Crop Production and Marketing Management

Level – IV

Based On, March 2018, Version 3 Occupational Standards

Module Title: - Improve and Manage Soils for Organic Production

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Instruction sheet

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

- Undertaking work in appropriate environment
- Conducting soil testing
- Assessing Soil acidity or alkalinity (pH), mineral balances and organic matter levels
- Assessing Soil texture, structure, salinity and sodicity.
- Analyzing results

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 work in appropriate environment
- Conduct soil testing
- Assess Soil acidity or alkalinity (PH) mineral balances and organic matter levels
- Assess soil texture ,structure& salinity and sodicity
- Analyze results

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the "Information Sheets-1
3. Accomplish the "Self-check"
4. If you earned a satisfactory evaluation proceed to "Information Sheet -2". However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning
5. Submit your accomplished Self-check. This will form part of your training portfolio.
6. Read the information written in the "Information Sheet 2".
7. Accomplish the "Self-check"

8. If you earned a satisfactory evaluation proceed to “Information Sheet -3”. In. However, if you’re rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity

9. Submit your accomplished Self-check. This will form part of your training portfolio.

10. Read the information written in the “Information Sheet 3”.

11. Accomplish the “Self-check”

    If you earned a satisfactory evaluation proceed to “Operation Sheet”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning

12. Read the “Operation Sheet” and try to understand the procedures discussed

Information Sheet 1 Undertaking work in appropriate environment and principles of organic agriculture

1.1. Introduction

Organic Agriculture is a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic Agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and good quality of life for all involved.

The overall strategy for increasing crop production yields and sustaining them at a high level must include an integrated approach to the management of soil nutrients, along with other complementary measures. An integrated approach recognizes that soils are the storehouse of most of the plant nutrients essential for plant growth and that the way in which nutrients are managed will have a major impact on plant growth, soil fertility, and agricultural sustainability.

The way soils are managed can improve or degrade the natural quality of soils.

- ***Mismanagement*** **has led to the degradation of millions of acres of land through**:-
  - ✓ Erosion,
  - ✓ Compaction,
  - ✓ Salinization,
  - ✓ Acidification, and
  - ✓ Pollution by heavy metals.

The process of reversing soil degradation is expensive and time consuming; some heavily degraded soils may not be recoverable. On the other hand, good management can limit physical losses

- Good management includes use of Cover crops and soil conservation measures
- ✓ Addition of organic matter to the soil; and
- ✓ Judicious use of chemical fertilizers, pesticides, and farm machinery.

Organic matter content is important for the proper management of soil fertility. Organic matter in soil helps plants grow by improving water-holding capacity and drought-resistance. Moreover, organic matter permits better aeration, enhances the absorption and release of nutrients, and makes the soil less susceptible to leaching and erosion

So long as agriculture remains a soil-based industry, there is no way that required yield increases of the major crops can be attained without ensuring that plants have an adequate and balanced supply of nutrients. The appropriate environment must exist for nutrients to be available to a particular crop in the right form, in the correct absolute and relative amounts, and at the right time for high yields to be realized in the short and long term.

1.2. Monitor indicators of soil fertility

Soil fertility depends not only on the presence of nutritive substances, in physiologically balanced quantities, but it is characterized by other factors, identified only by special methods. By these methods, the functions accomplished by the arable soil can be rendered evident and pursued in the cooperation system with the plants and microorganisms.

Soil fertility is the feature of the terrestrial loose crust to host complex processes (biotical, enzymical, chemical and physical) which store biomass, humus, and minerals.

Soil fertility is the condition of a soil rich in humus, in which the growth processes are getting on fast and efficiently, without interruption there must be permanently equilibrium between the growth processes and those of decomposition. The key of fertile soil and a thriving agriculture is the humus.

Soil indicators are often divided into physical, chemical, and biological categories depending on how they affect soil function. However, these categories are not always clearly designated since a soil property or indicator can affect multiple soil functions. For example, soil sodium content serves as a chemical indicator of soil function based on plant toxicity and water uptake effects while also serving as a physical indicator based on its effect on soil dispersion, crusting, and erosion. Organic matter, or more specifically soil carbon, transcends all three indicator categories and has the most widely recognized influence on soil quality. Organic matter affects other indicators, such as aggregate stability (physical), nutrient retention and availability (chemical), and nutrient cycling (biological), and is itself an indicator of soil quality.

Soil quality indicators of physical condition provide information related to aeration and hydrologic status of soil, such as water entry into soil and capacity of soil to hold water in the root zone. Since soil physical properties influence rooting depth and volume, they also affect nutrient availability and plant growth. Physical properties also provide information related to the soil's ability to withstand physical forces associated with splashing raindrops or rapid water entry into soil that contribute to aggregate breakdown, soil dispersion, and erosion.

- **Physical indicators commonly used to assess soil function and quality includes**:

- ✓ Aggregate stability
- ✓ Available water capacity
- ✓ Bulk density
- ✓ Infiltration
- ✓ Soil crusts
- ✓ Soil structure and macro pore

- **The major causes of poor soil quality**

- ✓ Wider gap between nutrient demand and supply coupled with low and imbalanced fertilizer use
- ✓ Emerging deficiency of secondary and micronutrients due to improper use of inputs such as water, fertilizers, pesticides etc.
- ✓ Decline in organic matter content in soil and insufficient use of organic inputs
- ✓ Acidification and Al^{3+} toxicity
- ✓ Development of salinity and alkalinity in soils
- ✓ Development of adverse soil conditions such as heavy metal toxicity
- ✓ Disproportionate growth of microbial population responsible for soil sickness

- ✓ Natural and man-made calamities such as erosion and deforestation occurring due to rapid industrialization and urbanization, etc.

1.3. **Undertaking work in an environmentally appropriate manner**

Cumulative negative nutrient balances heighten the impact of climatic factors, insecure tenure arrangements, and land and demographic pressures on soil fertility.

Harsh climatic conditions contribute to soil erosion in several parts of the world. Rapid water evaporation and inadequate and highly variable rainfall, for instance, deprive plants of the water necessary for growth.

High atmospheric temperatures, strong light, and heat-retentive, sandy soils can combine to make the local environment too hot for proper plant growth. Powerful, dry wind gusts may also damage plants through both lodging (which causes plants to fall over and die before harvest) and evaporation.

Together, these harsh climatic factors, coupled with poor soil management, have reduced soil fertility by contributing to soil and water erosion. Slight to moderate erosion slowly strips the land of the soil, organic matter, and nutrients necessary for plant growth.

This degradation increases the opportunity for drought and further erosion because it reduces the water-infiltration and water holding capacity of the soil. Severe erosion may create gullies that interfere with farm machinery use.

It may also lead to the conversion of land to lower-value uses, or its temporary or permanent abandonment. Off-farm erosion can lead to siltation in watersheds and a decline in water quality. In such an environment, effective soil, water, pest, and crop management becomes absolutely essential. But economic and other pressures often make it difficult for farmers and their families to efficiently manage the soil for long-term profitability and sustainability.
The nutrient management goal is to integrate the use of all natural and man-made sources of plant nutrients, so that crop productivity increases in an efficient and environmentally benign manner, without sacrificing soil productivity of future generations. The nutrient

management relies on a number of factors, including appropriate nutrient application and conservation.

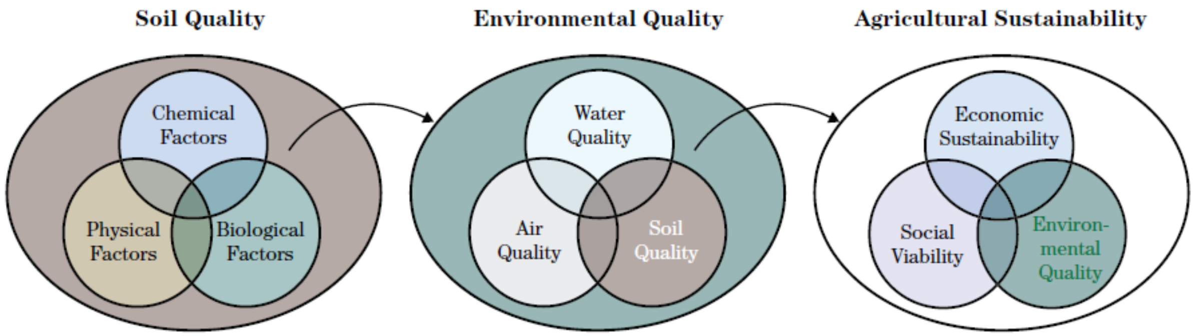


Figure1.soil fuction affect enviromental quaity.

The difficulties arising from poor management of plant nutrients and soil fertility are related mostly to environmental problems, declining yield, and unsustainable agriculture. The poor, primarily smallholder farmers in developing countries, pay the consequences in terms of reduced food security. The challenges are enormous and the responses are complex.

Environmental considerations, such as pollution and degradation of natural resources, are important but need not necessarily involve costly trade-offs between environmental and agricultural production concerns. Environmental priorities will differ between countries and regions. Agricultural intensification can be sustainable, provided that there is effective management of all plant nutrients. Blog 10 Ways Organic I

Fig.2. Managing Soil Health: Concepts and Practices

Healthy soils are the foundation for profitable, productive, and environmentally sound agricultural systems. By understanding how the soil processes that support plant growth and regulate environmental quality are affected by management practices, it is possible to design a crop and soil management system that improves and maintains soil health over time. This information is for farmers and gardeners who want to understand the physical, chemical, and biological components of healthy soil and how to manage them.

A healthy soil provides many functions that support plant growth, including nutrient cycling, biological control of plant pests, and regulation of water and air supply. These functions are influenced by the interrelated physical, chemical, and biological properties of soil, many of which are sensitive to soil management practices

- **Nutrient Cycling**

Nutrient cycling refers to the many pathways through which nutrients are added to, removed from, and changed within the soil. Nutrients are found in two basic forms in the soil: organic and inorganic (sometimes called “mineral"). Organic forms of nutrients contain carbon in the structure of the molecule, while inorganic forms do not. Nutrients are stored in several pools within the soil: as inorganic forms in soil particles, as organic forms in soil organic matter, as inorganic forms on cation exchange sites, and as organic and inorganic forms dissolved in the water surrounding soil particles, known as the soil solution.

- **Nutrients Stored in the Soil**

Soil solution: Inorganic and a few types of organic nutrients dissolved in the soil pore water are immediately available to plants.

Cation exchange sites: Nutrients with a positive charge are known as cations. **Macronutrient cations** are needed by plants in large quantities and include calcium, magnesium, and potassium. Negatively charged sites on clay and organic matter retain these positively charged plant nutrients. Nutrients on cation exchange sites are available to plants in the near term. The quantity of cation exchange sites in a given soil is termed cation exchange capacity (CEC).

Organic matter: Organic matter is composed of living and once-living material (e.g., plant residues, manure) in various stages of decomposition. The availability of nutrients to plants in the near to long term depends on the type of organic matter and the activity of soil organisms.

Decomposition is the breakdown of organic matter into simpler organic and inorganic compounds through processes carried out by soil organisms.

