated soil will create waterlogged anaerobic conditions that can kill plants and suppress aerobic soil microbes, while stimulating anaerobic microbes.

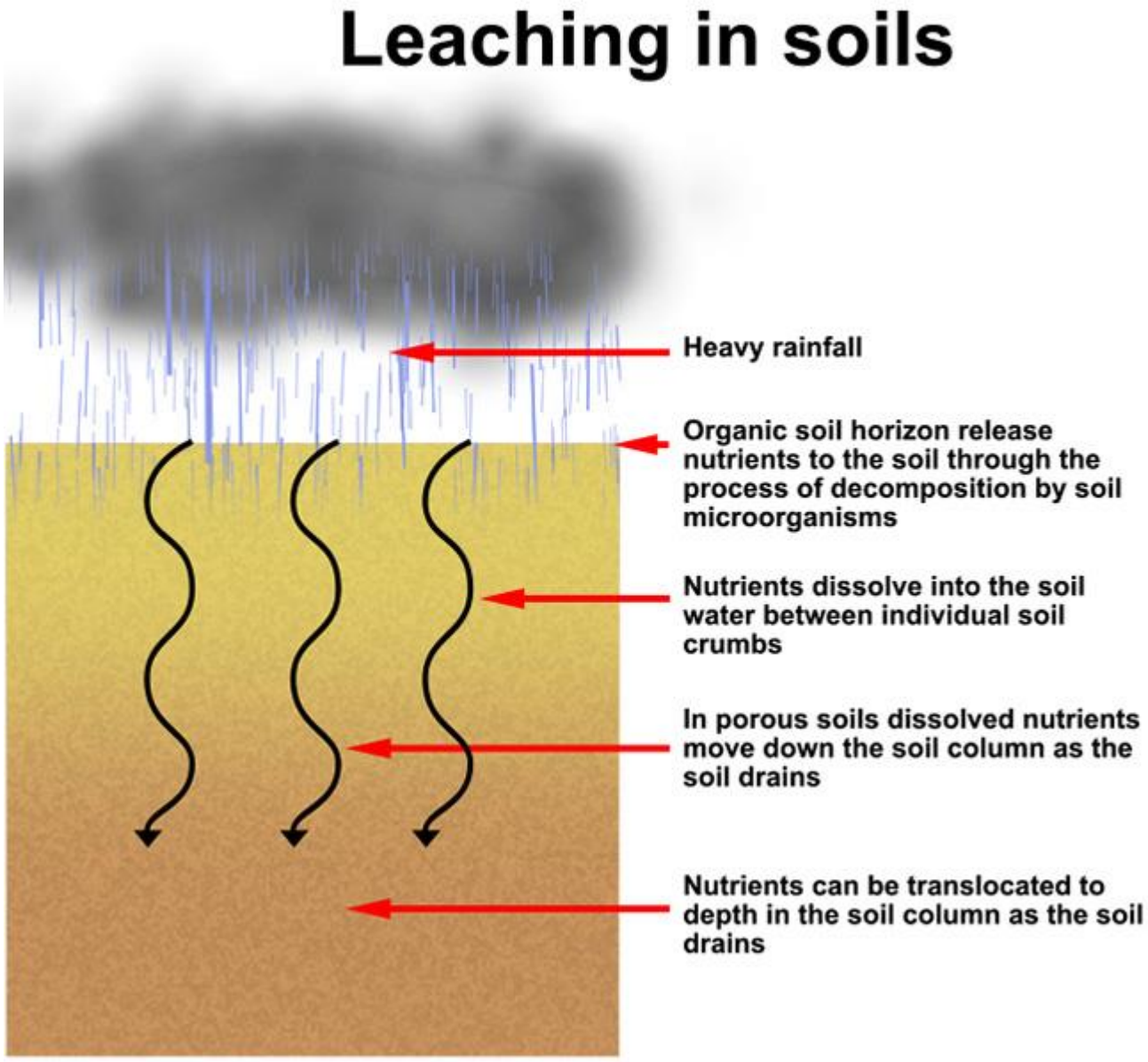


Figure3. Nutrients leaching in soil

Consider a sample of moist soil within a container such as a beaker. The weight of the moist soil consists of the weight of the dry soil particles plus the weight of the water within the soil. If more water is added to the soil, the wet weight of the soil increases. The dry weight of the soil particles within the sample is fixed one weight which is the dry weight. In contrast, there are an infinite number of wet weights, depending upon how much water is added to the soil.

Because of this, when doing lab experiments with soil, the moisture content of the soil is normally expressed on a dry weight basis, because the dry weight is constant over time, whereas the moist or wet weight can change over time. When expressing the results of an experiment such as the nutrient content of a soil, use of the dry weight basis provides standardization of the final result.

Procedure

I. Weigh both of the aluminum dishes.
II. Aliquot approximately 50 g of moist soil into each, aluminum, dish and reweigh the dishes. Hence, the moist weight of the soil sample is now known.
III. Dry the soil overnight at 105 °C in the oven.
IV. Remove the dishes from the oven and allow them to cool.
V. Reweigh the dishes plus the oven dry soil. Now the weight of the dry soil is known.

Results

Calculate the soil moisture content for each of the replicate samples using the following equation:

$$\% \text{ moisture content (MC) (Dry wt. basis)} = \frac{\text{weight of moist soil - weight of dry soil}}{\text{Weight of dry soil}}$$

Example Calculations:

M = 102 g

D = 90 g

% MC = 102-90/90

MC = 13.3%

With the addition of 5 g of water, new M = 107 and D still equals 90

= % MC = 107-90/90 which is new MC = 18.9%

Knowledge of the moisture content of a soil on a dry weight basis is useful in a number of ways. For example, if the experiments are conducted with soil that should be amended with a known concentration of ammonium fertilizer (for example 50 μg/g), then the moisture content on a dry weight basis must be determined. If the calculation was completed on a wet weight basis, the amount of fertilizer to be added would depend on the moisture content (and therefore the moist weight) of the soil sample. Likewise, if potted plants are considered, the moisture content must be known in order to make sure that the soil isn't too dry (not enough moisture for plant growth) or too wet (waterlogged and anaerobic). In a field situation, knowledge of the soil moisture content can prevent excess irrigation and leaching of soil nutrients.

1.6.Assessing soil biological activity by identifying and evaluating presence of organisms

Indicators of microbial activity in soil represent measurements at the ecosystem level ***(***e.g. processes regulating decomposition of organic residues and nutrient cycling, especially nitrogen, sulfur, and phosphorus***)***. Measurements at the community level include bacterial DNA and protein synthesis. Frequency of bacteriophages is a measurement at the population level.

The majority of higher plants exist in natural symbiosis with mycorrhizal fungi. The group of mycorrhizal fungi includes ectomycorrhizal (mainly forest trees), arbuscular mycorrhizal (terrestrial plants) and ericoid mycorrhizal (heather) fungi. They colonize plant roots and provide the plant with nutrients, especially phosphorus, due to the increased nutrient availability caused by the extra-radical mycelium. Furthermore, my corrhizal associations can have a positive influence on plant diversity, plant stress and disease tolerance, and on soil aggregation.

- **Human pathogens** can enter agricultural soils through amendment with manure and sewage sludge. The presence of human pathogenic bacteria in soil is an indicator of potential human infection and as such an indicator of human health. Presence of Escherichia coli, have traditionally been used as an indicator.
- **Nematodes** respond rapidly to disturbance and enrichment of their environment; increased microbial activity in soil leads to changes in the proportion of opportunistic bacterial feeders in a community. Over time the enrichment opportunists are followed by more general opportunists. Which include fungal feeders and different genera of bacterial feeders? This

succession of nematode species plays a significant role in decomposition of soil organic matter, mineralization of plant nutrients and nutrient cycling.

- **Arthropods and earthworms** chew the material and mix it with soil. A few fungi may break apart one complex compound into simpler components, then bacteria can attack the newly created compounds, and so on.

Assessing Soil health:-The main aim of integrated nutrient management (INM) system is to manage the soil fertility, sustain the agricultural productivity and improve the farmer's profitability through the judicious and efficient use of chemical fertilizers, organic manures, crop residues and bio-fertilizers. However, this does not mean adding everything everywhere, rather it is a well-considered, practical and efficient blend of diverse nutrient sources which can produce desired yields and maintain soil health on long-term basis.

Thus, INM system practices efficient and judicious use of all the major sources of plant nutrients through fertilizers, organic and other biological sources in an integrated manner so as to maximize economic yield for a given cropping system as well as to maintain soil health. Simultaneously, it helps to restore and sustain soil fertility and crop productivity as well as helping to check the emerging micronutrient deficiencies.

Moreover, it brings economy and efficiency into fertilizer use and positively affects the physical, chemical and biological properties of soil. Consequently, the increase in soil organic matter an optimum nutrient supply to the plants is ensured .In other words, it takes into account all the factors of soil and crop management, including management of all inputs such as water, agrochemicals, nutrients, etc.

Self-Check 1	Written test

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

Part I. Say true if the statement is correct and false if the statement is incorrect.

1. Arthropods and earthworms chew the material and mix it with soil
2. In outdoor natural environments, water is added to soil via rainfall or deliberate irrigation of plants
3. Soil and plant tissue tests can be used to assess the nutrient content of both the soil and plant, and to determine the nutrient need of a given plant in a given soil
4. Different crop types have specific nutritional requirements that must be met to achieve optimal growth and yield

Part II. Give short answer for the following question

1. What is soil compaction? (5 pts)
2. Elaborate the relationship between MOs and soil? (5 pts)
3. What are soil sampling techniques? (5 pts)
4. What is soil tests and tissue tests?(5 pts)
5. Mention soil related factors for plant health?(5 pts)

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

Part. II: Matching

A	**B**
1. Adding organic matter	**A.** Reduces the supply of air through pores in the soil
2. Transect	B. Value measures the ratio of H+ ions to OH- base ions in the soil.
3. pH	C. Reduce compaction
4. Soil compaction	D. Soil samples are taken along straight lines across the targeted area
5. Dark red	E. Iron and aluminum accumulation. feral and Ferro soil

Operation Sheet 1	Conduct soil sample

Procedure for soil sampling

To do the soil sampling activity you will go to field and choose a non cropped field of about 1hectar

Apply a systematic sampling technique

1st step -prepare your tools and equipments that are needed for soil sampling

2nd step- makes the sampling plan in the chosen field of about one hectare

- Is there any variability on the field in terms of slope, soil color, depth and texture?
- Consider also any other variability such as cropping history, fertilizer application, etc.

3rd step-following the variability you observed divide the one hectare field in to homogenous sampling units

4th step- taking one sampling unit area for one group, then locate the sampling points on you sampling unit.

- Choose a large distance/interval to locate the sampling points as your area is approaching to homogeneity
- In your group, if you approximately get about 0.25ha plot, then locate your sampling points in 15 meter intervals (Systematic sampling) or use other method

5th step -Using the auger takes at least 9 samples (or your own sample numbers) from the located points

- Put the soil sample you take in paper bag first and
- Then composite the nine paper bag samples in to one clean bucket

6th step -Finally takes your composite sample to laboratory for preparation

LAP TEST	Performance sheet

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following task within **60** minutes. The project is expected from each student or in a group to do it.

Task1. Perform soil sample

Task2. Determine soil texture

LG #19	LO #2 Assess soil health and fertility indicators

Instruction Sheet

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

- Undertaking principles of organic agriculture
- Assessing soil health by identifying and evaluating plant species present.
- Assessing and recording soil acidity or alkalinity (pH), mineral balances, organic matter levels, and plant performances
- Assessing and recording soil texture, structure, colour, salinity and sodicity
- Analyzing results to identify trends and areas for improvement

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:

- Undertake principles of organic agriculture
- Assess soil health by identifying and evaluating plant species present.
- Assess and record soil acidity or alkalinity (pH), mineral balances, organic matter levels, and plant performances
- Assess and record soil texture, structure, colour, salinity and sodicity
- Analyze results to identify trends and areas for improvement

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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 2

2.1.Undertaking principles of organic agriculture

2.1.1. Principles of Organic Farming

Organic agriculture follows the principles and logic of a living organism, in which all elements (soil, plant, farm animals, insects, the farmer and local conditions) are closely linked to each other. This is accomplished by using, where possible, agronomic, biological and mechanical methods, following the principles of these interactions, using natural ecosystem as a model.

Organic production system is designed to:

- Enhance biological diversity within the whole system;
- Increase soil biological activity
- Maintain long-term soil fertility
- Recycle wastes of plant and animal origin in order to return nutrients to the soil, thus minimizing the use of non-renewable resources
- Rely on renewable resources in locally organized agricultural systems
- Promote the healthy use of soil, water and air as well as minimize all forms of pollution that may result from agricultural practices
- Promote the careful processing methods agricultural products in order to maintain the organic integrity and vital qualities of the product at all stages
- Become established on any existing farm through a period of conversion, the appropriate length of which is determined by site-specific factors such as the history of the land, and type of crops and livestock to be produced.

The organic agriculture practices are based on the following principles**:**

I. Principle of health

Principle of health: Organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. Healthy soils produce healthy crops that foster the health of animals and people. Health is the wholeness and integrity of living systems. The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings

II. Principle of ecology

Organic farming should be based on living ecological system and cycles, work with them, emulate them and help sustain them. This Principe roots organic agriculture within living ecological systems. It states that production is to be based on ecological processes, and recycling. Nourishment and well-bring are achieved through the ecology of the specific production environment. Organic management must be adapted to local conditions, ecology, culture and scale. Input should be reduced by resource recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources. It should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity

III. Principle of fairness

Organic farming should build on relationships that ensure fairness with regard to the common environment and life opportunities. This principle emphasizes that those involved in organic agriculture should conduct human relationship in manner that ensures fairness at all levels and to all parties traders and consumers. It aims to produce a sufficient supply of good quality food and other products. Natural and environmental should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of

production, distribution and trade that are open and equitable and account for real environmental and social costs

IV. **Principle of care**

Organic farming should be managed in a precautionary and responsible manner to protect the health and well being of current and future generation and the environment. Organic farming is a living and dynamic system that responds to internal and external demands and conditions. This principle states that precaution and responsibility are the key concerns in management, development and technology choice in organic agriculture.

The important goals of organic farming : -

- Sufficiently high level of productivity
- Compatibility of cultivation with the natural cycles of the production system as a whole
- Maintaining and increasing the long-term fertility and biological activity of the soil
- Maintaining and increasing natural diversity and agro-biodiversity
- Maximum possible use of renewable resources
- Creation of a harmonic balance between crops and animal husbandry
- Creation of conditions in which animals are kept that correspond to their natural behaviour
- Protection of, and learning from, indigenous knowledge and traditional management systems

Advantages of organic farming

I. Nutrition poison -free and tasty food

The nutritional value of food is largely a function of its vitamin and mineral content. In this regard, organically grown food is dramatically superior in mineral content to that grown by modern conventional methods. A major benefit to consumers of organic food is that it is free of contamination with health harming chemicals such as pesticides, fungicides and herbicides.

There are reasonably consistent findings for higher nitrate and lower vitamin C contents in conventional vegetables (Woese et al., 1997). Several studies indicate that 10-60 percent more healthy fatty acids (like CLA's) and omega-3 fatty acids occur in organic dairy (Butler et al., 2008).