Mineralization is the release of plant-available forms of nutrients that occurs when soil organisms decompose organic matter.

Soil minerals: Nutrients in the mineral component of soils become available to plants in the very long term.

1.4 Principles of organic agriculture,

The four principles of organic agriculture are as follows

- Principle of health
- Principle of ecology
- Principle of fairness
- Principle of care

Healthy soil **Healthy crops** **Healthy livestock** **Healthy people**	**Agro-ecology** **Diversity** **Recycling**	**Ecological and social justice** **Fair Trade?**

- **Principle of health**

Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.

This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems - healthy soils produce healthy crops that foster the health of animals and people.

Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health.

- **Principle of ecology**

Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.

Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale.

Inputs should be reduced by reuse, recycling and efficient management of materials and

- **Principle of fairness**

Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities.

Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings.

This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties - farmers, workers, processors, distributors, traders and consumers. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products..

- **Principle of care**

Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken.

This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture.

Self-Check 1	Written Test

Name: ___________________________ Date: ________________

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

1) Write down the mismanagement practices that can affect soil.(4pts)
2) How above question is improved?(5pts)
3) What I soil?(4pts)
4) What are the indicators of soil fertilities?(4pts)
5) List down four principle organic Agriculture

Note: **Satisfactory rating - 20 points and above** **Unsatisfactory - below20points**

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

Information Sheet 2- Conducting soil testing

2.1 Soil testing

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 practicesSoil
- **Color Test:-**

Soil can be categorized in six groups according to the color and tone of the sample.

- ✓ Brown to Dark Black
- ✓ Black for surface horizon
- ✓ Dark Grey to Bluish
- ✓ White to Grey
- ✓ Dark Red
- ✓ Yellow to Reddish

- **Existence of Coarse Fragments test**

Key to classify coarse fragments by size**:**

- ✓ Gravel: Less than 75 mm size
- ✓ Cobbles: Between 75 mm and 250 mm size
- ✓ Stone: Between 250 mm and 600 mm size
- ✓ Boulders: More 600 mm size

The weight and volume of each group divided by the weight and volume of the original sample and multiplied with 100 will give us the percentage of rocky fragments in the sample (in weight or volume percentage).

A. Proportion of coarse fragments = Weight of rock / weight of soil sample x 100 (%)

B. Proportion of coarse fragments = Volume of rock / Volume of soil sample x 100 (%)

Key to classify coarse fragments by shape:

- ✓ Rounded
- ✓ Sub-rounded and Sub-angular (Slightly rounded or angular)
- ✓ Angular
- ✓ Flat-thin

- **Soil Consistence Test**

This is a very simple test. Take a soil ped between your thumb and forefinger and squeeze it until it pops or fall apart. If the soil is too dry squirt a small quantity of water on it.

- **There are four categories for the result of the test:**

- ✓ Loose: The soil structure falls apart before you handle it
- ✓ Friable**:** The ped breaks under small pressure
- ✓ Firm: The ped breaks under strong pressure
- ✓ Extremely firm: The ped does not break at all

- **Bulk Density Test**

Bulk density indicates how dense the soil is and how tightly it is packed according to the shape of the soil peds and the percentage of air space or pores. It is directly related to the compaction level of the soil. The bulk density indicator is measured with the dry mass per volume in g/cm3 or g/ml.

$$\text{Bulk density} = \frac{\text{Weight of cylinder and soil – weight of cylinder (soil mass)}}{\text{Volume of soil}}$$

- **Particle Density (Real density) Test**

The particle density test measures the mass of the soil in a specific volume, which is very similar to the bulk density test. The main difference is that the particle density only measures the density of the soil particle component and excludes the volume of pore spaces, which contains air and water.

Equations

A**.** Mass of soil = Mass of soil and container – Mass of empty container (g)

B. Mass of water = Mass of water, soil and container - Mass of soil and container (g)

C. Volume of water = Mass of water / Density of water (cm3 or ml), where the density of water equal to 1.0 g/cm3 or g/ml

D. Volume of soil = given volume of mixture (100 ml) – Volume of water (cm3 or ml)

E. Soil particle density = Mass of soil / Volume of soil (g/cm3 or g/ml**)**

- **Soil Porosity Test**

The fraction of pore space in the soil is called soil porosity and it measured in percentage.

Porosity = [1 – (Bulk density / Particle density)] x 100 (%)

Porosity = Pore space volume / Volume of soil x 100

- **Soil Moisture Tests**

The water holding capacity of a specific soil type is very important to calculate the necessary volume and frequency for irrigation during production.

Water holding capacity (Saturation water content) =[Weight of water when saturated / weight of solid (Dry soil)] x 100 (%)

Self-Check – 2	Written test

Name…………………………………………… ID………………………… Date…….

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

Test I: Short Answer Questions

1. What is the importance of knowing the soil texture?(5 pts)
2. Elaborate the relationship between salinity and nutrient flow ?(5 pts)
3. What are criteria's used to select soil types ?(5 pts)
4. What is soil and how it can be managed?(5 pts)
5. Mention different soil tests?(5 pts)
6. Why that assessing of soil structure is necessary?(3pts

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

Information Sheet 3- Assessing Soil acidity or alkalinity (pH), mineral balances and organic matter levels

3.1 Soil reaction / Soil pH

Soil reaction / soil pH/ is the measure of the degree of the acidity or alkalinity of a soil indicated by pH scale of 0- 14. Mathematically, pH is defined as the negative logarithm (base ten) of the activity (concentration) of hydrogen ions in the soil solution. The H^+ ion activity or concentration is expressed in gram atoms (or moles) per litter. In the formula **"p"** stands for logarithm and the capital letter **"H"** stands for hydrogen ion concentration or activity.

$$pH = -\log [H^+]$$

pH scale: value ranging from 0-14

pH value less than 7 is acidic

pH value greater than 7 is alkaline

pH value equals to 7 is neutral

NB: pH is an indicator of soil acidity. Classes used are:

pH range	Description
<4.0	Extremely acid
4.6-5.3	Very acid
5.3-6.0	Moderately acid
6.0-7.0	Slightly acid
7.0-7.0	Neutral
7.1-8.5	Moderately alkaline
>8.5	Very alkaline

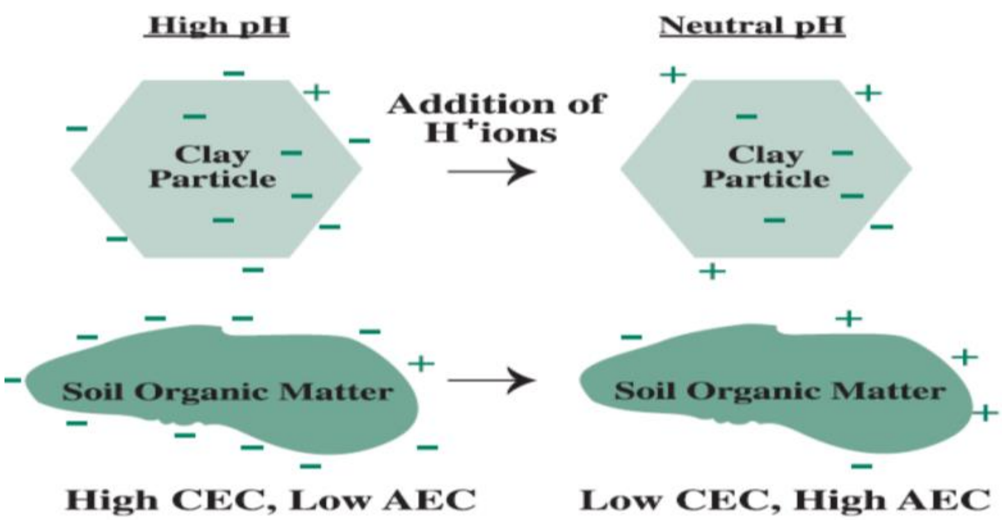
Precise measurement of soil reaction (pH) by determining active hydrogen ion concentration in soils is one of the most useful of soil testing procedures. Accordingly, when crop plants do not grow well, one of the first questions the soil scientist usually asks Because soil pH indicates indirectly a number of soil fertility characteristics. In general soil pH has a significant importance in soil-plant relationships because it determines the:

- ✓ Solubility and availability of plant nutrients
- ✓ Lime requirement of soils
- ✓ Activity of roots of higher plants, and
- ✓ Activity of desirable soil micro-organisms particularly the nitrogen fixers and nitrifies whose activities are seriously depressed in strongly acid and strongly alkaline soils.

From this, one can understand that soil pH influences nutrient absorption and plant growth in two ways:

- ✓ Direct through the toxic effect of H^+ ion on plant root growth and development
- ✓ Indirectly through its influence on nutrient solubility and availability and the presence of pH-dependent toxic ions other than H^+ ion.

The indirect effect is of great significance in most soils. Generally, for agricultural purpose, soils with pH values within the range of 5.8 to 7.5 are suitable and more trouble free than those with higher or lower pH values.



3.2 . Mineral balances

Mineral matter is the inorganic part of the soil and is the end product of the weathering process. Mineral matter generally makes up over 90% of the weight of dry soil and includes sand, silt, and clay. This mineral matter provides most of the mineral nutrients that are required for plant growth.

The 14 mineral nutrients are classified as either macronutrients or micronutrients based on their plant requirements. There are six macronutrients: Nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S). The macronutrients, N, P, and K, are often classified as primary macronutrients, because deficiencies of N, P, and K are more common than the 'secondary' macronutrients, Ca, Mg, and S. The micronutrients include boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni) and zinc (Zn).

Most of the macronutrients represent 0.1 - 5%, or 100-5000 parts per million (ppm), of dry plant tissue, whereas the micronutrients generally comprise less than 0.025%, or 250 ppm, of dry plant tissue. Note that Cl, a micronutrient, has plant tissue concentrations similar to some of the macronutrients.

Keep in mind that the classifications of micro vs. macronutrient refer to plant needs rather than plant uptake amounts. Each nutrient cannot be taken up by plants in its elemental or non-charged form, but instead is taken up in an 'ionic', or charged, form, with the exception of boric acid which is uncharged.

13. Albrecht testing method

The soil is the storehouse of fertility, or at least it should be. The minerals that the plants need in order to grow and reproduce another healthy generation all come from the soil and are stored there, in or on one of the following forms:
nutrients they need in the proper ratio, but to keep the soil loose and friable while retaining soil moisture.Our overall goal is to feed the soil and the soil organisms that in turn feed the plants. Our specific goal is that the soil should contain perfect nutrition for the crop we wish to grow. In the case of plants grown for food, we also want the crop to contain all of the nutrients essential for the health of the people or animals that will eating the food being grown. Luckily, most food crops do best with the same soil mineral balance.

The Calcium: Magnesium ratio sets the stage for all of the rest of the elements. If the Calcium level is too high in relation to Magnesium, the soil will be loose but will lose its texture and cohesiveness and water may drain through too easily and be lost. It will also be more prone to erosion from wind or water. If the Magnesium

Level is too high, the soil will be tight, preventing water and air from moving through easily.

Soil chart range of base saturation for most plants:

Calcium (Ca)++ min 750ppm	60% — 85% Optimum 68%	Ca & Mg together should add to 80% of exchange capacity in most agricultural soils pH 7 and lower
Magnesium (Mg)++ min 100ppm	10% — 20% Optimum 12%	
Potassium (K)+ min 100ppm	2% — 5% Optimum 4%	See Phosphorus (P)
Sodium (Na)+ min 25ppm	1% — 4% Optimum 1.5%	Essential for humans and animals
Hydrogen (H)+	5% — 10% Optimum 10%	A lone proton. The "free agent

A very heavy clay soil needs to be loosened up, so one would wish to see a Ca: Mg Saturation ratio of perhaps 75% (or even more) Calcium to 10% Magnesium.

A very loose sandy soil needs to be tightened up to hold water and prevent erosion In that case 60% Calcium and 20% Magnesium would be desired.

Heavy clay: 75% (or more) Calcium, 10% Magnesium

Loose sand: 60% Calcium, 20% Magnesium.

At no time do we want the Calcium saturation to be below 60% or the Magnesium saturation below 10% unless we are growing specialty crops such as blueberries or rhododendrons that like a high-Magnesium and somewhat acid soil or certain plants that prefer a very high Calcium "chalky" soil. In an "ideal" soil that has a good mix of sand, silt, and clay as well as a good level of organic matter, Professor Albrecht determined that the best ratio was 65%Calcium to 15% Magnesium. Further experience has convinced other agronomists that slightly different ratios work better for them. At soilminerals.com we usually recommend a "perfect" ratio of 68% Calcium to 12% Magnesium for soils below pH 7. This seems to be the ideal proportion not only to give the plants and soil life the

3.3 Organic matter levels

Organic matter is made up of dead and decaying plants and animals, as well as their by-products. Dead plants and animals, as well as the leaf litter produced by plants and droppings from animals, are left throughout the soil. Soil organisms such as insects, earthworms, fungi, and bacteria use these products for food and nutrients. The presence and amount of organic material affects the fertility of the soil.

Organic fertilizer is rich humus, polymer compounds, such as living microorganisms and various organic colloidal inorganic colloidal clay minerals, has a huge surface energy, and is available with delayed-nutrients, organic and inorganic nutrient pool of compatible, crops with a variety of nutrients needed for growth.

Commercial organic fertilizer is animal manure, plant and animal residues and other organic-rich resources as the main raw material, the use of factory-produced goods into circulation as fertilizer, with manure, compared with nutrient content, quality and stability characteristics. With the Development of modern agriculture and agricultural restructuring within the industry, organic fertilizers tend to industrialization, commercialization, the domestic market in the industrial production of fine organic fertilizer, organic inorganic fertilizer, which uses mostly organic ingredients coal, peat, manure, crop residues, waste food and fermentation Industry.

- **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:

$\% OM = [(W105 - W400) \times 100]/W105$

Where W105 is the weight of soil at 105°C (221°F) and W400 is the weight of soil at 400°C (752°F).

Self-Check – 3	Written test

Name………………………………………… ID……………………….. Date…….

Directions: Answer all the following questions listed below.

Part I: Short Answer Questions

1. Write the importance of in soil. (4pts)
2. Why that nutrient in soil said to be essential?(6)
3. Define Mineral balances
4. What is soil PH? (3pts.)
5. Why assessing of soil PH is necessary?(4pts)
6. What are the impacts of soil PH? Write at five points (6pts).

What is organic matter

Part II: choose the correct answer

1. Which one of the following element is primary nutrient for the plant?(4)
   a. A) N B) Mg C) Ca D) S
2. One of the following is not important organic materials?(4)
   A) Maintaining soil fertility
   B) The mineralization of nitrogen, phosphorus, and sulfur in the soil
   C) Reduce the soil's ability to hold nutrients.
   D) Structural stability

Note: Satisfactory rating 18 points Unsatisfactory below 18 points

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

4.1. Introduction

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

4.2 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 textu**re
  - ✓ 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.

4.3. Soil Structure

It is a field term descriptive of the gross, over all aggregation, or arrangement of the primary soil separate. Anyone who has ever made a mud ball knows that soil particles have a tendency to stick together. Attempts to make mud balls out of pure sand can be frustrating experiences because sand particles do not cohere (stick together) as do the finer clay particles.

The nature of the arrangement of primary particles into naturally formed secondary particles, called aggregates, is soil structure.

A sandy soil may be structure less because each sand grain behaves independently of all others.

A compacted clay soil may be structure less because the particles are clumped together in huge massive chunks. In between these extremes, there is the granular structure of surface soils and the blocky structure of subsoil. In some cases sub soils may have platy or columnar types of structure. Structure may be further described in terms of the size and stability of aggregates. Structural class is based on aggregate size, while structural grade is based on aggregate strength.

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

✓ **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.

- ✓ **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.

- ✓ **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

- ✓ **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.

4.4. Salt affected soils

Soil salinity, accumulation of high level of soluble salts, is common feature of arid and semiarid regions with low rainfall (less than 500 mm/year), and where the groundwater level is very close to the surface. The most common soluble salts responsible for soil salinity are the chlorides and sulfates of Ca, Mg, Na, and K. Worldwide more than 323 million ha of land is salt affected.

The presence of high levels of neutral salts (from sources other than carbonates) such as $CaSO_4$, Na_2SO_4, NaCl, CaCl, etc somehow lower soil pH by shifting the alkaline reaction to the left (i.e. reduce the production of the OH ions). As a result salt accumulation is common in alkaline soils. However, not all saline soils are alkaline.

- **Origins of salts in saline soils:**
- ✓ Weathering of minerals
- ✓ Gradual accumulation from poor quality irrigation water

- ✓ Geological salt deposition usually enriching the ground water and the ground water coming to the surface in low-lying areas
- ✓ Atmospheric deposition in form of dust
- ✓ Intrusion of sea water

Irrigation contributes to soil salinity in two ways. Firstly, poor quality irrigation water physically brings salts and leads to its build up. Secondly, even using good quality irrigation water excess irrigation results in the rise of the groundwater level which is salt loaded.

4.4.1. Measuring Salinity and Sodicity

Salt- affected soils adversely affect Plants because of the total concentration of salts (salinity) in the soil solution and because of concentrations of specific ions, especially sodium (sodicity). Techniques have been developed to characterise salt affected soils. These, along with pH include electrical conductivity (EC), exchangeable sodium percentage (ESP), and the sodium adsorption ratio (SAR). Salinity is measured primarily as EC and sodicity is primarily characterized by ESP and SAR.

i) Electrical conductivity (EC)

Pure water is a poor conductor of electricity but conductivity increases as more and more salt is dissolved in the water. Thus the electrical conductivity (EC) of the soil solution gives us an indirect measurement of the salt content. EC is expressed in terms of decisiemens per meter (ds/m).

ii) Sodium status (ESP and SAR)

Two expressions are used to characterise the sodium status of soils. The exchangeable sodium percentage (ESP) identifies the degree to which the exchange complex is saturated with sodium.

$$ESP = \left(\frac{\text{Exchangeable sodium(cmol/kg)}}{\text{Cation exchange capacity (cmol/kg)}} \right) * 100$$

ESP level of 15 are associated with pH values of 8.5 and above. Higher levels may bring the pH to above 10.

The sodium adsorption ratio (SAR) is a second more easily measured property that is becoming even widely used than ESP. It gives information on the comparative concentration of Na^+, Ca^{2+} and Mg^{2+} in soil solutions. It is calculated as follows:

$$SAR = \frac{[Na^+]}{(0.5[Ca^{2+}] + 0.5[Mg^{2+}])^{1/2}}$$

Where all the concentrations are in mmol of charge per liter ($mmol_c/L$). The SAR of the soil extract takes into consideration that the adverse effect of sodium is moderated by the presence of calcium and Magnesium ions.

4.4.2. Classification of Salt Affected Soils

Using EC, ESP, SAR characteristics, and soil pH, salt affected soils are classified as saline, saline-sodic and sodic.

- **Saline soils**

The processes that result in the accumulation of neutral salts are referred to as salinization. The salts are mainly chlorides and sulphates of sodium, calcium, magnesium and potassium. Saline soils contain a concentration of these salts sufficient to interfere with the growth of many plants. Salts are commonly brought to the soil surface by evaporating water, creating white crust, which accounts for the name white alkali that sometimes used to designate these soils. The EC, ESP, SAR and pH level of saline soils and the other two classes is given below.

Classes	PH	EC ds/m	ESP	SAR
Saline	<8.5	>4	<15	<13
Saline-sodic	>8.5	>4	>15	>13
Sodic	>8.5	<4	>15	>13

- **Saline-sodic soils**

Saline sodic soils have characteristics intermediate between those of saline and sodic soils. Like saline soils they contain appreciable level of neutral soluble salts but they have higher ESP and SAR level. Crop growth can be adversely affected by both excess salts and excess sodium levels. The physical and chemical conditions of saline-sodic soils are similar to those of saline. This is due to the moderating effect of the neutral salts.

- **Sodic soils**

The level of neutral soluble salts is low. However, the level of Na is high. The high pH level is due to the hydrolysis of sodium carbonate. Few plants tolerate the condition. Plant growth of those soils is constrained by toxicities of Na+, and HCO3- ions as well as their very poor physical conditions and slow permeability of water.

Highly hydrated mono-valent ions such as Na^{+} which are not very tightly held by the surface of colloid as a result the colloids are being dispersed. This condition is called **disperssion**, which is the opposite of **Flocculation**. Because of dispersion, caused by sodium, the dispersed colloides clog pores. The result of clogging of pores is lack of large pores which gives low level of water movement and aeration i.e. poor soil physical condition.

Because of the extreme alkalinity from high sodium content, the surface of sodic soils often discoloured by the dispersed humus that can be carried upward by the capillary water and deposited when it evaporates. Hence the name black alkali has been used to describe these soil

Assessment of Soil Salinity

Visual assessment of salinity only provides a qualitative indication; it does not give a quantitative measure of the level of soil salinity. That is only possible through EC measurement of the soil. In the field, collection of soil saturation extract from soil paste is not possible. Therefore, an alternate procedure is used, e.g. a soil:water suspension (1:1, 1:2.5, 1:5) for field salinity assessments.

- ✓ EC can be measured on several soil: water (w/v) ratios
- ✓ EC measurement at field capacity (fc) is the most relevant representing field soil salinity. The constraint in such measurement is difficulty to extract sufficient soil water
- ✓ Compromise is EC measurement from extract collected from saturated soil paste
- ✓ The relationship between ECfc to ECe is generally (ECfc = 2ECe) for most of the soils, except for the sand and loamy sand textures
- ✓ Laboratory measurement of soil extract salinity (ECe) is laborious. Thus, EC of extracts using different soil: water ratios can be measured in the field and correlated to ECe, because ECe is the appropriate parameter used in salinity management and crop selection.
- ✓ Commonly used soil: water ratios in field assessment of salinity are:

- 10 g soil +10 ml distilled water (1:1)
- 10 g soil +25 ml distilled water (1:2.5)
- 10 g soil +50 ml distilled water (1:5)

Self-Check – 4	Written test

Name…………………………………………… ID………………………… Date……

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

Short Answer Questions

1. What is Soil salinity?(5pts)
2. What are Calcareous soils? (4pts)
3. What is the importance of knowing the soil texture? (5 pts.)
4. Elaborate the relationship between salinity and nutrient flow? (5 pts.)
5. What are criteria's used to select soil types? (5 pts.)
6. What is soil and how it can be managed? (5 pts.)
7. Mention different soil tests? (5 pts.)