In crops, vitamin C ranges 5-90 percent more and secondary metabolites 10-50 percent more in organic, Also, less residues of pesticides and antibiotics are present (Huber and van de Vijver, 2009). Heaton, (2002) reported that organic food contains higher minerals and dry matter and 10-50 percent higher phyto-nutrients. Decreased cell proliferation of cancer cells was observed on extracts of organic strawberries (Olsson et al., 2006). The Parsifal study showed 30 percent less eczema and allergy complaints and less bodyweight among 14 000 children fed with organic and biodynamic food in five EU countries (Alfven et al., 2006). In animals, organic feed leads to increased fertility (Staiger, 1988) and increased immune parameters (Finamore et al., 2004). Other studies indicate that the most systematic differences between organic and conventional crops are the contents of secondary metabolites (Brandt & Mølgaard, 2001). Organically grown food tastes better than that conventionally grown. The tastiness of fruit and vegetables is directly related to its sugar content, which in turn is a function of the quality of nutrition that the plant itself has enjoyed. This quality of fruit and vegetable can be empirically measured by subjecting its juice to brix analysis, which is a measure of its specific gravity (density). The brix score is widely used in testing fruit and vegetables for their quality prior to export. Organically grown plants are nourished naturally, rendering the structural and metabolic integrity of their cellular structure superior to those conventionally grown. As a result, organically grown foods can be stored longer and do not show the latter's susceptibility to rapid mold and rotting

II. Lower growing cost

The economics of organic farming is characterized by increasing profits via reduced water use, lower expenditure on fertilizer and energy, and increased retention of topsoil. To add to this the increased demand for organic produce makes organic farming a profitable option for farmers

III. Enhances soil nourishment

Organic farming effectively addresses soil management. Even damaged soil, subject to erosion and salinity, are able to feed on micro-nutrients via crop rotation, inter-cropping techniques and the extensive use of green manure. The absence of chemicals in organic farming does not kill microbes which increase nourishment of the soil. Biodynamic farms had better soil quality: greater in organic matter, content and microbial activity, more earthworms, better soil structure, lower bulk density, easier penetrability, and thicker topsoil (Reganold et al., 1993); agricultural productivity doubled with soil fertility techniques: compost application and introduction of leguminous plants into the crop sequence (Dobbs and Smolik, 1996; Drinkwater et al., 1998; Edwards, 2007).

IV. More energy efficiency

Growing organic rice was four times more energy efficient than the conventional method (Mendoza, 2002). Organic agriculture reduces energy requirements for production systems by 25 to 50 percent compared to conventional chemical-based agriculture (Niggli et al., 2009

V. Carbon sequestration

Organic farms annually sequester 402 kg Carbon/ha, while conventional farms had losses of 202 kg (Clark et al., 1999; Küstermann et al., 2008; Niggli et al., 2009).

VI. Less water pollution

Less water pollution: in conventional farms, 60 percent more nitrate are leached into groundwater over a 5-year period (Drinkwater et al., 1998).

V. Environment friendly practices

The use of green pesticides such as neem, compost tea and spinosad is environment-friendly and non-toxic. These pesticides help in identifying and removing diseased and dying plants in time and subsequently, increasing crop defence systems. Organic farms' biodiversity increases resilience to climate change and weather unpredictability (Niggli et al., 2008).

Organic agriculture reduces erosion caused by wind and water as well as by overgrazing at a rate of 10 million hectare annually (Pimentel et al., 1995).

VI. **Organic farming is a source for productive labour**

Agriculture is the main employer in rural areas and wage labour provides an important source of income for the poor. Thus, by being labour intensive, organic agriculture creates not only employment but improves returns on labour, including also fair wages and non-exploitive working conditions. New sources of livelihoods, especially once market opportunities are exploited, in turn revitalize rural economies and facilitate their integration into national economies

Disadvantages of organic farming

I. Lower productivity

An organic farm cannot produce as much yield as a conventional or industrialized farm. A 2008 survey and study conducted by the UN Environmental Program concluded that organic methods of farming result in small yields even in developing areas, compared to conventional farming techniques. Though this point is debatable as the productivity and soil quality of an industrialized farm decreases rapidly over the years.

II. Requires skill

An organic farmer requires greater understanding of his crop and needs to keep a close watch on his crops as there are no quick fixes involved, like pesticides or chemical fertilizers. Sometimes it can be hard to meet all the strenuous requirements and the experience to carry out organic farming.

III. Time-consuming

Significant amounts of time and energy are required to execute the detailed methods and techniques that are required for a farm to be called an organic farm. Failure to comply with any of these requirements could result in loss of certification, which the farmer will not be able to

regain in up to three years. And it can be more time-consuming. Organic farming increases soil fertility by way of compost, and organic fertilizers and mulch. Organic fertilizers tend to be slow-release. As with control by botanicals, horticultural oils, and insecticidal soaps, organic fertilizers may need several applications before the desired results are brought about.

IV. More labour intensive

For organic farming considers biological, cultural and mechanical responses to production challenges. It focuses on plant and soil health through proper aeration, drainage, fertility, structure and watering. So there's more above and below ground grunt work involved.

V. Organic farming methods aren't as established and widespread - yet - as conventional production.

So organic control by botanicals such as pyrethrin can be more expensive than conventional controls by the longer established, more available, and wider ranging artificial, commercial, synthetic chemical pesticides

VI. Organic farming also requires a lot more inputs and more red-tape than conventional farming because certain practices must be met in order for a farm to retain the organic label. If anything slips, then the farm looses organic certification just like that

2.2.Assessing soil health by identifying and evaluating plant species present.

2.2.1. Identifying soil health

Soil health refers that continued capacity of soil to support crop production. It helps us to produce more food and preserves soil for next generation to utilize. Amount of food and its quality are strongly impacted by soil health. For example food insecurity is common in a region with highest rate of soil degradation. Thus soil health links with human health through quality of food produced concentration of micronutrients, protein and amino acids. Plant nutrition is defined as the chemical elements required for plants from the soil. These elements are differing in the form they absorbed, function and mobility.

i. Direct assessment of soil health

Some quick ways to identify a healthy soil includes feeling it and smelling it. Grab a handful and take a whiff. Does it have an earthy smell? Is it a loose, crumbly soil with some earthworms present?

Look at the surface and see if it is crusted, which tells something about tillage practices used, organic matter, and structure. Pushing a soil probe down to 12 inches, lift out some soil and feel its texture. If a plow pan were present it would have been felt with the probe. Turn over a shovelful of soil to look for earthworms and smell for actinomycetes, which are microorganisms that help compost and stabilize decaying organic matter. Their activity leaves a fresh earthy smell in the soil.

ii. Maintaining and improving soil quality

Soil quality is a function of many factors, including agro climatic factors, hydrogeology, and cropping/production practices. Soil quality can be degraded through three processes

- Physical degradation such as wind and water erosion and compaction
- Chemical degradation such as toxification, salinization, and acidification; and
- Biological degradation, which includes declines in organic matter, carbon, and the activity and diversity of soil fauna. Slowing down or stopping these processes will help maintain soil quality. Reversing the processes will improve soil quality over time.

- **Physical degradation: -** Erosion has long been considered the major agent of soil degradation worldwide. Another form of soil degradation is compaction, typically caused by heavy machinery and cattle trampling. Mineralogy is determining factors of vulnerability to compaction.
- **Chemical degradation: -** While salinity problems are often associated with irrigation, they can also occur in dry land areas where rainfall is insufficient to leach salts from the soil. Acidification, another chemical degradation process, can occur when bases (such as calcium, magnesium, potassium and sodium) are leached from the soil.

Biological degradation: - It affects the health of the soil and organic matter, which affects the physical and chemical properties of soils. Soil organisms contribute to the maintenance of soil quality and control many key processes such as decomposition of plant residue and organic material, nitrogen fixation, and nutrient availability. The assessment of soil health is thus important in determining the Sustainability of land management systems.

Balanced supply of elements to the plant is essential, otherwise nutrients will become imbalance.

Why you do soil test? To know how healthy soil is, to know how to improve it, to know nutrient status of soil, to know w/c crop is grow on it, etc. Soil is important to grow any types of crops. However; when nutrients imbalance in the soil, plant subjected to stresses and a constant deficiencies or toxicities will result therefore, if nutrients are less or more in the soil necessary measure should be taken.

Soil tests should be taken in such a manner to maximize their use as a soil fertility index based on comparison between sampling events. Consistency, in the areas of season, location (aided by GPS techniques), crop rotation, soil type and sampling depth must be maintained for proper soil test interpretation. Inconsistencies in any of these areas of soil sampling collection will lessen the interpretation value of soil test changes that occurred since the last soil sample was taken. Along with consistency, soil samples should reflect past soil and fertilizer/amendment management of a given field, taking into account tillage, crop rotation, fertilizer/ amendment placement and also soil characteristics (texture, slope and drainage). Following these guidelines will allow soil tests to be used more effectively for nutrient management and crop diagnostics.

Soil testing on regular bases is an important part of nutrient management. From the farmer's point of view, nutrient management is the process to maximize the proportion of applied nutrients that is used by the crop; in other words, maximizing the "Nutrient Use Efficiency (NUE)". Soil tests are used to evaluate soil fertility, which ultimately measures the soil nutrient content. It focuses on the measurement of available nutrients for the plants and excludes the total nutrient content. Total nutrient content value of the soil is useless for the farmer, because only a small quantity of them is available for the plant. Therefore it cannot provide information for

fertilizer calculations. Soil testing program is an analysis of the soil physical and chemical properties and an evaluation of the soil nutrient-supplying capacity at the time of sampling.

It contains **four activities**:

- Taking soil samples
- Analysis of soil samples
- Interpreting the results of the sample analysis
- Making recommendations for soil management and plant nutrition practices

Soil test results are utterly important for any kind of reasonable plant production activity for at least three reasons. First of all, they provide information on nutrient availability in the field. Secondly, with their aid the responses of a given crop to fertilization or liming can be estimated. Thirdly, they also provide information for the further development of fertilizer recommendations.

2.2.2. Evaluating plant species present/ Plant diagnosis/test

It is the second ways of knowing the nutrient status in the soil. Plant ability to uptake nutrients influenced by soil fertility, soil temperature, soil compaction, and soil moisture. Plant analysis can tell us the present actual nutrient up taken. Hence the amount of nutrient in the plant related to that available from soil. Generally plant analysis is made to identify deficiency and nutrient shortage and to aid nutrient supply.

There are two types of plant analysis

(1) Green tissue

(2) Total plant analysis.

The plant is able for better production, to utilize the growth factor occurring in minimum amount, in proportion as the other growth factors occur at the optimum value for the plant. Since the major nutrient elements (NPK) moves from old to new tissue the recent matured leaf is sufficient to test. Generally plant part like petiole, leaves and whole top can be taken as sample. Stage of plant sample is important in plant testing b/c nutrient status and demands change during

the season. Hence critical stage for plant test is during maximum vegetative growth and reproductive stage. However; the last stage is difficult to correct the problem.

B. Total plant analysis- obtaining the plant sample is a critical step in plant diagnosis. Not only is the physical position of the plant parts to be selected for analysis important .but also stage of development is important in its ability to reflect the nutrient needs of the plant . Ideally the sample from a normal, healthy plant should be obtained at the same time the problem plants are sampled. When the analysis are to be used for nutritional or diagnostic purpose , it is important that the plant samples be free from disease, insect damage and physical and chemical injury.

Preparation of plant samples for analysis:-

It involves several steps to ensure accurate and reliable results. Here is a step-by-step guide based on the search results:

- Inspection: Carefully examine the plant samples for physical condition, type of material, extent of contamination, and freedom from disease
- Sampling: Select representative plant samples that represent the overall plant population in the field.
    - ✓ For herbaceous plants, take leaves or fruiting structures
    - ✓ For small plants, the entire plant can be sent by digging up the roots
    - ✓ For trees, place both tree branches and roots in plastic bags and place in a padded cardboard box
    - ✓ For fruits and vegetables, wrap each sample individually in paper towels or newspaper and seal in a padded box
- Drying: Fresh plant tissue samples should be dried to a crisp and brittle state at a temperature of 70-80°C
- Drying may require 12 to 24 hours depending on the original condition of the sample
- Grinding: All tissue samples must be ground to pass a 2 mm sieve
    - ✓ A 5 gram sample is desired to complete all analyses

- Smaller samples should be ground more finely to ensure a homogeneous sample can be weighed
- Labeling: Assign a laboratory number to the sample bag, data sheet, and sample submission form
  - ✓ Use a sharpie to write the lab number on the sample bag and oven-dried paper bag
- Packaging: Package the samples securely and clearly label them. Each sample set should include a listing of sample numbers, PI or project name, and date. By following these steps, you can prepare plant samples for analysis, ensuring accurate and reliable results for your research or analysis.

A. Green tissue analysis:-

Green tissue analysis, also known as plant tissue analysis, is a process that involves determining the total elemental content of the whole plant or parts of plants, typically leaves or petioles (leaf stem). This analysis provides valuable insights into the nutrient status of plants at the time of sampling, allowing for the diagnosis of suspected nutrient deficiencies and the monitoring of nutrient levels during the growing season. The process involves several key steps, including sampling, preparation, and analysis. Here are the key points:

I. **Purpose**: Plant tissue analysis is used to diagnose suspected nutrient deficiencies, monitor nutrient levels during the growing season, and make fertilizer recommendations for certain crops

II. **Sampling**: It is important to take representative plant samples that accurately reflect the overall plant population in the field. For example, in the case of leaf tissue analysis, it is best to perform the analysis as soon as possible after the symptoms of a suspected nutrient deficiency are evident

III. **Preparation**: The preparation of plant tissue samples for analysis involves drying the samples to a crisp and brittle state at a specific temperature, grinding the samples to pass a 2 mm sieve, and labeling the samples with a laboratory number for identification

IV. **Analysis:** Plant tissue samples are typically analyzed for elements such as nitrogen, phosphorus, potassium, calcium, magnesium, manganese, iron, copper, boron, and zinc.

The final report includes the analytical results along with an interpretation based on the crop standard

V. **Interpretation:** The results of the analysis are used to make informed decisions about fertilizer applications, diagnose nutrient deficiencies, and monitor the nutrient status of plants throughout the growing season

In summary, green tissue analysis is a valuable tool for assessing the nutrient status of plants, diagnosing nutrient deficiencies, and making informed fertilizer recommendations. By following the proper sampling, preparation, and analysis procedures, growers can effectively monitor and manage the nutrient status of their crops. There are two methods that are commonly employed for carrying out green tissue analysis:

- The paper test for NPK.
- The glass vial test for NPK

The nitrate nitrogen test can be carried out by placing the cut portion of green plant tissue (petiole or stem) on a clear portion of the folded test paper. When nitrate powder is added to plant tissue and squired the paper color turned to red in the presence of nitrate. Nitrogen affiant pink color in dictates low in nitrate, nitrogen (deficient) level of nitrate nitrogen A red color is indicative of high test or adequate nitrate nitrogen

Tests for phosphate –phosphorus- can be carried out by squeezing the sap from the freshly cut plant tissue on to the paper strips (Re-agent No1, stannous oxalate, and re-agent No2 ammonium moybdate). An adequate supply of phosphorus is indicated by a medium blue to dark-blue color. Alight blue color denotes a deficiency of phosphorus. For the potassium tests: - the plant sap is squeezed on the three tests spots containing dipicrylamine and reagent No1 are added to give an orange color. Variation in the bright nests of the, color signify the amount of potassium present. The disappearance of orange color from the all three dots on the test paper signifies a very low test for potassium and orange in the middle and bottom dots indicates medium level

2.3.Assessing and recording soil acidity or alkalinity (pH), mineral balances, organic matter levels, and plant performances

Soil is characterized by its physical, chemical, biological and mineralogical properties.