Note: **Satisfactory rating - 25 points** **Unsatisfactory - below 25 points**

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

5.1 introduction

Soil Analysis Reference Guide Report Terms Parts per million (ppm) or lbs. /acre: Results for the major and minor elements are reported in parts per million (ppm) or lbs/acre. The reporting units will be printed right after the lab results.

When results are reported in ppm, convert to lbs/acre by multiplying the ppm number by 2 for a 6 inch sample depth. Meq/100g (mill equivalents per 100 grams):

Soil cations, such as calcium, magnesium, potassium, and hydrogen can be expressed in terms of their relative ability to displace other cations. The unit of measure is meq/100g. For example, one mill equivalent of potassium is able to displace exactly one mill equivalent of magnesium.

The cation exchange capacity of a soil, as well as the total amounts of individual cations, may be expressed using these units. Millimhos/cm (mmhos/cm):

Electrical conductivity measurements are often used to measure the amount of soluble salts in the soil. Conductivity is generally expressed in mmhos/cm. The conductivity increases with increasing soluble salts. Ratings: Some soil test readings on the report are given a rating of very low (VL), low (L), medium (M), high (H), or very high (VH).

The purpose of these ratings is to provide a general guideline for determining optimum nutrient levels for crop growth. Upon request, an unrated form can be obtained. Optimum levels may vary slightly from those shown on the Soil Analysis Report, however, the best value is dependent on many factors such as crop, yield potential and soil type. Tracking Information: A. Report Number:

All samples are filed by report number. When contacting A&L concerning a certain sample, be sure to refer to this number. B. Date Report is printed C. Account Number: An account number has been assigned to each A&L client. The use of this number will speed up sample processing and location of samples within the laboratory system. D. A&L Agronomist: Agronomist reviewing report E. Date sample was received in the lab F. Laboratory Number: The identification number assigned by the laboratory to each individual soil sample is shown here. G. Sample I.D.: The identification number assigned by the client to each individual sample is reported here.Because of limited space, sample ID's must be limited to 6 digits or characters.

5.2. Soil Analysis Reference Guide

- **Soil pH:** The soil pH measures active soil acidity or alkalinity. A pH of 6.9 or less is acid. Soils with a pH of 7.0 are neutral; values higher than 7.0 are alkaline. Under normal conditions the most desirable pH range for mineral soil is 6.0 to 7.0 and 5.0 to 5.5 for organic soil.
- **Buffer pH**: The buffer pH is a value used for determining the amount of lime to apply on acid soils with a pH less than 6.6. The lower the buffer pH, the higher the lime requirement.
- **Phosphorus**:

✓ **Four types of phosphorus tests may be reported:**

❖ The P1 (weak Bray) test measures phosphorus which is readily available to plants. The optimum level will vary with crop yield and soil conditions, but for most field crops, 20 to 30 ppm (40 to 60 lbs/acre) is adequate. Higher levels may be needed for especially high yields as well as for certain vegetable crops.

❖ The P2 (strong Bray) test measures readily available phosphorus plus a part of the active reserve phosphorus in soil. A level of 40 to 60 ppm or 80 to 120 lbs/acre is desirable for good yields of most crops.

❖ The Mehlich I (Double Acid) or Mehlich III extracts readily available phosphorus in slightly acid soils. A level of 30 to 50 ppm (60 to 100 lbs/acre) is adequate for most crops.

- The Bicarbonate P (sodium bicarbonate) test measures the amount of readily available phosphorus in slightly basic (pH of 7.0 – 7.2) to highly basic soils (pH 7.3 and greater). In basic soils the phosphorus exists mostly as alkaline earth phosphates. The extraction by dilute sodium bicarbonate correlates with what the crops can extract from these soils. The weak and strong Bray extractions are acidic (low pH). These extracting solutions are neutralized by the presence of free lime in higher pH soils, thus giving lower phosphorus test levels. To determine which phosphorus is listed on your report, see Soil Test Method. If the soil test method is listed as ammonium acetate it will be Bray P1 phosphorus.

- **Potassium:**

  This test measures available potassium. The optimum level will vary with crop, yield, soil type, soil physical condition, and other soil related factors. Generally, higher levels of potassium are needed in soils high in clay and organic matter; lower levels in soils which are sandy and low in organic matter. Optimum levels for light-colored, coarse-textured soils may range from 90 to 150 ppm or 180 to 300 lbs/acre. Dark-colored, heavy-textured soils may require p0-tassium levels from 120 to 240 ppm or 240 to 480 lbs/acre.

- **Magnesium and Calcium:**

  The levels of calcium and magnesium found in the soil are affected primarily by soil type, drainage, liming and cropping practices. These basic cations are closely related to soil pH. As the soil pH increases, the levels of calcium and/or magnesium usually increase. Calcium deficiencies are rare when the soil pH is adequate. Magnesium deficiencies are more common. Adequate magnesium levels normally range from 50 to 70 parts per million. The need for magnesium can be further deter-mined from its base saturation, which should be above 10 percent.

- **Sulfur (Sulphur):** The soil test measures sulfate sulfur (S04-S) which is readily available and preferred for plant uptake. Optimum levels of sulfur depend on organic matter content, soil texture, drainage, and desired yield goal. Whenever the following conditions exist, the need for sulfur will normally be increasingly important for optimum crop performance:

✓ Well drained, low CEC soils

- ✓ Soils low in organic matter
- ✓ Low soil pH (below 6.0)
- ✓ Use of high-analysis, low Sulphur fertilizers

- **Boron:**

Readily-soluble boron is extracted from the soil with hot water. Adequate levels range from 1 to 3 ppm. Factors to be taken into consideration when interpreting the boron test should include ph, organic matter and texture, as well as the crop to be grown.

- **Copper:**

A level of 1 to 1.8 ppm of copper or 2 to 3.6 lbs/acre should be sufficient for the acid extraction methods for DTPA extraction, 0.3 ppm is adequate. The soil ph, organic matter level, high rates of nitrogen, and the crop to be grown are important factors that should be considered when interpreting the copper test results.

- **Iron.**

A level of 5 to 10 ppm (10 to 20 lbs/acre) of extractable iron is usually adequate for either the 0.1 N HCI or the Mehlich extractions. For DTPA extraction, 5 ppm is adequate. Soil ph is a very important factor in interpreting the iron soil test.

- **Manganese.**

A test range of to 10 ppm (10 to 20 lbs/acre) of extractable manganese is usually adequate for 0.1 N HCI and Mehlich. For DTPA extraction, 1 ppm is adequate. Soil ph is especially important in interpreting manganese test levels. In addition, soil organic matter, crop, and yield goal must also be considered. Since manganese quickly converts to insoluble (unavailable) forms shortly after application, row or band treatments and foliar applications ae the recommended methods for applying manganese.

- **Zinc:**

A test level of 3 to 5 ppm (6 to 10 lbs/acre) is normally adequate for 0.1 N HCI and Mehlich. For DTPA, 1 ppm is adequate. Factors taken into consideration when interpreting the zinc test include available soil phosphorus, pH, crop and yield goal.

- **Sodium:**

Sodium is considered as it relates to the physical condition of the soil. Adverse physical and chemical conditions may develop in soil high in exchangeable sodium. These conditions may prevent the growth of plants. Reclamation of these soils involves the replacement of exchangeable sodium by calcium or magnesium and the removal of the sodium by leaching.

- **Soluble Salts:**

If the level of salinity is less than 1.0 mmhos/cm the effects are negligible. Readings greater than 1.0 mmhos/cm may affect salt-sensitive plants. A level greater than 2.0 mmhos/cm may require planting salt tolerant plants. An excessive concentration of various salts may develop naturally or be the result of poor irrigation water, excessive fertilization, or contamination from various chemicals or industrial wastes. One effect of high soil salt concentration is to produce water stress in a crop which may cause the plant to wilt or even die.

- **Organic Matter and ENR:** (Estimated Nitrogen Release) Percent organic matter is a measurement of the amount of plant and animal residue in the soil. The color of the soil is usually closely related to its organic matter content, with darker soils being higher in organic matter.
- The organic matter serves as a reserve for many essential nutrients, especially nitrogen. Bacterial activity releases some of this reserve nitrogen, making it available to the plant. The ENR is an estimate of the amount of nitrogen that will be released over the season. In addition to organic matter level, the ENR may be influenced by seasonal variations in weather conditions as well as physical soil conditions.

- **Nitrate:** The soil test measures nitrate-nitrogen (NO3-N) which is water soluble and readily available for the plant. When considering nitrogen levels needed for optimum crop performance, this test will indicate the level of nitrate present. Depth tests determining N03-N will give more detailed information for making nitrogen recommendations. It is important that other soil factors including organic matter content are taken into consideration when interpreting the nitrate-nitrogen soil test and predicting crop response. This test is not well suited for high CEC soil or high rainfall areas.
- **Additional Analyses:**

Additional requested analyses such as chloride or aluminum will be shown in this area.

- **Cation Exchange Capacity (CEC):**

Cation Exchange Capacity measures the soil's ability to hold nutrients such as potassium, magnesium, and calcium, as well as other positively charged ions such as sodium and hydrogen. The CEC of a soil is dependent upon the amounts and types of clay minerals and organic matter present.

The common measurement for CEC is mill equivalents per 100 grams (meq/100g) of soil. On most soils it will vary from 2 to 35 meq/100g depending upon the soil type. Soils with high CEC will generally have higher levels of clay and organic matter. For example, one would expect soil with a silty, clay loam texture to have a considerably higher CEC than a sandy loam soil. Although high CEC soils can hold more nutrients, good soil management is required if these soils are to be more productive.

✓ **Cation Saturation:**

Cation saturation refers to the proportion of the CEC occupied by a given cation (an ion with a positive charge such as calcium, magnesium, or potassium) or combination of cations referred to as bases. The percentage saturation for each of the cations will usually be within the following ranges for optimum performance: Potassium: 2 to 5 Magnesium: 10 to 40 Calcium: 40 to 80 19. Soil Test Method (Extraction): This lists the extraction method used for the soil analysis.

- **Soil Fertility Guidelines**
  - ✓ Crop to be grown
  - ✓ Yield Goal for crop to be grown (necessary when recommendations requested)
  - ✓ Reporting units: will be listed as lbs/acre or lbs/1000 sq. ft. (necessary when recommendations requested)
  - ✓ The guidelines are for yearly application of the lbs of the actual nutrient.
  - ✓ Best management practices and suggestions for application times, rates, etc.