Permeability (the rate at which water moves through the soil) and Water-Holding Capacity (WHC; the ability of a soils micro pores to hold water for plant use) of the soil is affected by

- The amount, size and arrangement of pores
- Macro pores control a soil's permeability and aeration.
- Micro pores are responsible for a soil's WHC Porosity is in turn affected by :-
  - ✓ Soil texture
  - ✓ Soil structure
  - ✓ Compaction
  - ✓ Organic matter

Soils have large quantities of most nutrients, yet the majority of these nutrients are not in the soil solution, but instead are bound to the soil. Some of these nutrients are available to plants because they are only weakly bound as exchangeable nutrients. The cation exchange capacity (CEC) is one measure of the total amount of exchangeable cations that can be held by the soil, and generally is a good general indicator of soil fertility. CEC is higher in soils with high amounts of clay and organic matter, and is lower in acid soils. Soil pH strongly affects the plant availability of each of the nutrients, with pH levels near 7 generally having optimum availability

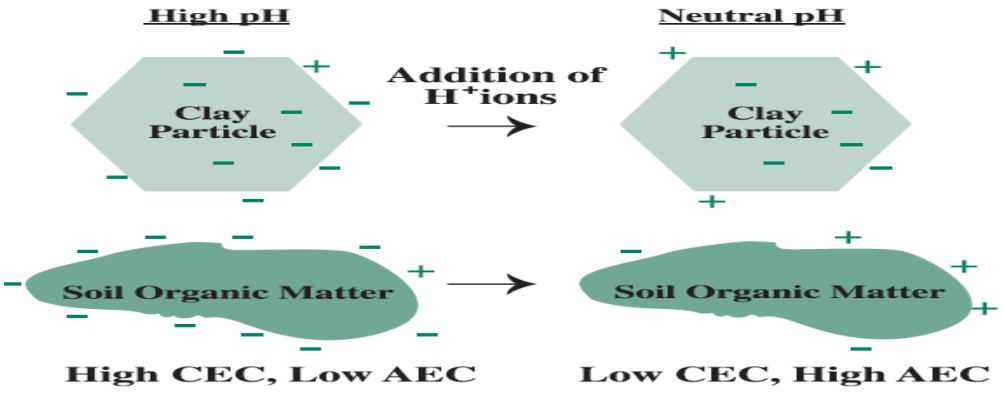
2.3.1. Assessing and recording soil acidity or alkalinity

Acidity and alkalinity in any solution is measured as pH. Soil pH is an estimate of the acidity/alkalinity of the soil solution, which is the water that is held in the soil.

PH = -log [H+], where [H+] = the hydrogen ion concentration. Because of the negative sign in the definition for pH, acidic soils have low pH values and alkaline soils have high pH levels. Soil pH affects the availability of all of the nutrients. For example, copper, iron, manganese, nickel, and zinc are all more available at low pH levels than at high pH levels because metals are bound very tightly to the soil or exist in solid minerals at high pH.

Conversely, the 'base' cations (Na+, K+, Ca+2, Mg+2) are bound more weakly to the soil, so can leach out of the surface soil, especially at low pH. Therefore, they are less available at low pH. There are many soils with pH levels above 7.5; therefore, there is a higher likelihood for iron, manganese, nickel, copper, zinc, and phosphorus deficiencies than in states with lower pH values, although deficiencies of the micronutrients are not often observed.

The optimum pH appears to be near pH 7, but keep in mind that every crop has different nutrient needs, and hence optimum Ph levels. For example, sweet clover has been found to have maximum yields near pH7.5, whereas soybeans and corn grow best near pH 6.8.Lower pH generally causes lower CEC, because the higher concentration of H+ ions in solution will neutralize the negative charges on clays and organic matter. Fertilizing with ammonia-based fertilizers is one way that PH may decrease over time. PH affects the surface charge, and hence the CEC and AEC of both clay particles and organic matter. The effect of PH on CEC is more pronounced for soil organic matter than for layer silicates, because all of the CEC on organic matter is dependent on PH. Note that the negative charges on the clay particle that are not on the edge of the particle are not neutralized.



Farmers see the direct **impacts of soil acidity** as lost productivity and reduced income through:

- Reduced yields from acid sensitive crops and pastures
- Poor establishment of perennial pastures
- Failure of perennial pastures to persist.
- Acidic soils also have impact on the community.

There is permanent degradation of the soil when the acidity leaches to a depth where it cannot be practically or economically corrected. This is a slow process and will most likely affect future generations more than it affects the present land managers.

Recharge of aquifers is due to less water use by plants affected by soil acidity. This can lead to dry land salinity and damage to infrastructure such as the breakup of roads.

There is an increase in soil erosion and addition of silt and organic matter to waterways as annual vegetation predominates on acidic soils, leaving the soils exposed to erosion for a significant part of the year.

2.3.2.Assessing and recording mineral balances

Assessing and recording mineral balances is crucial for understanding the nutrient status of plants, soil, and the overall health of an ecosystem. Here are some key steps to assess and record mineral balances:

- **Sampling:** Collect representative samples of plant tissue, soil, or water to analyze the mineral content. For plant tissue analysis, take leaves or petioles that are free from disease. For soil analysis, collect samples from different locations and depths to represent the overall soil population
- **Preparation**: Prepare the samples for analysis by drying, grinding, and packaging them according to the appropriate methods. For plant tissue analysis, dry the samples at a specific temperature grind them to pass a 2 mm sieve, and label them with a laboratory number. For soil analysis, store the samples in a cool, dry place until analysis can be performed
- **Analysis:** Analyze the samples for various macronutrients and micronutrients, such as nitrogen, phosphorus, potassium, calcium, magnesium, manganese, iron, copper, boron, and zinc. This can be done through methods like atomic absorption spectroscopy or Inductively Coupled Plasma Mass Spectrometry
- **Recording**: Record the analytical results in a clear and organized manner, including the laboratory numbers, sample locations, and dates of analysis. This data can be compiled in a spreadsheet or database for further analysis and interpretation

- **Data interpretation:** Interpret the results of the mineral analysis to identify any deficiencies, imbalances, or other issues that may impact plant growth, soil health, or ecosystem function. Use this information to make informed decisions about fertilizer applications, crop management practices, or environmental mitigation strategies. By following these steps, you can assess and record mineral balances in plants, soil, and water, providing valuable insights into the nutrient status of ecosystems and guiding decisions to promote sustainable agriculture and environmental stewardship.

2.3.3. Assessing and recording organic matter levels

Organic matter is made up of dead and decaying plants and animals, as well as their by-products. Assessing and recording organic matter levels in soil are important for understanding soil health and fertility. Here are some key points from the search results:

I. Sampling: Collect representative soil samples from different locations and depths to represent the overall soil population. A notable exception for depth of sampling are, soils which have been re-engineered using a mould board where the soil has experienced significant disturbance. In these situations, it is advisable to sample to a depth at least 10cm below the affected depth

II. Preparation**:** Prepare the soil samples for analysis by drying, grinding, and packaging them according to the appropriate methods. For example, in New Zealand labs, organic carbon is routinely measured as total carbon because inorganic carbon is mostly very low

III. Analysis: Analyze the soil samples for organic matter content using tests such as the loss-on-ignition method or the Walkley-Black method. Organic matter is typically expressed as a percentage of the soil's weight

IV. Recording: Record the analytical results in a clear and organized manner, including the laboratory numbers, sample locations, and dates of analysis. This data can be compiled in a spreadsheet or database for further analysis and interpretation

V. Interpretation: Interpret the results of the organic matter analysis to identify any deficiencies, imbalances, or other issues that may impact soil health and fertility. Use this information to make informed decisions about soil management practices, such as adding organic materials like solid or liquid manures, plants or crop residues. It is important to note that changes in

soil organic matter generally occur over many years, and it may take several years or longer to detect a significant change in soil organic carbon. Therefore, it is recommended to establish a baseline measurement and monitor changes over time to assess the effectiveness of soil management practices. By following these steps, you can assess and record organic matter levels in soil, providing valuable insights into soil health and fertility and guiding decisions to promote sustainable agriculture and environmental stewardship.

Organic matter is extremely important for:-

- Maintaining soil fertility
- The mineralization of nitrogen, phosphorus and sulfur in the soil
- The soil's ability to hold nutrients.
- Structural stability
- Water-holding capacity.

Organic matter is also very important in counteracting the negative effect of Exchangeable sodium ion accumulation.

Soil organic matter exists in two forms, as crop and microbial residues that, depending on soil temperature and moisture, are continuously undergoing decomposition, and as humus, an end product of organic matter decomposition, which is very stable and contributes to soil structural stability, as well as the water-holding and CEC of the soil.

Crop and microbial residues, upon decomposition, are the source for a number of essential plant nutrient elements, such as N, P, and B, whereas humus impacts the effectiveness of applied soil herbicides.

- Percent organic matter in the soil is determined by the formula:

% OM = [(W105 – W400) × 100]/W105 where W105 is the weight of soil at 105°C (221°F) and W400 is the weight of soil at 400°C (752°F).

Soil organic matter (SOM)

- ✓ Consists of living organisms, dead plant and animal residues.
- ✓ It is a reservoir for various essential elements.
- ✓ Contributes to CEC.
- ✓ Buffers soil pH.

2.3.4. Assessing and recording plant performances

What is the performance testing in plants?

A performance test is usually carried out after the construction or retrofit of a plant. It verifies that the plant can achieve its guaranteed parameters and function as intended.

Assessing and recording plant performance involves monitoring and evaluating the growth, development, and health of plants over time. Here are some key points from the search results:

I. Sampling: Collect representative plant samples that accurately reflect the overall plant population in the field. For example, in the case of leaf tissue analysis, it is best to perform the analysis as soon as possible after the symptoms of a suspected nutrient deficiency are evident

II. Preparation: Prepare the plant samples for analysis by drying, grinding, and packaging them according to the appropriate methods

III. Analysis: Analyze the plant samples for various macronutrients and micronutrients, such as nitrogen, phosphorus, potassium, calcium, magnesium, manganese, iron, copper, boron, and zinc. This can be done through methods like atomic absorption spectroscopy or Inductively Coupled Plasma Mass Spectrometry

IV. Recording: Record the analytical results in a clear and organized manner, including the laboratory numbers, sample locations, and dates of analysis. This data can be compiled in a spreadsheet or database for further analysis and interpretation

V. Interpretation: Interpret the results of the plant analysis to identify any deficiencies, imbalances, or other issues that may impact plant growth, health, or yield. Use this information to make informed decisions about fertilizer applications, crop management practices, or environmental mitigation strategies

VI. Monitoring: Monitor plant performance over time by regularly assessing plant growth, development, and health. This can involve visual inspections, measurements of plant height, biomass, or yield, and recording of environmental conditions such as temperature, humidity, and light intensity. By following these steps, you can assess and record plant performance, providing valuable insights into the nutrient status of plants, guiding decisions to promote sustainable agriculture and environmental stewardship, and monitoring the effectiveness of management practices over time.

2.4.Assessing and recording soil texture, structure, colour, salinity and sodicity

2.4.1. Assessing and recording soil texture

It is the relative proportions of sand, silt, and clay in a given soil on weight bases. It is important in determining the water-holding capacity of soil:

Fine-textured soils hold more water than coarse-textured soils but may not be ideal

Medium-textured soils (loam family) are most suitable for plant growth.

The size distribution of primary mineral particles, called soil texture, has a strong influence on the properties of a soil. Particles larger than 2 mm in diameter are considered inert. Little attention is paid to them unless they are boulders that interfere with manipulation of the surface soil.

Particles smaller than 2 mm in diameter are divided into three broad categories based on ***size*** as:

- Particles of 2 to 0.05 mm diameter are called sand;
- Those of 0.05 to 0.002 mm diameter are silt**;** and
- <0.002 mm particles are clay**.**

Therefore the texture of soils is usually expressed in terms of the percentages of sand, silt, and clay.

Some characteristics soil texture

- Sands are the largest particles and feel gritty
- Silts are medium-sized and feel soft, silky, or floury

- Clays are the smallest sized particles and feel sticky and are hard to squeeze

The fine and medium-textured soils (e.g. clay loams, silty clay loams, sandy silt loams) are favorable for production, due to their high available retention of water and exchangeable nutrients. The coarse-textured soils permit rapid infiltration due to their large pores between particles. The infiltration rates of finer-textured soils are smaller since the pore space between particles is mainly micro pores.

Soil texture also affects the soil temperature. Fine-textured soils hold more water than coarse-textured soils, therefore, the fine-textured soil heats up slower than the coarse textured soils. The fine textured soil has a larger total surface area than that of the coarse textured soil (Decreasing the particle size, increasing the surface area and vice-versa).

Sandy textured soil: It is characterized by its high porosity. They have bigger pores that do not permit the efficient storage of water. Generally, they are dry, infertile soils. The available water for plant: 2.5-3.0 cm per 30cm soil. The organic matter content reduces fast. Conditions inside the soil are aerobic. There is high risk for erosion. Loam textured soil: These are well-balanced soils with 40-45% sand, 30-40% silt and 20-25% clay.

They are preferred for crop production. Loamy soils with a high proportion of silt warm fairly quickly and have good water-holding capacity without becoming waterlogged. Loam type soil with high organic matter content generally has a granular structure and is dark in color.

The main problem with this type of soils is the loss of organic matter and degradation of soil structure. Human intervention in cultivation can cause this. Clay textured soil: It is fine textured soil with more clay size minerals, high porosity, but small discontinuous pores. These soils generally have a blocky structure.

The process of mineralization is restricted in this type of soil. There is high bulk density and little porosity. It is very difficult for plant roots to penetrate. Clayey soils are often waterlogged. These types of soils are capable of holding a huge quantity of water; but movement of water is very slow due to high surface tension. Between production, soil texture and several other indicators of the soil, such as bulk density, particle or real density, air space fraction, porosity and water

holding capacity, the relationship is direct. These indicators provide valuable information about soil conditions and characteristics, which influences the production and yield of crops.

2.4.2. Assessing and recording soil structure

Assessing and recording soil structure involves several methods and considerations to ensure a comprehensive understanding of soil health. Here are the key points from the search results:

I. **Geotechnical Analysis:** Geotechnical analysis, including soil composition and fertility management, measures nutrient content, pH levels, and soil texture to impact drainage, aeration, and nutrient availability. This involves a comprehensive site investigation, soil sampling, laboratory testing for various parameters, and data interpretation to optimize soil fertility

II. **Soil Survey Data Management:** Standard forms and electronic formats are used for recording and managing soil survey data. The variability of formats and content of information disseminated must be considered, and the system will likely need to be changed to meet future needs and demands

III. **Visual Evaluation:** A visual evaluation of soil structure is a straightforward assessment that can help identify important constraints, such as compaction. It involves observing the soil surface and profile, and assessing distinct soil layers separately using a spade. The timing of the assessment is important, and it should be done when the soil is moist but not too wet

IV. **Technology Utilization:** Webinars provide insights into utilizing technology to simplify measuring and recording soil structure, offering valuable tools for producers to enhance their soil assessment practices

V. **Disruptive Methods:** Direct observation and image analysis of soil thin sections using resin or wax-impregnated samples are used to measure the size, shape, and distribution of soil particles, providing advanced insights into soil structure assessment. By utilizing these methods and technologies, farmers and soil scientists can effectively assess and record soil structure, leading to informed decisions and practices to optimize soil health and fertility.

Four main types of soil structure (the arrangement of aggregates in a soil)

a. **Platy**- common with pudding or ponding of soils, it is like plate or leaf with level layers, the size is from above 5 mm to below 1 mm; appear in the plow pan or the surface layer.

The main problem with platy structured soils is soil compaction caused by the action of animals and machinery. These soils usually have higher bulk density, because they have less pore space, especially the fine-texture platy soils. This high bulk density heavily affects root penetration into the soil.

b. **Prismatic** (columnar) – common in sub soils in arid and semi-arid regions it is like column and prism, the size is from above 50 mm to below 10 mm, usually appear in subsoil.