Self-Check – 5	Written test

Name………………………………………… ID……………………… Date…….

Directions: Answer all the questions listed below.

1) Why soil analyzing is needed? (5 pts.)
2) What we analyses in 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(4pts.)

***Note:* Satisfactory rating - 24 points** **Unsatisfactory - below 24points**

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

Operation sheet 1	Estimating the percentage volume of coarse fragments

Materials

- ✓ Can
- ✓ Oven dry
- ✓ Beam balance
- ✓ Cylinder
- ✓ Sieve

Procedures

Step 1: the can is pushed into the soil horizon to obtain the sample.

Step 2: Dry the soil sample in oven and measure its weight

Step 3: Remove the sample from the can and measure the weight of the can.

Step 4: Fill the empty can with water. After that measure the volume of the water in a graduated cylinder.

Step 5: Sieve the soil sample using a #10 sieve (2 mm openings)

Step 6: Separate the rock fragments by size.

Step 7: Measure the weight of each group.

Step 8: Place a specific volume of water in a graduated cylinder.

Step 9: Place the group of fragments in the cylinder.

Step 10: Record the increase of water in volume. Do the measurements process for each group separately?

Operation sheet 2	Measuring PH of soil

Materials

- ✓ Beaker
- ✓ Ph meter
- ✓ Beam balance
- ✓ Distilled water

Procedure

A. PH in saturated soil paste (for identifying specific soil problem as acidity or alkalinity)

1. Take 100g of soil sample in 500ml beaker
2. Add small amount of distilled water at 1-2 minutes interval to the soil
3. Allow the beaker with a cover for about an hour
4. Adjust ph meter knob for the temperature
5. Carefully insert the glass and combined electrodes in the paste and take the reading

B. PH in soil-water suspension (1:2 or1:2.5 ratios for fertilizer recommendation)

1. Take 10 gm of soil sample in 50 or 100 ml beaker
2. Add 20 or 25 ml of distilled water and stir well for 5 minute and keep for half an hour
3. Again stir before immersing the electrodes and take the ph reading

LAP TEST	Performance Test

Name………………….ID……………..……..Date…………………………
Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2**hour. The project is expected from each student to do it.

Task-1 preform estimating the percentage volume of coarse fragments.

Task -2. Preform measuring pH of soil

LG #72	LO #2- Assess soil-related factors for selected plants.

Instruction sheet 2

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

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

- Identifying nutritional requirements of plant species
- Selecting soil analyses and suitable testing facilities
- Conducting soil and plant tissue sample collection
- Analyzing results of soil and tissue testing
- Assessing soil condition
- Assessing soil biological activity
- Assessing soil health

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 of plant species
- Select soil analyses and suitable testing facilities
- Conduct soil and plant tissue sample collection
- Analyze results of soil and tissue testing
- Assess soil condition
- Assess soil biological activity
- Assess soil health

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the "Information Sheets-1
3. Accomplish the "Self-check"
4. If you earned a satisfactory evaluation proceed to "Information Sheet -2". However, if your rating is unsatisfactory, see your teacher for further instructions
5. Submit your accomplished Self-check. This will form part of your training portfolio.
6. Read the information written in the "Information Sheet 2".
7. Accomplish the "Self-check"
8. If you earned a satisfactory evaluation proceed to "Information Sheet –
9. However, if your rating is unsatisfactory, see your teacher for further instructions
10. Submit your accomplished Self-check. This will form part of your training portfolio.
11. Read the information written in the "Information Sheet 3".
12. Accomplish the "Self-check"
13. If you earned a satisfactory evaluation proceed to "Operation Sheet".

Information Sheet 1- Identifying nutritional requirements of selected plant species

1.1. Introduction

Soil's potential for producing crops is largely determined by the environment that the soil provides for root growth. Roots need air, water, nutrients, and adequate space in which to develop. Soil attributes, such as the capacity to store water, acidity, depth, and density determine how well roots develop. Changes in these soil attributes directly affect the health of the plant. For example, bulk density, a measure of the compactness of a soil, affects agricultural productivity.

When the bulk density of soil increases to a critical level, it becomes more difficult for roots to penetrate the soil, thereby impeding root growth. When bulk density has increased beyond the critical level, the soil becomes so dense that roots cannot penetrate the soil and root growth is prevented. Heavy farm equipment, erosion, and the loss of soil organic matter can lead to increases in bulk density. These changes in soil quality affect the health and productivity of the plant, and can lead to lower yields and/or higher costs of production.

1.2 Identifying nutritional requirements of plant species

Nutrient requirements of crops depend on yield level, crop species, cultivar, or genotypes within species, soil type, climatic conditions, and soil biology. Hence soil, plant, and climatic factors and their interactions are involved in determining plant nutrient requirements. In addition to this, the economic value of a crop and the socioeconomic conditions of the farmer also are important factors in determining the nutrient requirements of a crop.

A shortage of one or more nutrients can inhibit or stunt plant growth. But excess nutrients, especially those provided by inorganic fertilizers, can be wasteful, costly, and, in some instances, harmful to the environment. Effective and efficient management of the soil storehouse by the farmer is thus essential for maintaining soil fertility and sustaining high yields. To achieve healthy growth and optimal yield levels, nutrients must be available not only in the correct quantity and proportion, but in a usable form and at the right time.

Plant growth is the result of a complex process whereby the plant synthesizes solar energy, carbon dioxide, water, and nutrients from the soil. In all, between 21 and 24 elements are necessary for plant growth.

The primary nutrients for plant growth are nitrogen, phosphorus, and potassium (known collectively as NPK). When insufficient, these primary nutrients are most often responsible for limiting crop growth. Nitrogen, the most intensively used element, is available in virtually unlimited quantities in the atmosphere and is continually recycled among plants, soil, water, and air. However, it is often unavailable in the correct form for proper absorption and synthesis by the plant.

In addition to the primary nutrients, less intensively used secondary nutrients (sulfur, calcium, and magnesium) are necessary as well. A number of micronutrients such as chlorine, iron, manganese, zinc, copper, boron, and molybdenum also influence plant growth. These micronutrients are required in small amounts (ranging from a few grams to a few hundred grams per hectare) for the proper functioning of plant metabolism. The absolute or relative absence of any of these nutrients can hamper plant growth; alternatively, too high a concentration can be toxic to the plant or to humans.

Self-check 1	Written test

Name………………………………………… ID……………………… Date…….

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

1. What is nutritional requirements of plant species (5 pts.)
2. Elaborate the relationship between MOs and soil? (5 pts.)

5. Mention soil related factors for plant health (4pt.)

Note: Satisfactory rating -2 4 points Unsatisfactory - below 24 points

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

Information Sheet 2- Selecting soil analyses and suitable testing facilities

2.1. **Conducting soil analyses**

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 and cropping practices, and 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) *Micronutrients* (B, Cl, Cu, Fe, Mo, Mn, Zn) *Other elements* (Al, Na)	Nutrient element status
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

Self-check 2	Written test

Name………………………………………… ID……………………… Date…….

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

1. What is soil compaction?(5 pts)
2. Elaborate the relationship between soil organic matter 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(5pts.)

Note: Satisfactory rating - 20 points Unsatisfactory - below 18 points

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

Information Sheet 3- Conducting soil and plant tissue sample collection

3.1. Soil sampling

Soil sampling is the process of taking a small sample of soil, which is then sent to a lab to determine the nutrient content. The analysis of the soil is carried out by taking samples of the soil and performing laboratory tests, which is then followed by an interpretation of the results.

Soils are naturally variable horizontally as well as vertically, which requires careful consideration in terms of sampling technique. Topography and soil type are common factors for determining where, within sampling boundaries, to collect a single soil composite.

- **The most common samplings collection designs are the following:**

1- Grid sampling: A grid with suitable spacing is placed on the map and measured. The sampling will be taken at the intersections of the grid or from inside of the grid cells. Grid sampling provides equally spaced observations and it reveals any systematic variation across the tract under study.

2- Random sampling: Sample locations are selected at random, with equal probabilities of selection and independently from each other. The sample produced from one sampling area consists of 10-20 sub-samples collected randomly throughout the sampling area using a zigzag pattern. The sub-samples should only be collected from representative sites, avoiding areas like anthills, bunds, boundaries, etc. The sampling process starts with the cleaning of the surface area then removing the top litter from the surface to approximately 1 cm deep. Dig a “V” shaped hole to a depth of 15 cm to collect a sample of the topsoil; for a sample of subsoil, the hole should be about 45 cm deep.

3- Random stratified sampling: The area is first divided into a number of subsections, called *strata*, and then random sampling design is applied to each of the strata separately. The random sampling method is not a systematic collection technique; meanwhile the stratified random sampling method provides a kind of mixture of the systematic and non-systematic soil sampling collection methods.

4- Transects: Soil samples are taken along straight lines across the targeted area.

The spacing between sampling points might be equal, nested, or random. 5- Target sampling: Based on specific attributes (e.g. slope, aspect, plan or profile curvature, color, etc.) the technician identifies homogeneous and heterogeneous patterns of the targeted area, which will allow the fixation of representative sampling points where the sampling will be taken. This technique minimizes the effort and cost and maximizes the information content.

- **Importance of sampling**

The idea behind importance sampling is that certain values of the input random variables in a simulation have more impact on the parameter being estimated than others. If these "important" values are emphasized by sampling more frequently, then the estimator variance can be reduced.

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.

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.**

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

3.2. Plant Tissue sampling

Plant tissue analysis shows the nutrient status of plants at the time of sampling. This, in turn, shows whether soil nutrient supplies are adequate. In addition, plant tissue analysis will detect unseen deficiencies and may confirm visual symptoms of deficiencies. Toxic levels also may be detected.

- **The two primary objectives for conducting a tissue test**.

(1) Identify quickly the nutritional statusof the plant *for verification* of an apparent nutrient element insufficiency.

(2) 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:

1. Plant tissue test is conducted in the field rather than on collected tissue that is sent to a laboratory for analysis.

2. Plant 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.

- **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.

Self-Check – 3	Written test

Name…………………………………………… ID………………………… Date…….

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

1. What are the design soil sampling techniques? (2 pts.)
2. Why soil sampling is necessary? (2 pts.)
3. Write some importance of soil sampling. (2 pts.)
4. What are the criteria's of soil sampling?(2 pts.)

Note: **Satisfactory rating - 8points** **Unsatisfactory - below 8points**

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

Information Sheet 4- Analyzing results of soil and plant tissue testing

4.1 Introduction

Soil testing is the best tool for monitoring soil fertility levels and providing baseline information for cost-effective fertilization programs. This information allows for management actions that adjust soil fertility status in order to meet specific forage-nutrient requirements. Routine soil testing can identify nutrient deficiencies and inadequate soil pH conditions that may negatively affect forage production. Soil tests can also indicate nutrients that are present at adequate levels, providing the opportunity to eliminate unnecessary soil amendments.

A major limitation associated with soil testing is that it typically accounts for the plant-available nutrient pool present in the surface (4 to 6 inches) soil layer. However, the subsoil can be an important source of water and nutrients, particularly in perennial crop systems. In addition, some nutrients are highly mobile in the soil and can easily leach into subsoil, resulting in nutrient accumulation at deeper soil depths. Unlike soil testing, plant tissue analysis can account for the plant-available nutrient pools present at multiple soil depths, including deeper horizons. Because of the extensive root system in some plants, plant analysis is a complement to the soil test to better assess the overall nutrient status of a perennial forage system, while revealing imbalances among nutrients that may affect crop production

- **Soil 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 can also occur naturally.

- **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;-

- ✓ 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.

- ✓ Look for the one factor that is most limiting plant growth. Be careful — it may not be N, P, or K.
- ✓ Use tissue tests to increase knowledge of plant nutrition.
- ✓ 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.

Self-Check – 4	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below.

1. What is nutrient cycling? (5 pts.)
2. How soil fertility can be enhanced?(5 pts.)
3. What is **t**issue test result ? (5 pts.)

Note: Satisfactory rating - 25 points and above Unsatisfactory - below 25points .

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

Information Sheet 5 - Assessing soil condition for drainage, compaction, Aeration, water infiltration and moisture conservation techniques

- **water infiltration**

Infiltration is the process of water entry into the soil through the earth's surface. The water at the soil surface can originate from rain, snowmelt or anthropogenic activities

Amount of water in the soil and capacity of soil to hold water are depend upon different factors, such as texture of soils, Compactness of soils, arrangement of soils and Organic matter contents of the soil.

Drainage- is the removal of water by laying drains in or under fields. Soil water drainage capacity is different in different soils, because of soil pore size. The soil which has large pore size has high drainage capacity than small pore size soil. Water infiltration drainage rate will increase as the pore space increases.

Example **sand soil >silt soil> clay soil drainage capacity**. So we have to assess the soil water drainage capacity before we select the area for crop production.

Compaction- is the compression of soil and making it hard. Highly compacted soils have high water holding capacity than less compacted soils. If the soil is compacted indicates the pore space of the soil is filled with water.

This is mostly the property of clay soil. This has its own impact for some crops to be grown.

Aeration- is the replacement of stagnant soil air with fresh air. Soil nutrient availability can also be influenced by compaction as one of the main effects of compaction is on soil aeration, which can lead to de nitrification (loss of nitrogen into the atmosphere).

A well-aerated soil is one in which gases are available to growing aerobic organisms (particularly higher plants) in sufficient quantities and in the proper proportions to encourage optimum rates of the essential metabolic processes of these organisms.

Sufficiently aerated soil must have at least two characteristics:

Sufficient space devoid of solids and water

Ample opportunity for the ready movement of essential gases into and out of these spaces.

Water infiltration-is the entry of water from air to soil. Infiltration rate is the maximum rate at which a soil in given condition can absorb rain/irrigation water as it comes at the soil surface.

- **Infiltration rate depends on:**
  - ✓ Initial moisture content of the soil
  - ✓ Conditions of soil surface and
  - ✓ Permeability of various soil layers

Soil Moisture Conservation techniques

There are a variety of methods that can be used to conserve soil moisture. Most of these soil moisture conservation techniques are relatively low cost and complexity approaches, primarily relying on the presence of required materials and technical capacity locally. Many of the methods rely on providing some kind of cover for the soil to minimize evapotranspiration and direct soil exposure to heat and sun. Generally, most methods used for soil quality improvement and conservation, will also yield benefits to soil moisture conservation. Examples of methods for reducing excess soil moisture loss include following:

- Soil conservation:
- Mulching:
- Cover Cropping:
- Contouring:
- Green manuring:
- Conservation Tillage.
- Crop rotation.
- Mixed cropping

Self-Check – 5	Written test

Name………………………………………… ID……………………… Date…….

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

Test I: Short Answer Questions

1. How we assessing soil condition?(3)
2. What is soil condition?(2)
3. What are the indicators of soil Quality? (4)

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 9 points**

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

6.1. Soil biological activity

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, mycorrhizal 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.

Self-Check – 6	Written test

Name………………………………………… ID……………………… Date…….

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

1. Write role of microorganism in soil(4pts.)
2. What is the relation between plant and mycorrhizalfungi(5pts.)?
3. Write some important microorganism found in soil (4pts.)?

Note: Satisfactory rating - 13 points Unsatisfactory - below 13 points

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

7.1 Soil Health

Soil health is the capacity of a soil to function. How well is your soil functioning to infiltrate water and cycle nutrients to water and feed growing plants?

Soil health is defined as the continued capacity of soil to function as a vital living system, by recognizing that it contains biological elements that are key to ecosystem function within land-use boundaries.

These functions are able to sustain biological productivity of soil, maintain the quality of

Surrounding air and water environments, as well as promote plant, animal, and human health Soil is a living factory of macroscopic and microscopic workers who need food to eat and Places to live to do their work.

There are more individual organisms in a teaspoon of soil than there are people on earth; thus, the soil is controlled by these organisms.
Tillage, fertilizer, livestock, pesticides, and other management tools can be used to improve soil health, or they can significantly damage soil health if not applied correctly.
Managing for soil health (improved soil function) is mostly a matter of maintaining suitable habitat for the myriad of creatures that comprise the soil food web.
Managing for soil health can be accomplished by disturbing the soil as little as possible, growing as many different species of plants as practical, keeping living plants in the soil as often as possible, the soil covered all the time.
There are several criteria to consider when selecting soil health and soil quality indicators.

- **In general, appropriate indicators** should be:
  - ✓ Easy to assess.
  - ✓ Able to measure changes in soil function both at plot and landscape scales.
  - ✓ Assessed in time to make management decisions.

- ✓ Accessible to many farmers.
- ✓ Sensitive to variations in agro-ecological zone.
- ✓ Representative of physical, biological or chemical properties of soil.
- ✓ assessed by both qualitative and/or quantitative approaches.

- **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

- **Management Practices to Improve Soil Health**

- ✓ Reduce Inversion Tillage and Soil Traffic
- ✓ Common Primary Tillage Implements
- ✓ Moldboard Plow
- ✓ Inverts the soil to bury residues, terminate cover crops and perennial sod, and kill weeds

- Disk Plow
- Concave disks mounted in a gang cut residue and invert soil laterally, loosening soil and mixing residue into the soil
- Soil disturbance and residue incorporation depends on the size, shape, and tilt angle of the disks
- Chisel Plow
- Curved shanks with chisel points are dragged through the soil without inversion
- Loosens surface soil, mixes some residue into the soil
- Soil disturbance and residue incorporation depends on the width and twist of chisel points

Fig .tillage with moldboard and chisel plow.

Tillage with a moldboard plow (left side of the photo) inverts the soil, burying weeds, sod, and surface residue. Chisel plowing (right side of the photo) loosens the soil without inversion, retaining residue on the soil surface.

Tillage can also disrupt the hyphal network of mycorrhizal fungi, which can lead to their decline over time. When not managed carefully, most inversion and non-inversion tillage methods compact the subsoil, creating a plow pan, which restricts root growth and access to water and nutrients in the subsoil. Excessive wheel and foot traffic can compact the surface soil, reducing macro porosity and impeding root growth.

- **Increase Organic Matter Inputs**

To maintain or increase soil organic matter levels, inputs of organic matter must meet or exceed the losses of organic matter due to decomposition. Healthy crops can be a valuable source of organic matter, and crop residues should be returned to the soil to the extent possible. Incorporation of cover crops or perennial crops and judicious additions of animal and green manure and compost can also be used to increase or maintain soil organic matter. Soil organic matter content can be monitored over time if you request an organic matter analysis when submitting soil fertility samples to your soil testing laboratory. Be sure that your organic matter comparisons over time are based on data from the same lab or from labs that use the same procedure for organic matter analysis, as results can differ significantly between analysis methods.

- **Use Cover Crops**

Cover crops contribute numerous benefits to soil health. They keep the soil covered during the winter and other periods of time when crops are not growing, reducing the risk of erosion. The biomass produced by cover crops is usually returned to the soil, enhancing organic matter levels. Cover crops with taproots can create macrospores and alleviate compaction. Fibrous-rooted cover crops can promote aggregation and stabilize the soil. Species of cover crops that host mycorrhizal fungi can sustain and increase the population of these beneficial fungi. Legume cover crops can add nitrogen to the soil through nitrogen fixation. Cover crops can retain nitrate and other nutrients that are susceptible to leaching losses.

Fig7.Forage radish, a tap rooted cover crop (left), and cereal rye, a fibrous-rooted cover crop (right)

- **Reduce Pesticide Use and Provide Habitat for Beneficial Organisms**

Beneficial insects that contribute to biological control or pest organisms can be harmed by the application of broad-spectrum insecticides. Farms aping is a whole-farm, ecological approach to increase and manage biodiversity with the goal of increasing the presence of beneficial organisms.

- **Rotate Crops**

Diverse crop rotations will help break up soil borne pest and disease life cycles, improving crop health. Rotations can also assist in managing weeds. By growing diverse crops in time and space, pests that thrive within a certain crop are not given a chance to build their populations over time. Rotating crops can also help reduce nutrient excesses.

- **Manage Nutrients**

Carefully planning the timing, application method, and quantity of manure, compost, and other fertilizers will allow you to meet crop nutrient demands and minimize nutrient excesses. Healthy, vigorous plants that grow quickly are better able to withstand pest damage. However, over fertilizing crops can increase pest problems. Increasing soluble nitrogen levels in plants can decrease their resistance to pests, resulting in higher pest density and crop damage.

- **Managing Nutrients in Soil**

Nitrogen (N) Management

- ✓ Nitrate nitrogen is susceptible to leaching losses because the negative charge of the molecule is not held by cation exchange sites of soil particles. Leaching occurs mainly in the fall, winter, and early spring.
- ✓ Nitrogen in urea-containing fertilizers and manure is susceptible to volatilization losses as ammonia gas when not incorporated into the soil.
- ✓ Nitrate nitrogen can be lost to the atmosphere through conversion into nitrous oxide and nitric oxide gases by microorganisms in warm, poorly aerated soil.
- ✓ Nitrogen losses can be minimized with appropriate timing and application of fertilizers and manures and by using cover crops to limit leaching losses in the winter.
- ✓ Phosphorus (P) Management
- ✓ Phosphorus is tightly bound to soil particles and does not easily diffuse through the soil.
- ✓ Mycorrhizal fungi can assist plant roots in P acquisition in low-P soils.
- ✓ Adding organic matter can mask the P binding sites on soil particles, increasing P availability.
- ✓ Phosphorus can accumulate to excessively high levels when P inputs in manure and fertilizer exceed P removal by crops; this can occur in soil that receives annual manure applications at rates to supply crop nitrogen needs.
- ✓ Erosion can transport soil particles with high levels of P into waterways where P can become a pollutant.
- ✓ Environmental P pollution can be limited by reducing erosion and maintaining soil P levels in the optimum range of 30–50 ppm Mehlich 3 P.