The prismatic types of soil are of especially low quality and infertile. They normally occur in the lower horizons instead of the surface, but their presence in the surface horizon usually indicates sodic or alkaline conditions.

c. **Blocky –** common in sub soils especially in humid regions. It is irregular shape, rough surface, the size is from above 100 mm to 10 mm. appear in any soil layer

They are very hard soils, difficult to work with. The plant root has difficulty penetrating these dense soils, and in some cases it is almost impossible.

These soils tend to swell under wet conditions, and crack when dry. The clay content is high, mainly 2:1 type expanding clay. Land preparation for planting is an especially difficult task

d. **Granular** (crumb) – common in surface soils with high organic matter content

This type of soil carries a risk of compaction by animals and machinery. The wheels of machinery and continuous cropping reduce both the organic matter content and the granular structure of the soil as well as lowering the pore space. Compaction also happens in open land with granular soil that has been subjected to shallow cultivation.

2.4.3. Assessing and recording colour

Assessing and recording soil color is an important aspect of soil analysis, as it can provide valuable information about soil composition, fertility, and health. Here are some key points from the search results:

i. Visual assessment: Soil color can be assessed visually by observing the color of the soil surface and profile. Soil color can be influenced by factors such as organic matter content, mineral composition, and moisture levels
ii. Munsell color chart: The Munsell color chart is a standardized color chart used to describe soil color. It provides a consistent and objective way to describe soil color, which can be useful for comparing soil samples over time or between different locations
iii. Laboratory analysis: Soil color can also be analyzed in a laboratory using spectrophotometry or colorimetry. These methods provide a more precise and quantitative measure of soil color, which can be useful for research or monitoring purposes
iv. Recording: Record the soil color in a clear and organized manner, including the laboratory numbers, sample locations, and dates of analysis. This data can be compiled in a spreadsheet or database for further analysis and interpretation
v. **I**nterpretation: Interpret the results of the soil color analysis to identify any patterns or trends that may indicate changes in soil composition, fertility, or health. Use this information to make informed decisions about soil management practices, such as adding organic materials or adjusting irrigation practices.

By following these steps, you can assess and record soil color, providing valuable insights into soil health and fertility and guiding decisions to promote sustainable agriculture and environmental stewardship.

Colour is one of the most obvious characteristics of soil. Colour can also provide a valuable insight into the soil environment and hence is very important in assessment and classification. The most influential colours in a well drained soil are white, red, brown and black. White indicates the predominance of silica (quartz), or the presence of salts; red indicates the accumulation of iron oxide; and brown and black indicate the level and type of organic matter. A

colour triangle can be used to show the names and relationships between the four influential colours.

What determines soil colour four main factors influence the colour of a soil

Mineral matter derived from the constituents of

- The parent material
- Organic matter
- The nature and abundance of iron
- Moisture content

Mineral matter – rocks are broken down to form soils, and sometimes these rocks give their colour to the soil. More usually the colour of the soil results from compounds such as iron. Organic matter – humus, the final stage of organic matter breakdown is black. Throughout the stages of organic matter breakdown the colour imparted to the soil varies from browns to black. Sodium content influences the depth of colour of organic matter and therefore the soil. Sodium causes the organic matter (humus) to disperse more readily and spread over the soil particles, making the soil look darker (blacker).

Iron– Red, yellow, grey and bluish-grey colours result from iron in various forms. Under average conditions of air and moisture, iron forms a yellow oxide imparting a yellow colour to the soil. Where soils are well draining or under dry conditions, iron forms red oxides imparting a red colour to the soil. Yet in waterlogged soil, with a lack of air, iron forms in a reduced state giving the soil grey/green/bluish-grey colours.

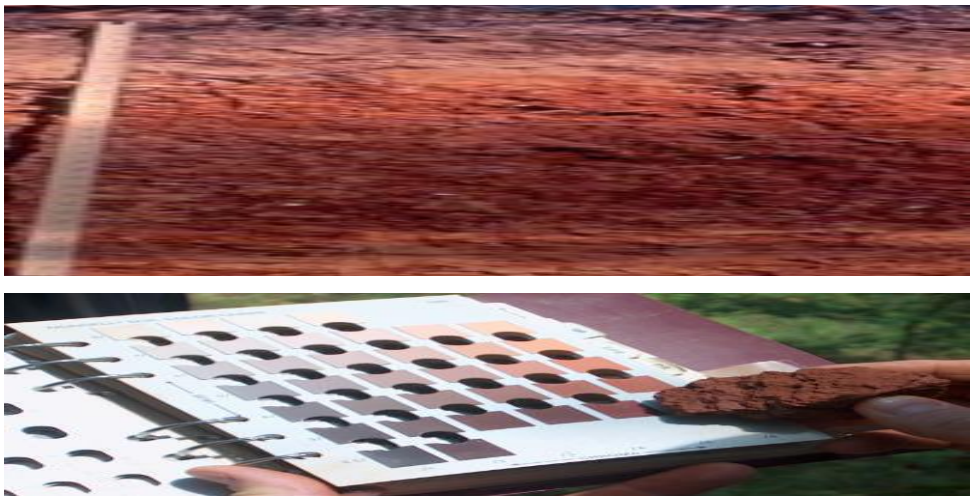
Water– Soil colour darkens as the soil changes from dry to moist. But longer term colour changes are linked to water relations as well. Careful observation of colour can help to identify problems of water logging or leaching. Poorly drained soils are often dominated by bluegrey colours often with yellow mottling. Well drained soils will usually have bright and uniform colour

Munsell's Soil Color Chart

How do you record soil color? The most widely used method for determining soil colors is comparison of soil samples with the color chips in the Munsell soil color charts. It is a booklet formed from the complete edition of the Munsell Book of Color (vide US Department of Agriculture Handbook No. 18: Soil Survey Manual) and consists of seven soil color charts popularly called "Soil Collection Display 199." Each soil color chart (in the form of a loose leaflet) consists of different standard color chips systematically arranged according to Munsell's notations. The arrangement is by three simple variables that combine to describe all colors and are known in Munsell's system as hue, value, and chroma."

The "hue" notation of a color indicates its relation to red, yellow, green, blue, and purple. The "value" notation indicates its lightness. The "chroma" notation indicates its strength (intensity). The colors displayed on the individual soil color chart are of constant hue designated by a symbol in the upper right hand corner of the card. Vertically, the colors become successively lighter from the bottom of the card to the top by visually equal steps—their value increases from bottom upward. Horizontally, they increase in chroma to the right and become grayer to the left. The value notation of each chip is indicated by the horizontal scale across the bottom of the chart.

Soil colors are used to infer pedogenic processes in soils. The main pigmenting (coloring) agents in soils are organic matter, iron, and, to a lesser extent, manganese. When these agents are not covering the mineral grains, the natural color of the grains is visible. Most mineral grains are naturally gray. The contrast of color is shown in Figures 3 and 4, where two soils have similar texture and structure yet differ in color scheme. When a soil horizon has more than one color, the dominant color by volume is the matrix color.



Figer 2.soil color chart

Soil color is influenced by its mineral composition as well as water and organic contents. For example, soils high in calcium tend to be white, those high in iron reddish, and those high in humus dark brown to black.

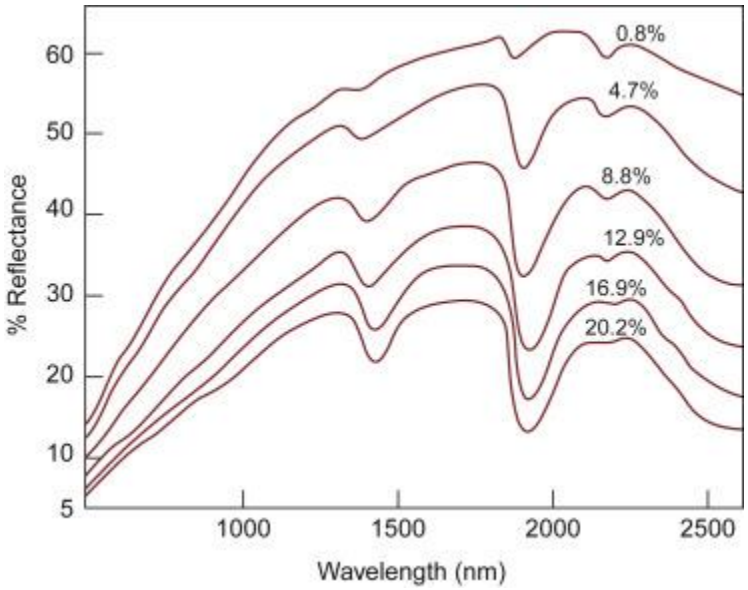
Soil needs only about 5% organic material to appear black when wet. Soil color is also a reflection of its age and the temperature and moisture characteristics of the climate. Cooler regions tend to have grayish to black topsoil due to the accumulation of humus. In moist, warm regions, soils tend to be more yellowish-brown to red depending on the hydration of ferric oxide and extensive weathering of the soil's parental mineral.

Rapid mineralization of the organic content in warm, moist regions means that humus accumulation is insufficient to have a major impact on soil color. Arid soils tend to be light in color (little staining from the low organic content) and primarily express the color of their mineral content.

Following rain, water temporarily darkens soil color by increasing light absorption. In addition, moisture can have long-term effects on soil color. For example, under anaerobic waterlogged conditions, iron oxides occur primarily in the ferrous state. These can give the soil a subtle bluish-gray tint. A mottled rusty or streaked appearance in a grayish matrix may indicate variably or improperly drained soils. A blackish color in the absence of organic material may indicate staining by manganese oxides.

Color influences the rate of soil warming in the spring and cooling in the fall. Dark soils, irrespective of moisture content, absorb more heat than do more reflective, light-colored soils (Oke, 1987). Soils of higher moisture content, being darker, absorb more solar radiation (Fig. 5.8) but warm more slowly than drier soils do.

This apparent anomaly arises from the high specific heat of water it consumes large amounts of energy during warming. Consequently, the surfaces of sandy and coarse soils both warm and cool more rapidly than do clayey soils of the same color. Rapid cooling (heat loss) from the soil at night can generate significant warming of the air and fruit close to the ground. Reflective ground cover can slow warming of the soil during the spring but moderate its decline during the fall. Analogous variation in daily soil temperature occurs under mulches (Whiting et al., 1993; see Fig 4.71). In contrast, plastic mulches often enhance early vineyard soil warming (Ballif and Dutil, 1975).



2.4.4. Assessing and recording salinity and sodicity

Assessing and recording salinity and sodicity in soil is crucial for understanding soil health and fertility. Here are some key points from the search results:

- **Visual assessment:** Visual assessment of salinity only provides a qualitative indication and does not give a quantitative measure of the level of soil salinity

- **Soil sampling**: Collect representative soil samples from different locations and depths to represent the overall soil population
- **Laboratory analysis:** Soil salt content can be measured in a laboratory by measuring the total dissolved solids in a sample
- **Electrical conductivity** (EC) is a common measure of soil salinity, and soil pH can be determined from the same extract.
- **Electrical conductivity:** The device used to measure salinity of water is an EC meter. With the right soil water mixtures, they can be used to measure salinity of soil as well
- **Sodicity assessment**: Sodicity, or sodium adsorption ratio (SAR), is a measure of the concentration of sodium ions in relation to the concentration of calcium and magnesium ions in soil. Sodic water is defined as having a SAR greater than 12
- **Monitoring:** Regular soil salinity monitoring is essential for understanding how saline the soil is at different depths and whether the salinity is increasing or not over time
- **Mapping:** Mapping salinity from measurements can be done using vehicle-mounted EM devices to measure points along transects, then analyze the results and map estimated salinity levels onto a farm plan. By following these steps, you can assess and record soil salinity and sodicity, providing valuable insights into soil health and fertility and guiding decisions to promote sustainable agriculture and environmental stewardship..

2.4.5. Assessing and recording sodicity

If the soil contains high amounts of exchangeable sodium, it is called sodic soil.

Soils with high sodium content tend to be very dense, and the root penetration of the plant is extremely difficult. This is caused from the sodium ions forming the soil plateletsinto compact structures.

Biocatalysts such as humic acid are highly effective in neutralizing the sodium content**.** Negatively charged humic acid molecules remove and segregate the positively charged ions, therefore the clay platelets (with negative charges across their face) repel each other. The platelets move apart from each other, loosening the soil structure, thus enabling water penetration.

The effect of salts on the crop growth is believed to be mainly osmotic in nature and hence related to total concentration rather than the concentration of individual ionic species. Two methods are commonly used for determination of salt concentration: total dissolved solid (TDS) and electrical conductivity (EC). The former method is accurate in the case of water free of bicarbonate. In the electrical method, EC of water sample is determined which is approximately proportional to the amount of salts present in the water.

Quality characteristics of irrigation water based on electrical conductivity

Class	EC(dsm^{-1})	Quality characterization
1	1.5	Extra fresh ,normal ,excellent ,very sweet ,non-saline, very high quality
2	1.5-3.0	Fresh ,slightly saline ,good, sweet, low salinity ,high quality
3	3.0-5.0	Brackish ,moderately saline ,fair ,medium salinity, marginal quality
4	5.0-10.0	Saline ,bad, low(poor)quality
5 6	10.0-15.0 15.0	Highly saline, very bad, very low quality Excessively saline ,highly bad, extremely low (poor)quality

The relationship among parameters (EC, SAR and RSC) on the basis of which water quality can be characterized

Class	EC(dsm^{-1})	SAR	RSC(meq/l0
A-Good	< 2.0	<10.0	< 2.5
B—Normal	2.4	<10.0	< 2.5
C-Sodic	< 4.0	>10.0	> 2.5
D-Marginal saline	4-8	<10.0	0
E-Poor	>4 .0	>10.0	>2.5

2.5.Analyzing results to identify trends and areas for improvement

The analysis of results to identify trends and areas for improvement in organic farming can be informed by various sources. Increased consumer demand for organic products has led to the growth of organic farming in more regions, with a wider range of retailers selling organic food and increased research and development (R&D) funds being allocated to organic agriculture

Additionally, recent reports emphasize the need for increased funding and support for organic research to address the unique challenges and opportunities in organic farming

. Furthermore, the harmonization and standardization of soil measurement data and analysis, as well as the development of new techniques and methods, are highlighted as essential steps to build a thriving marketplace that rewards farmers and to ease the analysis of soil data

By leveraging these insights and focusing on soil health, biodiversity, and sustainable practices, organic farmers can analyze their results to identify trends and areas for improvement, ultimately supporting the continued growth and success of organic farming.

Self-Check 2	Written test

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

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

1. Texture analysis is done by determining the percentage of sand, silt and clay in a given soil
2. If the soil contains high amounts of exchangeable sodium, it is called *sodic soil*.
3. The most widely used method for determining soil colors is comparison of soil samples with the color chips in the Munsell soil color charts.
4. fine textured soil has a larger total surface area than that of the coarse textured soil

Part II: Fill in the black space

1. **----------** is an analysis of the soil physical and chemical properties and an evaluation of the soil nutrient-supplying capacity at the time of sampling
2. **----------** is due to less water use by plants affected by soil acidity.