- **Organic improve soil health**

✓ **Higher Matter**

Soils rich in organic matter hold more air and water and produce higher yields than soils low in organic matter**.** They also supply a steady release of nutrients to plants, inhibit erosion, and host a robust population of beneficial microorganisms.

Adding compost, using cover crops and mulches, and limiting tillage—basic principles of organic soil management—increase and preserve organic matter.

Fig9.plant with higher matter

✓ **Holding Nitrogen**

Like carbon dioxide, nitrous oxide is a potent greenhouse gas. Good news: Organic methods can lock up nitrogen and carbon.

Fig10. soil with high N

- ✓ **Fixing Nitrogen**

Nodules that form on the roots of legumes contain bacteria that extract nitrogen from the air and fix it in the soil, allowing the next crops planted in the rotation to absorb it as a nutrient.

- ✓ **Microbe Management**

A robust population of beneficial soil microorganisms improves nutrient and water availability and helps suppress disease-causing pathogens.

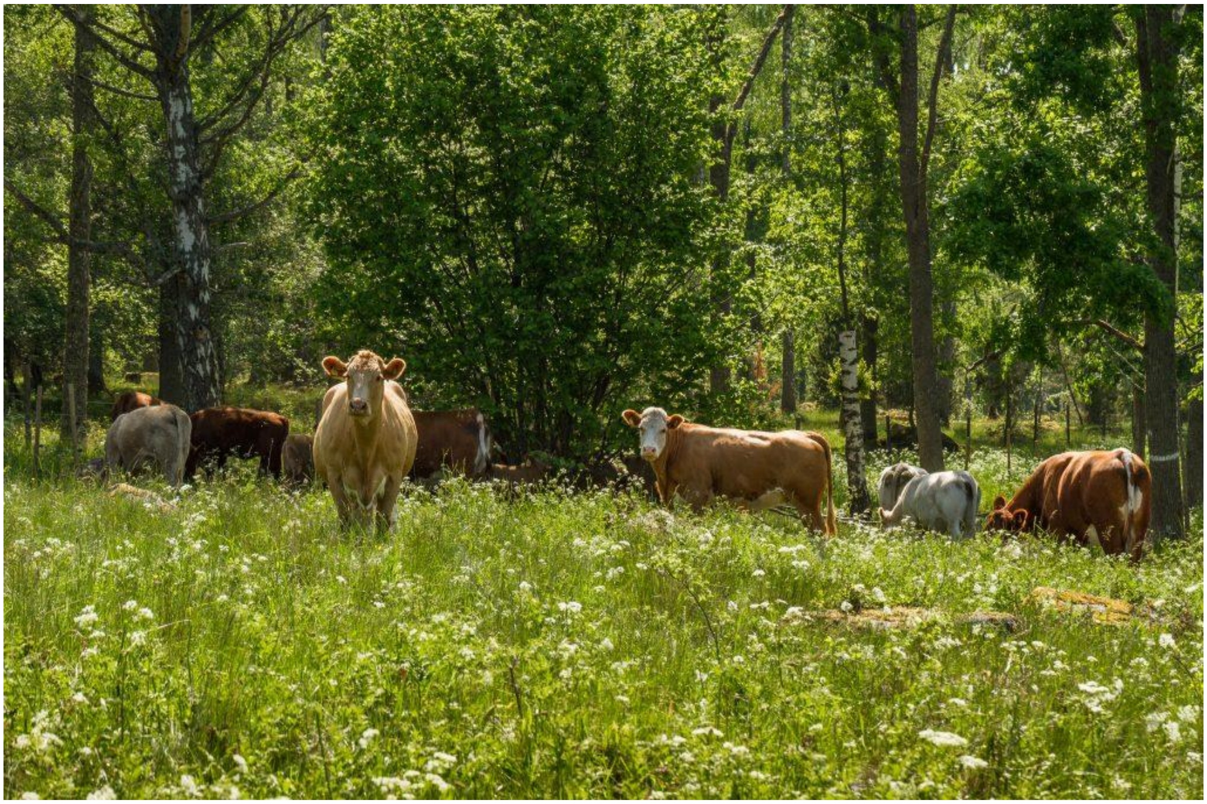


Fig11. Different organism which generate microbes.

- ✓ **Good Fungi**

Arbuscular mycorrhizal fungi (AMF) are beneficial microorganisms that colonize almost all types of plants. They effectively extend the reach of plants' roots, helping them to gather water and nutrients from a larger volume of soil.

AMF colonization has been shown to help crops thrive in dry conditions and in soils with elevated salt levels. Inoculating crops with commercial AMF preparations can be costly, but organic soils tend to be high in native AMF, reducing or eliminating the need for inoculation

- ✓ **Uncultivated Places**

Permanent pastures studied in southern Sweden had higher levels of AMF diversity than cultivated fields. Among the cultivated fields, those managed organically had more biological activity than those managed conventionally, again suggesting that tillage and other practices can encourage or discourage AMF populations**.**

- ✓ **Carbon Capture**

The benefits of high levels of organic matter in the soil extend beyond the farm. Organic matter is rich in carbon, and carbon that is tied up in the soil isn't in the atmosphere, where rising levels may be destabilizing our climate.

Compared with conventional agricultural practices, organic farming methods foster not only higher levels of soil organic matter but also of humified (sequestered) carbon (4.1 percent versus 2.85 percent of the total soil volume), according to the National Soil Project data analysis published in Advances in Agronomy by Mickiewicz and others.

Additionally, the percentage of soil organic matter in a sequestered form is higher in soils managed organically compared to conventionally (57.3 percent versus 45 percent). Specifically, the organic soils are higher in humic acids, the compounds that give topsoil its rich, brown color.

- ✓ **Vetch Plus**

Planting cover crops of hairy vetch can supply all the nitrogen even field corn needs for maximum production.

- ✓ **Stimulus Formula**

Methods other than maintaining a living cover crop and limiting tillage may encourage AMF colonization. Researchers in Brazil reported in the Archives of Agronomy and Soil Science that spraying young bean shoots with an anaerobically fermented mixture of fresh water, cattle manure, cow's milk, sugarcane molasses, and mineral salts stimulates AMF colonization and enhances mineral availability in the soil**.**

✓ **Health Test**

Researchers and testing laboratories are working to roll out soil tests that are more accurate and more cost-effective. The tool estimates plant-available N, P, and K and provides a “Soil Health Calculation”: a numerical measure of the health of your soil based on nutrient and C, N, and P cycling.

Self-Check – 7	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below.

1. What is soil health?
2. Write ways of improving soil health.
3. What is the role of organic fertilizer in improving soil health?
4. Write the management practice that improve soil health.

***Note:* Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

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

Operation sheet I	Carry out soil sampling

Materials required

- ✓ Auger, Knife -Spade /shovel
- ✓ Measuring tape/ruler -Sampling jars/plastic bags
- ✓ Sticky labels -Field test kits
- ✓ Soil information charts

Procedures

1. Prepare soil sampling materials
2. Divide your farm according to the kind of crops grown or to be grown, type of soil (sandy, clayey or loamy) and topography (level, flat, sloping or hilly).
3. Collect soil samples separately from the different soil unit areas and place them in separate containers.
4. Brush away stone, rubbish, trash or grass on the surface of the land.
5. Using the shovel push it down the surface or topsoil to a depth of approximately 15 cm and get a slice of soil sample and Place this in a container.
6. Get similar samples at random from as many as 10 sites and mix them in a container.
7. Get a composite soil sample of about 1 kilo to represent the soil unit area.
8. Air dry the soil samples by spreading them in old newspapers or mats under the shade or indoor.
9. Be sure to avoid contaminations among the samples and keep them away from dirt or foreign matters especially cigarette ash.
10. Divide representative soil samples into four and Remove soil samples 1and 3 and retain soil samples 2 and 4.
11. Repeat the process four times until you obtain one kilo.
12. When air-dried, get at least 1 kilo from each composite soil sample and place it separately in a cloth or plastic bag.
13. Label the bags properly and take them to the Soils Laboratory for analysis

0peration sheet: II	Plant tissue sampling and testing by Acid Digestion

Materials

- ✓ Beaker
- ✓ HNO_3,H_2O_2,HCL
- ✓ Beam balance
- ✓ Digestion tube
- ✓ Thermometer
- ✓ Funnel

Procedures

1. Weigh 0.5 g dried (80°C; 176°F), 0.84-mm (20-mesh screened) plant tissue into a beaker or digestion tube.
2. Add 5.0 mL concentrated HNO_3. Cover with watch glass or place funnel into mouth of the digestion tube. Let stand overnight.
3. Place covered beaker on a hot plate or digestion tube into a port of a digestion block and digest at 125°C (257°F) for 1 h. Remove beaker or digestion tube from plate or block and let cool.
4. Add 3 mL 30% H_2O_2 to the beaker or digestion tube and digest at 125°C (257°F). Repeat additions of 30% H_2O_2 until digest is clear. Add HNO_3 as needed to prevent digest from going to dryness.
5. When the digest is clear, remove the watch glass or funnel and reduce temperature of hot plate or block to 80°C (176°F). Take nearly to dryness. Residue should be colorless. If not, repeat Step
6. Add 1:10 HNO_3 or HCl to bring to final volume of 10 mL. Clear solution is ready for elemental assay.

Operation sheet III	Plant tissue analysis

Objectives

1. To familiarize the Trainee with Plant tissue analysis

Material required

1. Potassium test paper (3 spots on the paper (3 spots on paper)
2. Nitrate powder
3. Sample bag
4. P-K reagent No1 and P-reagent No2
5. Sharp knife
6. Needle nosed pliers

Procedures

1. Take a plant sample (petiole or stem) from field
2. Cut the portion of the green plant tissue and place on folds test paper
3. Add nitrate powder to the tissue and squeeze together.
4. Then observe the color changes and report to your instructor

Name………………….ID…………..……..Date………………………….

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2**hour. The project is expected from each student to do it.

Task-1 Undertake plant tissue analysis.
Task -2.performe soil sampling and labeling.

LG #79	LO #3- Select and implement allowable techniques and inputs to optimize soil fertility.

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 • Identifying and evaluating suitable nutrient cycling techniques • Calculating appropriate inputs • Selecting and managing cover crop and pasture systems • Applying and monitoring mulching and composting systems • Designing and implementing crop cropping systems • Selecting and implementing cultural practices 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 • Identify and evaluating suitable nutrient cycling techniques • Calculate appropriate inputs • Select and managing cover crop and pasture systems • Apply and monitoring mulching and composting systems • Designing and implement crop rotations • Select and implementing cultural practices
Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the “Information Sheets-1
3. Accomplish the “Self-check”
4. If you earned a satisfactory evaluation proceed to “Information Sheet -2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity
5. Submit your accomplished Self-check. This will form part of your training portfolio.
6. Read the information written in the “Information Sheet
7. Accomplish the “Self-check”
8. If you earned a satisfactory evaluation proceed to “Information Sheet However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity
9. Submit your accomplished Self-check. This will form part of your training portfolio.
10. Read the information written in the “Information Sheet.
11. Accomplish the “Self-check”
12. If you earned a satisfactory evaluation proceed to “Operation

Information Sheet 1- Identifying range of allowable inputs

1.1. Select and implement allowable techniques and inputs fertility

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

- **Identifying Range of allowable input**

✓ by the total nutrients added,

✓ y controlling the net mineralization-immobilization patterns,

✓ as a source of C and energy to drive microbial activities, (iv) as precursors to SOM fractions, and

✓ Through interactions with the mineral soil in complexing toxic cations 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.