Part III: Short Answer Questions

1. List the Four main types of soil structure
2. Write the important organic matter
3. What are the advantages organic Farming
4. Mention the principles of organic farming

Operation Sheet 2	Soil texture analysis

Objectives

- Use proper lab techniques to determine percent sand, silt and clay of soil samples
- Determine soil texture category using information gathered in this exercise and the provided soil triangle

Hypothesis

- the commercial potting soil will have a loamy soil texture and will provide the best texture for growing plants

Materials

- sieve (2mm)
- balance
- sodium hexametaphosphate solution, 5%
- Para- film
- plastic sedimentation cylinder (1L)
- thermometer
- marking pen
- amyl alcohol (w/eyedropper)
- disposable plastic gloves
- blender
- graduated cylinder (100ml)
- hydrometer
- paper bags, small
- rinse bottles
- mortar and pestle

Procedure

1. Work in groups by lab table.
2. Each lab table will process one sample of soil (potting, fill or compost)
3. Obtain approximately 75g of your assigned soil.
4. Use the mortar and pestle to composite (mix thoroughly, removing coarse root material) the soil sample to a homogeneous mixture.

1. Pass the soil sample through a 2mm sieve.
2. Weigh both the **gravel** (the portion that does not pass through the sieve because the particles are >2.00mm) and the soil portion (the portion that did pass through the sieve because the particles are <2.0mm) of the sample.

Record this data in Table 1 and on the transparency (or blackboard).

3. Prepare dispersion as follows:

a. Place 50g of sieved soil (the portion that passed through the 2.0mm sieve) in a blender.

b. Add 100ml of 5% sodium hexametaphosphate solution.

C. Add enough distilled water to bring the level of the liquid up to the 950ml or 3 1/2 cup mark.

d. Blend for the following lengths of time depending on soil type:

1) Fill: 15 minutes

2) Compost: 10 minutes

3) Potting soil: 5 minutes

4. Transfer the dispersion to a sedimentation cylinder:

a. Pour the dispersion from the blender into a sedimentation cylinder.

b. Use a rinse bottle containing distilled water to wash the remnants of the dispersion from the blender into the sedimentation cylinder.

c. Add distilled water to fill the cylinder to the 1L mark.

5. Cover the top of the cylinder with Para film and mix the dispersion by holding your palm over the cylinder mouth and inverting repeatedly to create a suspension.

a. If the surface of the suspension becomes covered with foam, add one drop of amyl alcohol to the surface.

6. Place the hydrometer into the cylinder and begin recording time immediately (this is time = 0 seconds).

a. Record the hydrometer reading at time = 40 seconds, 15 minutes, 30 minutes, 45 minutes and 60 minutes.

b. Between each hydrometer reading, carefully remove the hydrometer, rinse with distilled water, and dry it.

c. Record your hydrometer reading in Table 1 and on the transparency (or blackboard).

d. After final reading, remove, clean and dry the hydrometer and return it to its box.

Data Analysis

1. Transfer all data from the transparency to your Table 1.

2. Determine the mean mass of the gravel and soil portions of each soil (based on two replicates of each) and record in Table 1 and on the transparency (or blackboard).

3. Determine the mean hydrometer reading at each time interval for each soil (based on two replicates of each) and record in Table 1 and on the transparency (or blackboard).

4. Using the mean hydrometer reading for each time interval for each soil and a "blank" reading provided by your instructor, determine and record in Table 1 and on the transparency (or blackboard) the corrected hydrometer reading using the following formula

a. If "blank" reading is <1.000: corrected hydrometer reading = actual hydrometer reading - (1.000 - "blank" hydrometer reading)

b. If "blank" reading is >1.000: corrected hydrometer reading= actual hydrometer reading + ("blank" hydrometer reading - 1.000)

c. The "blank" hydrometer reading was prepared using 900ml of distilled water and 100ml of sodium hexametaphosphate in a sedimentation cylinder within soil.

5. Determine the % gravel and %n soil for each sample based on the mean masses of the gravel and soil portions of the sample relative to the total mass.

Record this information in Table 2. Use the following formulae:% gravel = {(mass of gravel)/(mass of gravel + mass of sifted soil)} x 100% soil = {(mass of sifted soil)/(mass of gravel + mass of sifted soil)} x 100

C. For the soil portion of the sample, determine the % sand, % silt, and % clay for each soil type. Record this information in Table 2.

Use the following formulae: % sand 100 - ((corrected hydrometer reading at 40 sec X 100) / 50g) % clay = (corrected hydrometer reading at 60 min x 100) /50g % silt = 100 – (% clay + % sand)

D. Using the soil texture diagram provided below, determine the texture category for each soil type. To use this diagram, find the % clay, % sand and % silt for each soil on the appropriate side of the triangle and then follow an adjacent line toward the center of the diagram until the three lines meet. Read the soil texture category under the intersection of the three lines.

Operation Sheet 2	Soil Color determination

Soil exhibits a variety of colors. Soil color may be inherited from the parental material (i.e., lithocentric) or sometimes may be due to soil-forming processes (acquired or genetic color). The color of soil renders a valuable key for the identification of soil type.

Main Materials Required

The main materials required are:

I. a soil auger (for collection of soil sample)
II. a Munsell's soil color chart
III. a bucket for keeping the collected soil 1 × 10-L capacity
IV. One sheet of white foolscap paper
V. One 50 × 50 cm cardboard sheet.

Procedure

1. The soil sample is collected following the standard procedure.
2. The dried soil sample is spread uniformly over a cardboard sheet and is held directly behind the apertures separating the closest matching color chips.
3. The particles of the soil are matched with the color chips of Munsell's Soil Color Chart.
4. After matching the sample soil color with the color chips of Munsell's chart, the color name and the Munsell's notation are ascertained from the chart.
5. Field observations are recorded in the following table.

Locality ---------- Date---------- Time----------

Sample no	Hue	Value	Chroma	Color	Expression

LAP Test 2

Name……..ID……Date……..

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following task within **60** minutes. The project is expected from each student or in a group to do it.

Task1. Perform soil texture analysis

Task2. Perform soil color

LG #3	LO #3 Select and implement allowable techniques and inputs for organic farming

Instruction Sheet

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

- Identifying range of allowable inputs requirements of Organic and Biodynamic Produce based on the National Standard
- Identifying , evaluating and implementing Suitable nutrient cycling techniques
- Calculating appropriate inputs based on soil/plant analyses, crop removal and plant/animal observations.
- Selecting and managing cover crop and pasture systems
- Developing, applying and monitoring organic soil fertility improvement practices and cultural practices
- Designing and implementing cropping systems to improve soil fertility.

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:

- Identify range of allowable inputs requirements of organic and biodynamic produce based on the National Standard
- Identifying , evaluating and implementing Suitable nutrient cycling techniques
- Calculating appropriate inputs based on soil/plant analyses, crop removal and plant/animal observations.
- Selecting and managing cover crop and pasture systems
- Developing, applying and monitoring organic soil fertility improvement practices and cultural practices
- Designing and implementing cropping systems to improve soil fertility.

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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 3

3.1. Identifying range of allowable inputs requirements of Organic and Biodynamic Produce based on the National Standard

Continuous cropping without adequate restorative practices may endanger the sustainability of agriculture. Nutrient depletion is a major form of soil degradation. A quantitative knowledge on the depletion of plant nutrients from soils helps to understand the state of soil degradation and may be helpful in devising nutrient management strategies**.**

Nutrient-balance exercises may serve as instruments to provide indicators for the sustainability of agricultural systems.

The types of input and output data that are relatively easy to measure include flows of materials, such as fertilizer, manure, crop residues and harvested grains. Similarly, values for the export of nutrients in the harvested product are usually derived from secondary data relating to yields and nutrient contents in the harvested parts. Plant species reveal substantial variations in nutrient uptake. These depend on a number of factors such as

- Climate
- Soil properties
- Farmers' crop management. Export of nutrients in crop residues varies depending on residue management by the farmer, which differs greatly between and within countries.

3.1.1. Identifying Range of allowable input

Inputs can influence nutrient availability

(i) By the total nutrients added,

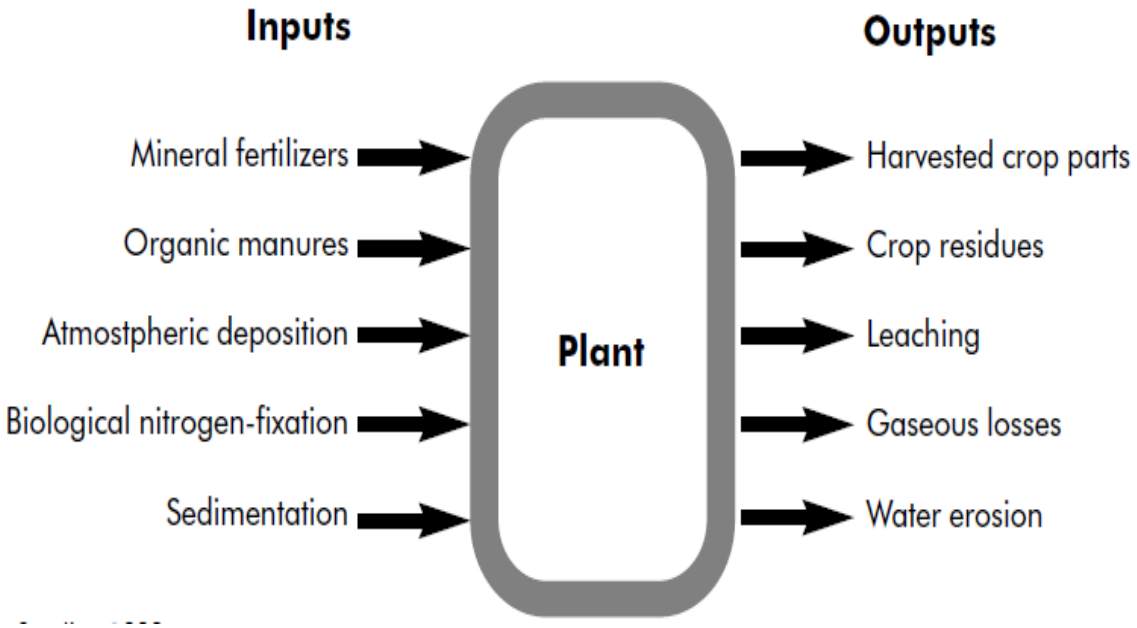
(ii) By controlling the net mineralization-immobilization patterns

(iii) As a source of C and energy to drive microbial activities

(iv) As precursors to SOM fractions,

(v) Through interactions with the mineral soil in complexing toxiccations and reducing the P sorption capacity of the soil.

In addition to these direct effects on nutrient availability, organic materials can affect root growth, pests, and soil physical properties that in turn influence nutrient acquisition and plant growth. The net effect of these different mechanisms on nutrient availability and plant growth differ with climatic regime, soil type, and quality and quantity of organic inputs.



Inputs such as manures, cover crops, and green manures have generally been assessed in terms of their N concentration; while relatively little attention has been paid to other macronutrients and micronutrients present. Organic inputs should be considered as complete fertilizers (N-P-K), perhaps the best being those containing or releasing the nutrients in the ratios and rates required by crops.

3.2. Identifying , evaluating and implementing Suitable nutrient cycling techniques

Soil stores, moderates the release of, and cycles nutrients and other elements. During these biogeochemical processes, analogous to the water cycle, nutrients can be transformed into plant available forms, held in the soil, or even lost to air or water. Nutrient cycling can be assessed by measuring the following indicators:

VII. Fertility Indicators

Including mineral nitrogen, potentially mineralizable nitrogen, soil nitrate, soil test phosphorus, potassium, sulfur, calcium, magnesium, boron, and zinc

i. Organic Matter Indicators

Including C:N ratio, decomposition, microbial biomass carbon, particulate organic matter, soil enzymes, soil organic matter, total organic carbon and total organic matter.

ii. Soil Reaction Indicators includes soil pH

Soil is the major "switching yard" for the global cycles of carbon, water, and nutrients. Carbon, nitrogen, phosphorus, and many other nutrients are stored, transformed, and cycled through soil.

Decomposition by soil organisms is at the center of the transformation and cycling of nutrients through the environment. Decomposition liberates carbon and nutrients from the complex material making up life forms-putting them back into biological circulation so they are available to plants and other organisms. Decomposition also degrades compounds in soil that would be pollutants if they entered ground or surface water.

The carbon cycle illustrates the role of soil in cycling nutrients through the environment. More carbon is stored in soil than in the atmosphere and above-ground biomass combined. Soil carbon is in the form of organic compounds originally created through photosynthesis in which plants convert atmospheric carbon dioxide (CO_2) into plant matter made of organic carbon compounds, such as carbohydrates, proteins, oils, and fibers. The organic compounds enter the soil system when plants and animals die and leave their residue in or on the soil. Immediately, soil organisms begin consuming the organic matter, extracting energy and nutrients and releasing water, heat, and CO_2 back to the atmosphere.

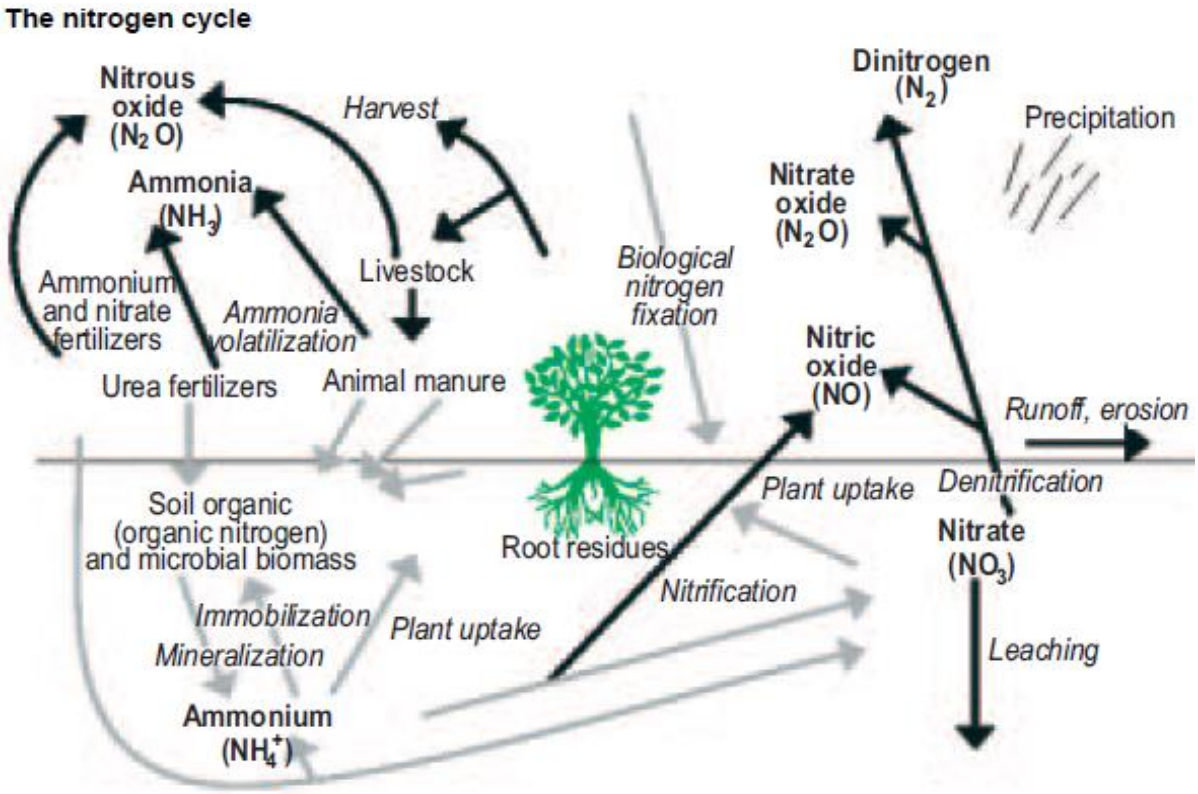
Nitrogen cycle

Nitrogen is an element essential in all organisms, occurring in proteins and other nitrogenous compounds, e.g. nucleic acids. Although organisms live in nitrogen-rich environments (78% of the atmosphere is nitrogen) the gaseous forms of nitrogen can only be used by certain organisms. Free nitrogen must first be fixed into a useable form.

Free nitrogen in the atmosphere is mainly fixed by two groups of bacteria, *Azotobacter* and *Clostridium*. The nitrogen is then used to manufacture proteins in their bodies, when they die, their proteins are broken down by decomposers (mainly bacteria and other micro-organisms), and converted into ammonia.

During electrical changes in the atmosphere (e.g. lightning), free nitrogen is fixed (combined) finally forming nitrate; nitrates are taken up by plants which use them to manufacture proteins; animals (herbivores) eat plants and convert plant proteins to animal proteins, while carnivores obtain their plant proteins by indirect means (by eating herbivores); when plants and animals die, the proteins in their bodies are broken down into ammonia by decomposers.

The process is known as ammonification; ammonia is converted to nitrites by nitrite bacteria (Nitrosomonas and Nitrosococcus). Nitrites are again converted to nitrates by nitrate bacteria (*Nitrobacter) this* process is known as nitrification; different types of bacteria are also able to break down nitrates, nitrites and ammonia which results in the release of nitrogen. This process is known as de-nitrification.

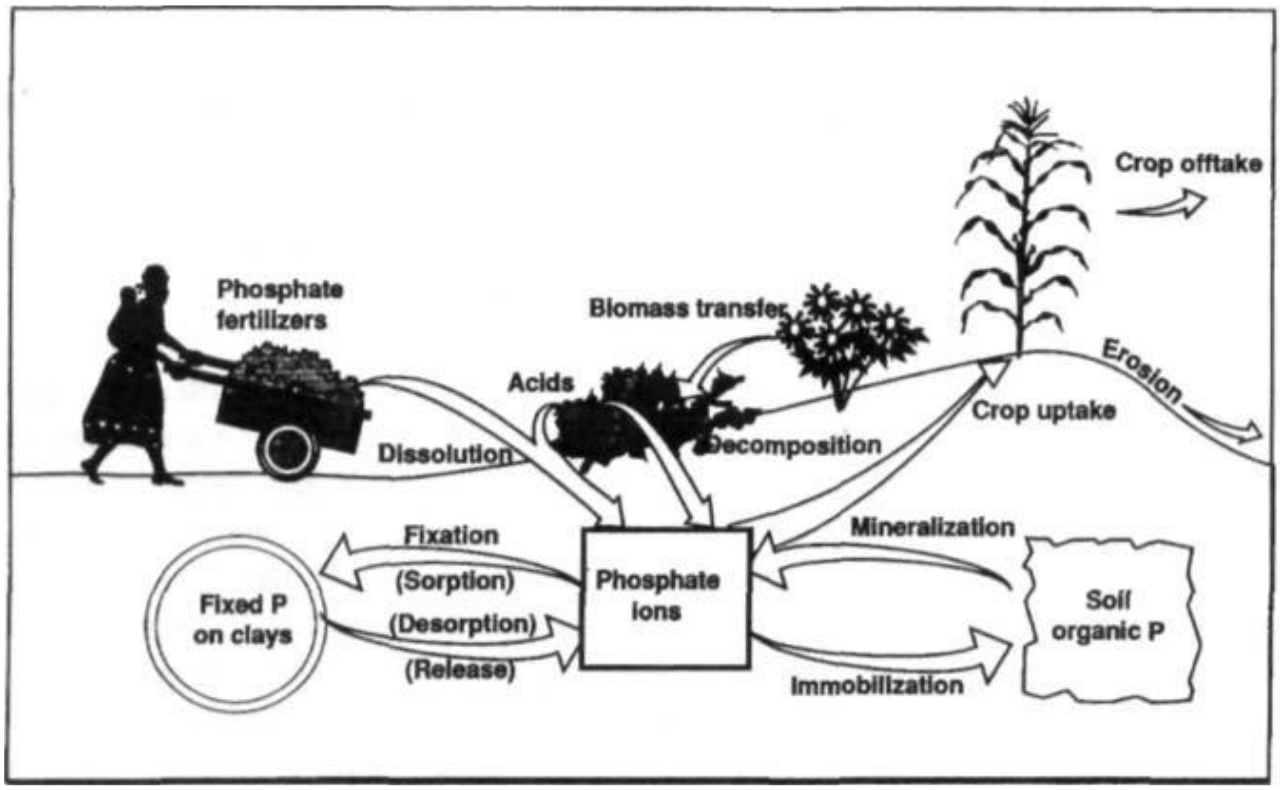


Figer1. Nitrogen cycle

Phosphorus cycle

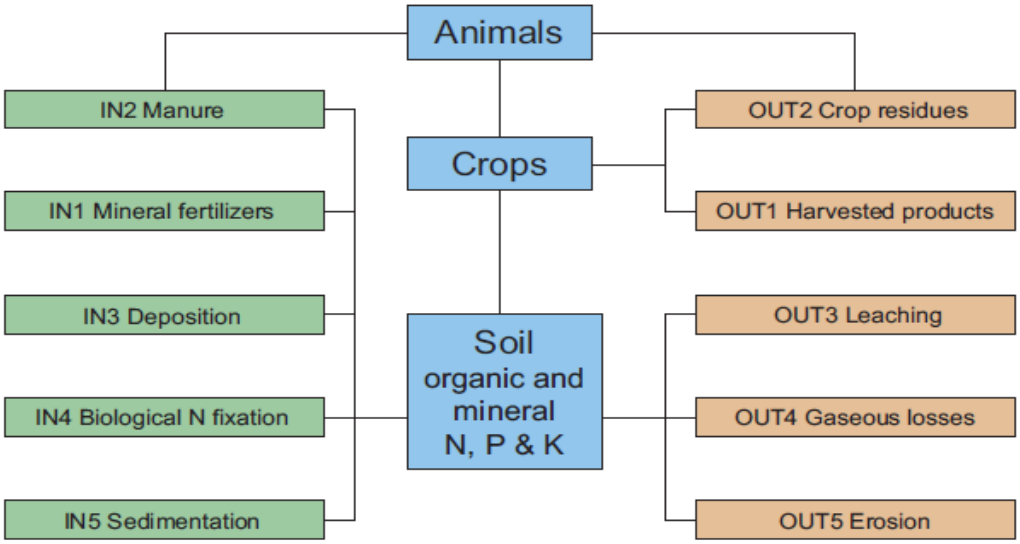
The phosphorus cycle differs from many other biogeochemical cycles because it does not involve the atmosphere in any significant way (although there is some evidence of an atmospheric component in the form of PH_3). Phosphorus and phosphorus-based compounds are usually solids at normal temperatures and pressures found on Earth, and any phosphorus in the atmosphere is usually only present in the form of dust particles.

Phosphorus - which is an essential nutrient - is usually found in the form of the phosphate ions (PO_4^{3-} and HPO_4^{2-}). It is an important component of nucleic acid molecules (DNA & RNA) and of the cellular energy carrier ATP. Phosphorus is also an important building block of bones and teeth, where it is found in the form of calcium phosphate.



Figer 2. Phosphorous cycle

3.3. Calculating appropriate inputs based on soil/plant analyses, crop removal and plant/animal observations.



$$OUT1 = \frac{\Sigma\ (area \times content \times yield)}{Total\ area}$$

$$OUT2 = \frac{\Sigma\ (area \times content \times yield)}{Total\ area} \times removal\ factor$$

OUT3 (N) = (0.0021 + 0.0007 × F) × R + 0.3 × (IN1 + IN2) - 0.1 × UN

Where:-

- *R*: rainfall (annual average, mm),
- *F*: soil fertility class (1 - low; 2 - moderate; 3 - high),
- IN1 + IN2: total application of fertilizer and manure
- UN: total uptake of N.

OUT4 (N) = 'Base' + 2.5 × F + 0.3 × (IN1 + IN2) - 0.1 × UN

Where:

- 'Base': a constant value, covering relative wetness of the soils
- *F*: soil fertility class (1 - low; 2 - moderate; 3 - high),
- IN1 + IN2: total application of fertilizer and manure.
- *UN*: total uptake of N.

3.4. Selecting and managing cover crop and pasture systems

A green cover is a type of organic mulch, only growing. They are referred to as green manures or cover crops when it is tilled back into the soil. Cover crops or green manures can be used as a soil management technique to increase soil fertility. Mainly it is used because it is cheaper than applying large amounts of compost. Tilling cover crops into poor, infertile soil over a period of years will return fertility to the soil and make it productive.

Some common cover crops are hairy vetch, alfalfa, clovers, annual rye or buckwheat or other annual grasses or legumes. It just takes a little longer than adding compost. Even tilling in a natural covering of weeds before their seed production has started will add to the soil.

If using cover crops to increase fertility, the soil should be tested to see if it is lacking in any minerals. Add the deficient minerals according to soil test recommendations. One drawback in arid regions to consider is whether your cover crops will be competing for the limited available moisture.

Cover crops are often seeded in fall as a winter cover. In addition to being used to increase soil fertility, cover crops prevent erosion, crowd out weeds, and return nitrogen to the soil**.** The deep-rooted grasses and legumes bring up minerals and nutrients from the subsoil.

3.5. Developing, applying and monitoring organic soil fertility improvement practices and cultural practices

Compost and mulch go hand in hand with any gardening project. Compost is a natural soil fertilizer, with built-in time release that adds valuable nutrients to the soil for healthy plant growth. Compost is made up of organic matter (food, leaves) that has been broken down by insects and bacteria to create humus, a rich dark material that looks like soil. Mulch is created from a number of natural materials (wood chips, compost, leaves), and is used to control weed growth, retain soil moisture, provide winter protection and add organic matter to the soil.

3.5.1. Mulching

A layer of mulch will: help prevent the germination of weed seeds and reduce the need for weeding; moderate soil temperature and keep plant roots cool; retain soil moisture and reduce the frequency of watering; protect the soil from crusting and erosion caused by rain and wind; and provide winter protection for sensitive and shallow-rooted plants. Mulch can be divided into organic and in organic mulches. *Organic mulches,* including wood chips, bark, cocoa bean hulls, leaves, and leaf mold, compost and grass clippings help to improve the soil by adding organic matter and nutrients as they decompose. Inorganic mulches, such as crushed stone, plastic and landscape fiber are generally used in more permanent locations such as paths. They are not

recommended for gardens since they do not add any beneficial nutrients to the soil: can be difficult to install and remove, and can limit the growth of self-seeding wildflowers.

3.5.2. Composting systems

Composting converts kitchen and garden waste into dark colored soil that is high in nutrients. Composting is the name given to a method of breaking down organic waste, usually in a container or heap. Decomposition occurs due to the action of naturally occurring bacteria and fungi. Small creatures, such as earthworms and millipedes help to complete the process.

Requirements for Efficient Decomposition

Efficient decomposition occurs if aeration, moisture, particle size, and nutrient levels (nitrogen) are maintained for optimum microbial activity.

i. Aeration

Oxygen is required for microbes to decompose organic wastes efficiently. Some decomposition occurs in the absence of oxygen ***(***anaerobic conditions); however, the process is slow, and foul odors may develop.

ii. **Moisture**

Adequate moisture is essential for microbial activity. Dry compost will not decompose efficiently. Proper moisture encourages the growth of microorganisms that break down the organic matter into humus.

iii. Particle Size

Grinding the organic material before composting greatly reduces decomposition time. The smaller the size of an organic refuse particle, the more quickly the microbes can consume it.

iv. Temperature

Temperature of the compost pile is very important to the biological activity taking place. Low outside temperatures slow the activity down, while warmer temperatures speed up decomposition.

Composting precautions

Compost is produced from natural materials and contains a variety of living organisms. On rare occasions, these organisms have been associated with illness and allergies in humans. For health reasons, it is important to:

- Wash your hands after handling compost.
- Protect broken skin by wearing gloves.
- Avoid handling compost in confined spaces.
- Keeps compost moist to prevent spores or bacteria becoming air borne

3.6. Designing and implementing cropping systems to improve soil fertility.

The practice of growing different kinds of crops, one at a time, in a definite sequence on the same piece of land is referred to as crop rotation**.** In designing a good crop rotation, the farmer must decide what crops to have in the rotation, in what sequence the crops should occur, and for how many years or season each cycle of the rotation must run.

Factors that affect crop rotation

The choice of a rotation for a particular farm depends upon the following:

- Adaptation of the crops to a particular soil, climate, and economic conditions.
- Prevalence of weeds, plant diseases, and insect pests may also limit the kinds of crops that can be grown in a locality.
- Crops may be selected for rotation so as to spread labor throughout the year.

Factors to consider in deciding the sequence of crops (principles of crop rotation)

I. The target crop (the main crop) should be planted immediately after the legumes or fallow period.

II. Crops which are deep feeders should alternate with shallow feeders.

III. Crops that are botanically similar or are likely to be attacked by the same diseases and pests should not normally follow each other in the rotation.

The number of years for which each cycle of the rotation should run is determined by the number of crops in the rotation, the length of their growing seasons and how frequent the farmer can grow the target crop without running into problems of disease and soil fertility

3.7. Selecting and implementing Cultural practices to enhance soil fertility

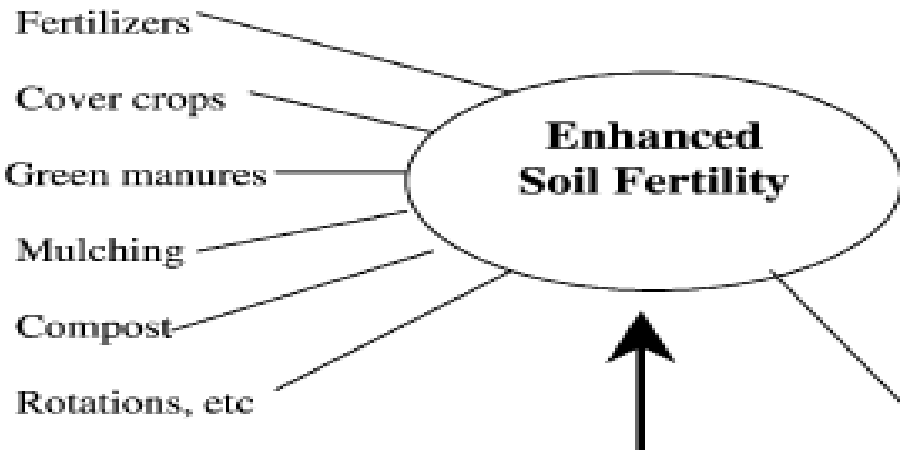
Compost is used as an organic amendment to improve physical, chemical and biological properties in the soil. Adding compost will increase the moisture-holding capacity of sandy soils, thereby reducing drought damage to plants. When added to heavy clay soils, compost improves drainage and aeration and reduced water logging damage to plants. Compost increases the ability of the soil to hold and release essential nutrients. The activity of earthworms and soil microorganisms beneficial to plant growth is promoted with compost additions. Other benefits of adding compost include improved seedling emergence and water infiltration due to a reduction of soil crusting.

Over time, yearly additions of compost create a desirable soil structure, making the soil much easier to work. For improving soil physical properties, add and incorporate one to two inches of well-decomposed compost in the top six to eight inches of soil. Use the lower rate for sandy soils and the higher rate for clay soils. To a limited extent, compost is a source of nutrients.

Mulch provides many benefits to the soil.

- Conserves moisture by slowing evaporation.
- Slowly creates topsoil through the decomposition of the organic matter. This is a slow process of soil building.
- Maintains even soil temperature, cooler in the summer, warmer in the winter and a more even temperature from dawn to dusk.
- Prevents soil crusting and increases water in-soak and aeration.
- Helps stops soil erosion by holding it in place.
- Prevents heavy rain from splashing soil on the lower leaves of plants, keeping the pores open.
- Helps prevent compaction on walkways throughout the garden and beds.
- Helps feed and increases the beneficial soil life at the surface.

Generally, cultural practices to enhance soil fertility include the following:



Self-Check 3	Written Test

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

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

1. Mulch slowly creates topsoil through the decomposition of the organic matter?
2. Yearly additions of compost create a desirable soil structure, making the soil much easier to work
3. **T**he choice of a rotation for a particular farm depends upon the adaptation of the crops to a particular soil, climate, and economic conditions.
4. Fertility Indicators including mineral nitrogen, potentially mineralizable nitrogen, soil nitrate, soil test phosphorus, potassium, sulfur, calcium, magnesium, boron, and zinc

Part II: Short Answer Questions

1. What is nutrient cycling?
2. How soil fertility can be enhanced?
3. What are cover crops?
4. How aeration affects composting?
5. Mention soil inputs and out puts?

Part III: Fill in the blank space

I. ----------is used as an organic amendment to improve physical, chemical and biological properties in the soil

II. Ammonia is converted to nitrites by nitrite bacteria (Nitrosomonas and Nitrosococcus). Nitrites are again converted to nitrates by nitrate bacteria (*Nitrobacter) this* process is known as _____

III. ---------- Include C:N ratio, decomposition, microbial biomass carbon, particulate organic matter, soil enzymes, soil organic matter, total organic carbon and total organic matter.

LG #4	LO #4 Implement, monitor and evaluate organic farming activities

Instruction Sheet

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

- Developing and implementing principles of organic farming program
- Identifying and implementing essential characteristics of organic farming
- Monitoring and implementation program and results in terms of soil biodiversity to industry practice.
- Reviewing and refining organic farming program to ensure it responsive changing conditions
- Taking, documenting and reporting remedial action to improve organic farming production

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:

- Develop and implement principles of organic farming program
- Identify and implement essential characteristics of organic farming
- Monitor implement program and results in terms of soil biodiversity to industry practice.
- Review and refine organic farming program to ensure it is responsive to changing conditions
- Take, document and report remedial action to improve organic farming production

Learning Instructions:

5. Read the specific objectives of this Learning Guide.
6. Follow the instructions described below.
7. Read the information written in the information Sheets
8. Accomplish the Self-checks
9. Perform Operation Sheets
10. Do the “LAP test”

Information Sheet 4

4.1. Developing and implementing of organic farming program

Developing and implementing an organic farming program involves several key steps, which can be guided by research, government regulations, and best practices in the field. Here are some important aspects to consider:

I. Understand the principles of organic farming: Familiarize yourself with the four basic principles of organic farming: health, ecology, fairness, and care. These principles guide the development and implementation of organic farming practices.

II. Develop a farm plan: Create a detailed plan outlining your organic farming goals, target markets, production methods, and management practices. This plan should also include information on soil and water conservation, waste management, and integration with other farm enterprises.

III. Obtain certification: To be considered organic, farms must undergo a rigorous certification process, which includes inspections, documentation, and verification of compliance with standards set by the USDA or other relevant regulatory bodies

IV. Implement sustainable practices: Organic farming relies on environmentally friendly practices to maintain soil health, promote biodiversity, and reduce reliance on synthetic inputs. Some key practices include crop rotation, soil conservation techniques, cover cropping, composting, green manure, and biological pest and disease management.

V. Monitor and adjust: Regularly monitor your farm's performance, tracking metrics such as soil health, crop yield, and pest and disease management. Use this data to adjust your practices and make improvements as needed to ensure the long-term success of your organic farming program.

VI. Educate and engage with stakeholders: Build relationships with customers, suppliers, and other stakeholders to communicate the benefits of organic farming and address any concerns or questions they may have

VII. Stay informed and adapts: Keep up-to-date with the latest research, regulations, and best practices in organic farming. Be prepared to adapt your practices and strategies to stay competitive and successful in the organic marketplace.

By following these steps, you can develop and implement a robust organic farming program that promotes sustainable agriculture, supports environmental stewardship, and provides high-quality, organic products to consumers.

4.2. Identifying and implementing essential characteristics of organic farming

Identifying and implementing essential characteristics of organic farming involves adhering to a set of principles and practices that promote sustainable agriculture, protect the environment, and enhance soil health. Some of these essential characteristics include:

Environment-friendly approach: Organic farming aims to protect water, air, and soil from chemical pollution while maintaining ecological balance

I. Natural processes: Organic farming relies on natural processes and materials for soil fertility, crop nutrition, pest and weed management, and conservation of biological diversity
II. Soil health: Maintaining and enhancing soil and water quality is crucial for organic farming. This can be achieved through practices such as crop rotation, soil conservation techniques, cover crops, and composting, conservation of wetlands, woodlands, and wildlife: Organic farming promotes the preservation of wetlands, woodlands, and wildlife habitats, contributing to biodiversity conservation
III. Avoidance of synthetic inputs: Organic farming prohibits the use of synthetic fertilizers, sewage sludge, irradiation, and genetic engineering
IV. Crop rotation: This practice helps maintain soil health, prevent erosion, and increase crop yield
V. Reduced tillage: Organic farming often involves less intensive tillage, such as no-till or reduced-till methods, to conserve soil organic matter and reduce soil erosion
VI. Mulching: Organic mulches, such as straw or compost, can reduce the need for synthetic fertilizers and help retain soil moisture

VII. Natural pest and disease control: Organic farming emphasizes the use of biological pest and disease control methods, such as crop rotation, mechanical cultivation, and the introduction of beneficial predators and parasites

VIII. Pasture livestock: Organic farming requires that livestock be pastured and fed with organic feed, and livestock waste must be used as a fertilizer for plants

By implementing these essential characteristics, organic farming systems can promote sustainable agriculture, protect the environment, and provide high-quality, organic products to consumers.

Main concepts behind organic farming

Organic farming is based upon the integrated biodiversity sustainable agricultural system, which means that soil health is connected with animals, plants, humans, and their economic activities, so we must use such farming techniques which are environment friendly and safe for soil structure, soil quality, animals, plants as well humans life and health.

4.2.1. Characteristics of organic farming

- Environment-friendly way of farming
- Protect water, air, and soil from chemical pollution
- Maintain ecological balance
- Use natural ways to increase agricultural production
- Best opportunity for farmers to become self-sufficient
- Minimum investment is required
- Maximum use of local material
- Long term good health effects on land
- Maintain soil fertility
- Food produced from organic farming has good quality and exotic taste

4.2.2. Need of organic farming

Organic farming is the necessity of this era because humans have depleted soil, air, and water quality with the excessive use of chemicals. With the massive increase in human population, the demand for food has rapidly increased and farmers used high yield variety seeds to get maximum production. They used chemical fertilizers to maintain the nutrient balance of the soil and to get maximum output. They used pest and insect killers to avoid diseases or insect attacks on agricultural products. So air has been polluted from chemical sprays.

Soil yield has decreased due to repetitive production of crops and it became toxic. Underground and freshwater sources have become polluted and unhealthy for consumption, so the solution to all these problems is associated with natural farming practices. Organic farming has long-term environmental, economic, and social benefits. It can naturally enhance soil fertility. Farmers use those methods which can control diseases and pest attack without damage to the natural environment. Agricultural output is cost-effective and of supreme quality.

4.2.3. Benefits of organic farming

- Organic farming can protect land from degradation
- Biodegradable natural fertilizers are only used in organic farming
- High yield soil is achieved
- Protect soil from washed away during ploughing and heavy rainfall
- Organic foods are rich in nutrients
- Soil productivity can increase

How to start organic farming?

Organic farming can be practiced at small landholdings and does not require a large farm size. For watering the crop, rainwater and groundwater must be available. No need for an artificial supply of water to the fields.

Groundwater and soil quality must be tested in a laboratory. Organic fertilizers manure and food must be available. Seeds must be chemical-free. The farmer must decide about the crop he wants to grow or the animal he wants to raise organically.

4.3. Monitoring implementation program and results in terms of soil biodiversity to industry practice.

Monitoring the implementation program and results in terms of soil biodiversity to industry practice involves the development and implementation of a comprehensive monitoring plan. This plan should include the collection of data to assess the impacts of agricultural practices on soil biodiversity.

The monitoring plan should also involve the assessment of the effectiveness of industry practices in promoting soil biodiversity. Additionally, it is important to develop measurable goals and objectives and use appropriate core indicators to measure soil biodiversity performance across agricultural operations.

The monitoring plan should enable the detection of changes towards favorable conditions for soil biodiversity as a consequence of implementation of industry practices. Furthermore, the plan should involve in-depth sampled monitoring beyond the scope of certification audits, and the focus should lie on monitoring reductions of negative impacts on soil biodiversity and the creation of potentials for more biodiversity on the farm and its surrounding areas. By following these guidelines and developing a robust monitoring plan, industry practitioners can effectively assess and improve their impact on soil biodiversity.

4.4. Reviewing and refining organic farming program to ensure it responsive changing conditions

To ensure soil and plant nutrient program that you have planned, to implement it is necessary to review and refine as if it is responsive to changing conditions.

You may simply ask yourself question like:

- Is it the plan bring change or not?
- Is it the plan improve the soil health problems?
- Is it the plan solve plant nutrition problem?
- Is the plan appropriately meeting our objective requirements?

By answering those question you can review and refine the program

4.5. Taking, documenting and reporting remedial action to improve organic farming production

4.5.1. Taking remedial action to improve organic farming

Taking remedial action to improve organic farming involves implementing various strategies and practices that promote sustainable agriculture, protect the environment, and enhance soil health. Some of these practices include:

I. Soil health and management: Maintaining and enhancing soil quality is crucial for organic farming. This can be achieved through practices such as crop rotation, soil conservation techniques, cover crops, and composting
II. Crop rotation: Rotating crops between plant families helps prevent soil erosion, build organic matter, fix nitrogen, and increase farm biodiversity
III. Soil fertility: Organic farming relies on natural processes and materials for soil fertility, such as compost, green manure, and biological fertilizers
IV. Pest and disease management: Organic farming emphasizes the use of natural pesticides and biological control methods, such as the 'PAMS' strategy (Predict, Avoid, Minimize, and Sustain)
V. Water management: Organic farming aims to improve water use efficiency and nutrient cycling by reducing reliance on synthetic fertilizers and promoting sustainable water practices
VI. Biodiversity: Maintaining and enhancing biodiversity is essential for organic farming, as it contributes to soil health, pollinator conservation, and pest management

VII. Fertilizers: Organic farming relies on natural fertilizers, such as compost, green manure, and animal waste, to promote soil health and fertility

VIII. Weed management: Organic farming practices, such as crop rotation and mechanical cultivation, help control weeds and maintain a healthy balance in the ecosystem

By implementing these practices, organic farming can contribute to a more sustainable and environmentally friendly agricultural system that promotes healthy crop production and improves soil health

4.5.2. Documenting remedial action to improve organic farming

Documenting remedial action to improve organic farming involves implementing various strategies and practices that promote sustainable agriculture, protect the environment, and enhance soil health. Some key practices to document and consider include:

- Soil Health and Management**:-** Documenting practices such as crop rotation, soil conservation techniques, cover cropping, and composting to maintain and enhance soil quality
- Fertility Management**:** Recording the use of organic fertilizers, compost, and green manure to promote soil fertility and crop nutrition
- Pest and Disease Management: Documenting the use of natural pesticides, crop rotation, and biological control methods to manage pests and diseases sustainably
- Biodiversity Conservation: Recording practices that promote and enhance biodiversity, such as sustainable weed and pest management approaches.
- Water Management: Documenting practices that improve water use efficiency, prevent soil erosion, and enhance nutrient cycling
- Compliance and Recordkeeping: Maintaining detailed records of all practices, inputs, and management activities to ensure compliance with organic farming standards and for future reference. By documenting these practices, organic farmers can track their remedial actions, ensure compliance with organic standards, and contribute to the long-term sustainability of their farming operations.

4.5.3. Reporting remedial action to improve organic farming

To report remedial action to improve organic farming, it is important to document the practices and strategies implemented to promote sustainable agriculture, protect the environment, and enhance soil health. This documentation can include practices such as crop rotation, soil conservation techniques, cover cropping, composting, natural pest and disease control, and biodiversity conservation

Additionally, it is important to monitor the implementation of these practices and track their effectiveness in improving soil biodiversity and other key metrics. This monitoring can involve the collection of data on soil health, crop yield, pest and disease management, and other relevant factors. By documenting and reporting on these practices and their outcomes, organic farmers can demonstrate their commitment to sustainable agriculture and contribute to the growth and success of the organic farming industry.

How can we improve organic farming?

To improve organic farming, several key practices and characteristics can be implemented:

- Environment-friendly approach: Organic farming is an environmentally friendly way of farming that protects water, air, and soil from chemical pollution and maintains ecological balance
- Soil health and biodiversity: Organic farming methods, such as composting, mulching, and the use of bio-fertilizers, promote healthy crop growth and soil richness, leading to better biodiversity and improved soil systems
- Avoidance of synthetic inputs: Organic farming works in harmony with nature by avoiding the use of synthetic fertilizers, GMOs, or pesticides, and instead, relies on natural processes and materials to support the cycling of on-farm resources and conserve biodiversity
- Water and nutrient management: Organic farming practices aim to improve water use efficiency, nutrient cycling, and finding alternative nutrient resources to replace chemical fertilizers.

- Research and innovation: Continued research and innovation are necessary to explore new agro ecological approaches, technologies, and production methods that can increase crop production and quality in organic farming, while also improving soil fertility, conserving natural resources, and preventing phenomena such as soil erosion and soil organic carbon loss By implementing these practices and characteristics, organic farming can be improved to meet the growing demand for environmentally friendly and sustainable food production.

Self-Check 4	Written Test

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

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

1. Biodegradable natural fertilizers are only used in organic farming
2. Review and refine is necessary to ensure soil and plant nutrient program that you have planned, to implement it.
3. Organic farming can be practiced at small landholdings and does not require a large farm size.
4. Environment-friendly way of farming is one of the characteristics of organic farming
5. Organic farming is a natural way of crop production and livestock rising
6. Organic farming has long-term environmental, economic, and social benefits.

Part II: Short Answer Questions

1. List the characteristics of organic farming
2. What types of fertilizers are used in organic farm production and list them?

Test 3: Fill in the blank space

1. ---------- is a natural way of crop production and livestock rising?
2. ---------- is the necessity of this era because humans have depleted soil, air, and water quality with the excessive use of chemicals

LG #5	LO #5 Maintain quality standard of the products of organic farming

Instruction Sheet

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

- Implementing organization guideline to confirm organic farming principles
- Maintaining production processes to ensure soil biodiversity
- Labeling products properly to ensure the correct design specifications
- Archiving adequate documentation of operation, to ensure accredited certification

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:

- Implement organization guideline to confirm organic farming principles
- Maintain production processes to ensure soil biodiversity
- Label products properly to ensure the correct design specifications
- Archive adequate documentation of operation, to ensure accredited certification

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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the "LAP test"

Information Sheet 5

5.1. Implementing organization guideline to confirm organic farming principles

Amidst nutrition facts, ingredient lists, and dietary claims on food packages, "organic" might appear as one more piece of information to decipher when shopping for products. Understanding what the organic label means can help shoppers make informed purchasing choices.

Organic is a labeling term found on products that have been produced using cultural, biological, and mechanical practices that support the cycling of on-farm resources, promote ecological balance, and conserve biodiversity. The National Organic Program – part of USDA's Agricultural Marketing Service – enforces the organic regulations, ensuring the integrity of the USDA Organic Seal.

In order to make an organic claim or use the USDA Organic Seal, the final product must follow strict production, handling and labeling standards and go through the organic certification process. The standards address a variety of factors such as soil quality, animal raising practices, and pest and weed control. Synthetic fertilizers, sewage sludge, irradiation, and genetic engineering may not be used.

Organic producers rely on natural substances and physical, mechanical, or biologically based farming methods to the fullest extent possible. Organic produce must be grown on soil that had no prohibited substances (most synthetic fertilizers and pesticides) applied for three years prior to harvest. As for organic meat, the standards require that animals are raised in living conditions accommodating their natural behaviors, fed organic feed, and not administered antibiotics or hormones.

There are four distinct labeling categories for organic products–100 percent organic, organic, "made with" organic ingredients, and specific organic ingredients.

In the "100 Percent Organic" category, products must be made up of 100 percent certified organic ingredients. The label must include the name of the certifying agent and may include the USDA Organic Seal and/or the 100 percent organic claim.

In the “Organic” category, the product and ingredients must be certified organic, except where specified on National List of Allowed and Prohibited Substances. Non-organic ingredients allowed per the National List may be used, but no more than five percent of the combined total ingredients may contain non-organic content. Additionally, the label must include the name of the certifying agent, and may include the USDA Organic Seal and/or the organic claim.

For multi-ingredient products in the “made with” organic category, at least 70 percent of the product must be certified organic ingredients. The organic seal cannot be used on the product, and the final product cannot be represented as organic – only up to three ingredients or ingredient categories can be represented as organic. Any remaining ingredients are not required to be organically produced but must be produced without excluded methods (genetic engineering). All non-agricultural products must be allowed on the National List. For example, processed organic foods may contain some approved non-agricultural ingredients, like enzymes in yogurt, pectin in fruit jams, or baking soda in baked goods.

Multi-ingredient products with less than 70 percent certified organic content would fall under the “specific organic ingredients,” and don’t need to be certified. These products cannot display the USDA Organic Seal or use the word organic on the principal display panel. They can list certified organic ingredients in the ingredient list and the percentage of organic ingredients.

Becoming familiar with organic labeling allows consumers to make informed decisions about the products they purchase. Consumers can be assured that the integrity of USDA organic products is verified from farm to market. You can learn more about organic labeling by visiting: Labeling Organic Products.

5.2. Maintaining production processes to ensure soil biodiversity

Crop Standards

The organic crop production standards require that:

- Land must have had no prohibited substances applied to it for at least 3 years before the harvest of an organic crop.
- Soil fertility and crop nutrients will be managed through tillage and cultivation practices, crop rotations, and cover crops, supplemented with animal and crop waste materials and allowed synthetic materials.
- Crop pests, weeds, and diseases will be controlled primarily through management practices including physical, mechanical, and biological controls. When these practices are not sufficient, a biological, botanical, or synthetic substance approved for use on the National List may be used.
- Operations must use organic seeds and other planting stock when available.
- The use of genetic engineering, ionizing radiation and sewage sludge is prohibited.

5.3. Labeling products properly to ensure the correct design specifications

What do the organic product labeling rules cover?

Covers wording allowed on both the front panel and the information panel of a packaged product:

- **Principal display panel (PDP):** portion of the package most likely to be seen by customers at the time of purchase
- **Information panel (IP):** includes ingredient statement (list of ingredients contained in a product, from highest to lowest percentage of final product) and other product information
- **View complete rules** in the "Product Composition" section of the USDA organic regulations

What do the four different organic labels mean?

"100 Percent Organic"

- Used to label any product that contains 100 percent organic ingredients (excluding salt and water, which are considered natural)
- Most raw, unprocessed or minimally processed farm crops can be labeled "100 percent organic"
    - **PDP:** May include USDA organic seal and/or 100 percent organic claim
    - **IP:** Identify organic ingredients (e.g., organic dill) or via asterisk or other mark

"Organic"

- Any product that contains a minimum of 95 percent organic ingredients (excluding salt and water)
- Up to 5 percent of ingredients may be nonorganic agricultural products and/or nonagricultural products on the National List (nonorganic agricultural products and several nonagricultural products on the National List may only be used if they are not commercially available as organic)
    - **PDP:** May include USDA organic seal and/or organic claim
    - **IP:** Identify organic ingredients (e.g., organic dill) or via asterisk or other mark

"Made with Organic _____"

- Product contains at least 70 percent organically produced ingredients (excluding salt and water), with a number of detailed constraints regarding ingredients that comprise the nonorganic portion
    - **PDP:** May state "made with organic (insert up to three ingredients or ingredient categories)"; must not include USDA organic seal anywhere, represent finished product as organic, or state "made with organic ingredients"
    - **IP:** Identify organic ingredients (e.g., organic dill) or via asterisk or other mark

Specific organic ingredient listings

- Specific organic ingredients may be listed in the ingredient statement of products containing less than 70 percent organic contents—for example, “Ingredients: water, barley, beans, organic tomatoes, salt.”
  - **PDP:** Must not include USDA organic seal anywhere or the word “organic”
  - **IP:** May only list certified organic ingredients as organic in the ingredient list and the percentage of organic ingredients; remaining ingredients not required to follow the USDA organic regulations

The handling standards require:

- All non-agricultural ingredients, whether synthetic or non-synthetic, must be included on the National List of Allowed Synthetic and Prohibited Non-Synthetic Substances.
- In a multi-ingredient product labeled as “organic,” all agricultural ingredients must be organically produced, unless the ingredient(s) is not commercially available in organic form and listed on Section 205.606.
- Handlers must prevent the commingling of organic with non-organic products and protect organic products from contact with prohibited substances. Labeling Multi-Ingredient Products
- Products sold; labeled, or represented as organic must have at least 95 percent certified organic content.
- Products sold, labeled, or represented as “made with” organic must have at least, 70 percent certified organic content.
- Products containing less than 70 percent organic content may identify specific ingredients as organic in the ingredients list.

5.4. Archiving adequate documentation of operation, to ensure accredited certification

To archive adequate documentation of operations and ensure accredited certification, organizations should follow several guidelines:

I. Create and maintain documentation**:** Develop and maintain proper documentation to support the organization's business needs, including records management, policies, and procedures
II. Electronic records management: Implement electronic recordkeeping solutions to manage and store digital materials, ensuring that they are accessible, secure, and well-organized
III. Preservation and access: Maintain written documentation of decisions, actions taken, and preservation metadata logged, stored, and linked to pertinent digital objects
IV. Audit and certification: Conduct regular self-assessments and, if certified, notify certifying bodies of operational changes that will affect the organization's accreditation status
V. Compliance with standards: Adhere to relevant industry standards, such as the TRAC Metrics for Trustworthy Repositories Audit & Certification, to ensure that the organization's documentation and practices meet established criteria
VI. Regular review and updates: Periodically review and update the organization's documentation and practices to ensure they remain relevant and effective in supporting the organization's accredited certification. By following these guidelines, organizations can effectively archive adequate documentation of their operations and ensure their accredited certification.

Self-Check 5	Written Test

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

Part I. Write True if the statement is correct and false if the statement is incorrect

1. There are four distinct labeling categories for organic products
2. Products containing less than 70 percent organic content may identify specific ingredients as organic in the ingredients list.
3. Any product that contains a minimum of 95 percent organic ingredients (excluding salt and water)
4. The use of genetic engineering, ionizing radiation and sewage sludge is prohibited in organic crop production
5. Organic producers rely on natural substances and physical, mechanical, or biologically based farming methods to the fullest extent possible

Part II .Short Answer question

1. List four distinct labeling categories for organic products?
2. What are the four distinct labeling categories for organic product?

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LG #6	LO #6 Document organic farming program

Instruction Sheet

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

- Establishing detailed plan, objectives, specifications and associated costs program requirements
- Developing and documenting detailed procedures and schedules program on-site
- Recording production and soil data for future planning and intervention

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:

- Establishing detailed plan, objectives, and specifications and associated costs program requirements.
- Develop and document detailed procedures and schedules program on-site
- Record production and soil data for future planning and intervention

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
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 6

6.1. Establishing detailed plan, objectives, and specifications and associated costs program requirements

To establish a detailed plan, objectives, and specifications, along with associated costs for an organic farming program, you can follow these steps:

- Develop a business requirements document: This document should include an executive summary, project objectives, project scope, stakeholders, SWOT analysis, financial statements, functional requirements, schedule and deadlines, and cost-benefit analysis
- Project planning: During the project planning phase, define the scope of the project using a work breakdown structure (WBS) and estimate costs, quality, and resources. Identify risks and assumptions that could affect the project and create a risk management plan
- Functional specifications document: This document should describe all external user and programming interfaces that the product must support, including project scope, risks and assumptions, product overview, and use cases
- Budget planning: Specify the budgeted cost to be incurred at the completion of the project, taking into account staff, resources, and equipment requirements
- Procurement planning: Focus on vendors outside your company and plan for procurement activities, as well as contracting any third-party suppliers
- Project management: Implement a project management methodology to track progress, manage risks, and ensure that the project stays on time and within budget. This methodology should include a project scope statement, risk management plan, change management plan, cost management plan, resource management plan, and stakeholder management plan. By following these steps, you can establish a comprehensive plan, objectives, and specifications, along with associated costs for your organic farming program, ensuring that the project is well-organized and on track for success.

Additionally, you can refer to the guidelines and requirements set by relevant regulatory bodies, such as the National Organic Program (NOP) in the United States, to ensure that your program meets the necessary standards and requirements for organic certification

6.2..Developing and documenting detailed procedures and schedules program on-site

To develop and document detailed procedures and schedules for an on-site organic farming program, you can follow these steps:

- Develop a business requirements document: This document should include an executive summary, project objectives, project scope, stakeholders, SWOT analysis, financial statements, functional requirements, schedule and deadlines, and cost-benefit analysis
- Project planning: During the project planning phase, define the scope of the project using a work breakdown structure (WBS) and estimate costs, quality, and resources. Identify risks and assumptions that could affect the project and create a risk management plan
- Functional specifications document: This document should describe all external user and programming interfaces that the product must support, including project scope, risks and assumptions, product overview, and use cases
- Budget planning: Specify the budgeted cost to be incurred at the completion of the project, taking into account staff, resources, and equipment requirements
- Procurement planning: Focus on vendors outside your company and plan for procurement activities, as well as contracting any third-party suppliers
- Project management: Implement a project management methodology to track progress, manage risks, and ensure that the project stays on time and within budget. This methodology should include a project scope statement, risk management plan, change management plan, cost management plan, resource management plan, and stakeholder management plan
- Develop detailed procedures and schedules: Develop detailed procedures and schedules for the on-site organic farming program, including
    - ✓ soil health and management
    - ✓ crop rotation, pest
    - ✓ disease management
    - ✓ water management
    - ✓ biodiversity conservation

These procedures and schedules should be based on best practices and industry standards, such as those set by the National Organic Program (NOP) in the United States By following these steps, you can develop and document detailed procedures and schedules for an on-site

organic farming program, ensuring that the project is well-organized and on track for success. Additionally, you can refer to the guidelines and requirements set by relevant regulatory bodies, such as the NOP, to ensure that your program meets the necessary standards and requirements for organic certification

6.3. Recording production and soil data for future planning and intervention

What are the things to record in the production of organic?

The importance of recording production and soil data for future planning and intervention in the context of soil science and agriculture is highlighted in the search results. The potential for long-term understanding of soil data, including soil carbon levels and soil management for crops, is emphasized. It is recommended to implement a core set of measurements and processes to facilitate soil data reuse, ensuring the long-term value of the data.

The development of data management protocols for soil carbon quantification and the use of electronic formats for soil data management are also discussed. Additionally, the search results include a webinar providing insights into utilizing technology to record and manage soil data. These resources emphasize the value of comprehensive soil data collection and management for sustainable agriculture and environmental stewardship.

6.4. Recording workplace information, the appropriate format

Recording workplace information is essential for:-

- ✓ maintaining accurate and up-to-date records
- ✓ ensuring compliance with legal requirements
- ✓ Facilitating efficient management of employee information.

To effectively record workplace information, consider the following formats and practices:

- Paper-based and software-based filing systems: Implement a combination of paper-based and software-based filing systems to store, classify, and maintain documents and records
- Electronic storage systems: Use electronic storage systems for retaining records, ensuring that the format is easily accessible and retrievable
- Cloud-based storage: Consider using cloud-based storage solutions to store and access records remotely, providing easy access and collaboration for authorized personnel

- Compliance with legal requirements: Ensure that your record-keeping practices align with relevant laws and regulations, such as the Health Insurance Portability and Accountability Act (HIPAA) and data privacy law
- Standardized processes: Establish standardized processes for capturing and recording employee information, ensuring that all data is complete, up-to-date, and error-free
- Regular audits: Periodically review and update your record management practices to stay current with any changes in laws and regulations, as well as to identify and rectify any discrepancies or outdated information
- Feedback and assessment: Seek feedback from HR professionals, managers, and employees to identify any pain points or areas of improvement in your record management processes. By implementing these best practices, workplace information can effectively manage and ensure compliance with legal requirements, while maintaining accurate and up-to-date records for your organization

Records are a powerful tool to make implementing organic production work more rewarding. One forgets a lot within a year and as the years go by it becomes very difficult to remember what happened when and why. Even for a nursery of a single species to raises planting material for improved fallows. Records do help. Moreover, for a single species you do not have to write down a lot. Other Information that should be recorded in the work place is like standard operating procedures (SOPs), specifications, production schedules /instructions, routine maintenance schedules, work notes, Material Safety Data Sheets (MSDS), manufacturer's instructions or verbal direction from the manager, supervisor or senior operator.

- Evaluating and reporting of evaluation results to concerned bodies is done at the work completion
- Report is an official document comprising of :-
    - ✓ Activities undertaken
    - ✓ Work progress/status and achievements of objectives and goals
    - ✓ Resource utilization
    - ✓ Risks and problems and corrective measures taken
    - ✓ Strengths and weakness

- ✓ Summary and recommendations

Self-Check 6	Written Test

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

Part I: write True if the statement is correct and false if it is incorrect

1. Evaluating and reporting of evaluation results to concerned bodies is done at the work completion
2. Report is an official document comprising of summary and recommendations
3. Detailed on-site procedures and schedules required for program are developed and documented
4. Using electronic storage systems for retaining records, ensuring that the format is easily accessible and retrievable
5. Specify the budgeted cost to be incurred at the completion of the project, taking into account staff, resources, and equipment requirements known budget planning.

Part II: Short Answer Questions

1. What are the things to record in the production of organic?
2. Report is an official document comprising of?
3. _____ describe all external user and programming interfaces that the product must support, including project scope, risks and assumptions, product overview, and use cases?

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The experts who developed the learning guide

No	Name	Qualification	Educational Level	Region (College)	Phone number	E-mail
1	**Eyob Birhane**	**Agronomy**	**MSc**	**Alage ATVET college**	**09 13047105**	**yeroosaan@yahoo.com**
2	Dabi Kebede	Agronomy	MSc	Agarfa ATVET college	0922685140	dhabik@gmail.com
3	Tefera Merga	Plant protection	MSc	Holleta ATVET college	0956052325	tafemerga@gmail.com
4	Isa Ibrahim	MSc	MSc	Gewane ATVET college	0917388460	isaibrahim67@gmail.com
5	Muftah Mohammed	Horticulture	MSc	Mizan ATVET college	0979729703	muftahkawo@gmail.com