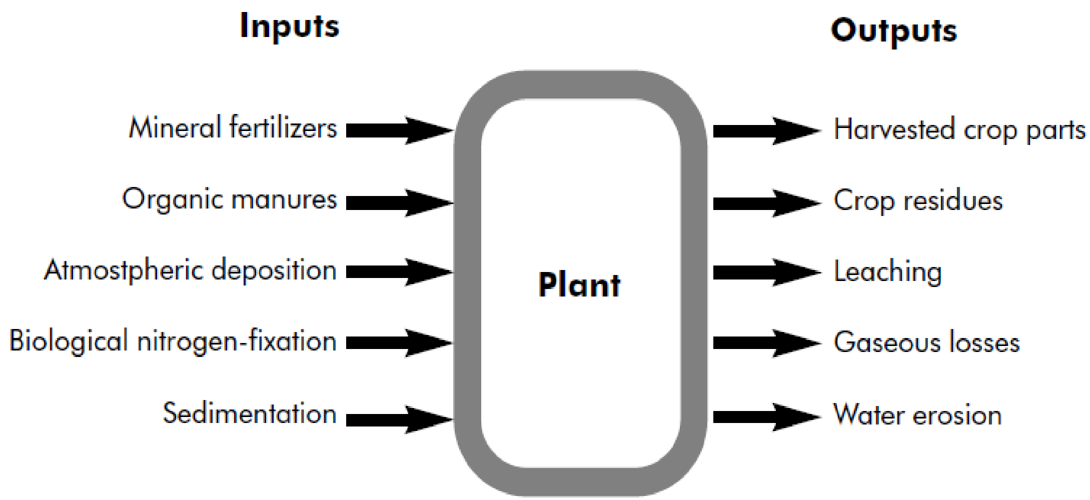


Fig12..Input and output.

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.

Self-check 1	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below.

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

***Note:* Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 2- Identifying and evaluating suitable nutrient cycling techniques

2.1. Introduction

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:**

✓ **Fertility Indicators**

Fertility Indicators including mineral nitrogen, potentially mineralizable nitrogen, soil nitrate, soil test phosphorus, potassium, sulfur, calcium, magnesium, boron, and zinc.

✓ **Organic Matter Indicators**

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 .

✓ **Soil Reaction Indicators**

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 (CO2) 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 CO2 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 (*Nitrosamines* 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 denitrification.

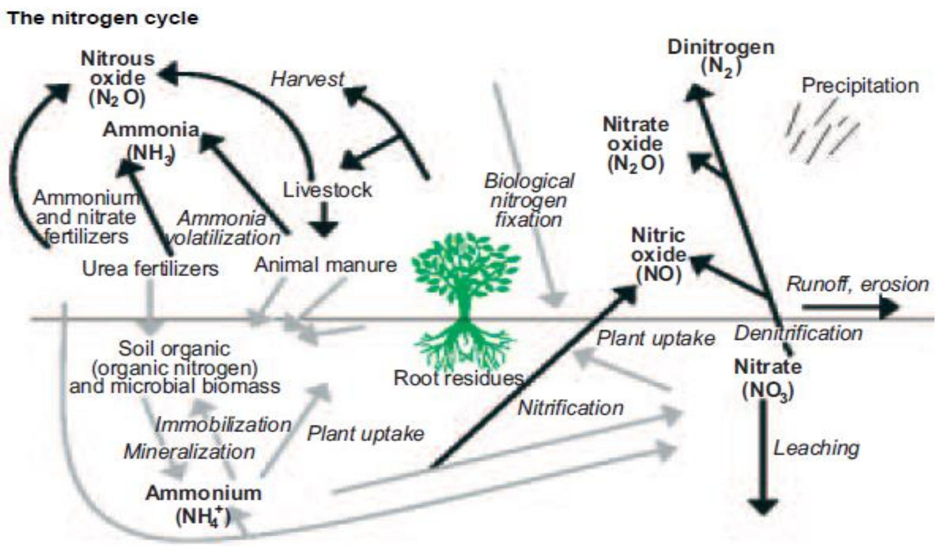


Fig13.nitrogen cycle.

✓ 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.

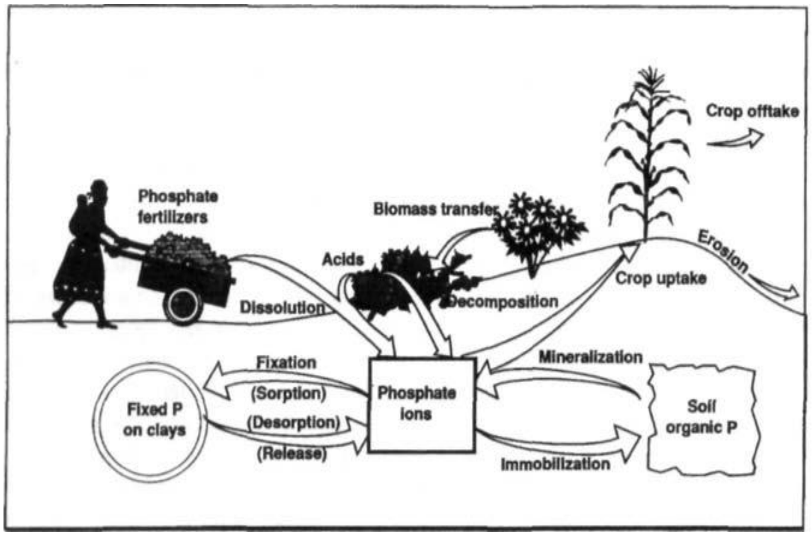


Fig14. Phosphorus cycle

Self-Check – 2	Written test

Name………………………………………… ID………………………… Date…….

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

Test I: Short Answer Questions

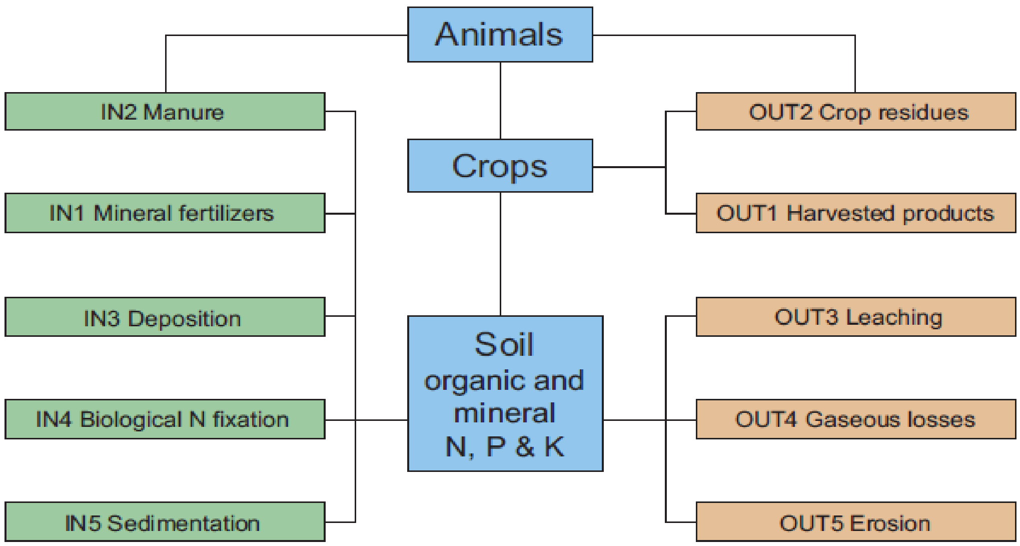
1. What is nutrient cycling?(5 pts.)
2. How soil fertility can be enhanced ?(5 pts)
3. What are cover crops ?(5 pts)
4. How aeration affects composting?(5 pts)
5. Mention soil inputs and out puts?(5 pts)

Note: **Satisfactory rating - 24 points and above Unsatisfactory - below 24 points**

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

Information Sheet 3- Calculating appropriate inputs

3.1. Calculating Appropriate inputs



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

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

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

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.

$$OUT4\ (N) = \text{'Base'} + 2.5 \times F + 0.3 \times (IN1 + IN2) - 0.1 \times UN$$

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.

Self-Check – 3	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below.

1. Write organic agricultural inputs.

2. What is output?

Part I: Calculation.

1. Calculate assume that 100tn of compost is needed for one hectare ,how much compost is needed for 2000cm^2 land.

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

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

Information Sheet 4- Selecting and managing cover crop and pasture systems

4.1. Introduction

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.

Self-Check – 4	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. List types of grinding wheel.

1. What is cover crop?
2. Write importance of cover crops.
3. Write some example of cover crop.

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

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

Information Sheet 5 - Applying and monitoring mulching and composting systems

5.1. Developing, applying and monitoring Mulching and composting systems

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.

3.1. Mulching

Mulching is a widely-practiced gardening technique that is beneficial for plants when done properly. It is the act of covering the soil with mulches, such as bark, wood chips, leaves, and other organic material, in order to preserve moisture and improve the condition of the soil.

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 inorganic 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

- **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

3.2. Composting systems

Composting is defined as the biological degradation process of heterogeneous solid organic materials under controlled moist, self-heating, and aerobic conditions to obtain a stable material that can be used as organic fertilizer.

Compost is a mixture of ingredients used to fertilize and improve the soil. It is commonly prepared by decomposing plant and food waste and recycling organic materials. The resulting mixture is rich in plant nutrients and beneficial organisms, such as worms and fungal mycelium. Compost improves soil fertility in gardens, landscaping, horticulture, urban agriculture, and organic farming.

The benefits of compost include providing nutrients to crops as fertilizer, acting as a soil conditioner, increasing the humus or humic acid contents of the soil, and introducing beneficial colonies of microbes that help to suppress pathogens in the soil. It also reduces expenses on commercial chemical fertilizers for recreational gardeners and commercial farmers alike. Compost can also be used for land and stream reclamation, wetland construction, and landfill cover

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.

Compost is an organic fertilizer that can be made on the farm at very low cost. The most important input is the farmer's labour. Compost is decomposed organic matter, such as crop residues and/or animal manure. Most of these ingredients can be easily found around the farm.

Composting converts kitchen and garden waste into dark colored soil that is high in nutrients.

- **Requirements for Efficient Decomposition**

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

- **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.

- **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.

- **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.

- **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 airborne.

- **The composting process**
- ✓ Heating phase
- ✓ Cooling down phase
- ✓ Maturation phase
- **Methods to make compost**
  - ✓ Indore method

- ✓ Bangalore method
- ✓ Heating process or block method
- ✓ Pit composting
- ✓ Trench composting
- ✓ Basket composting
- ✓ Boma composting

- **Composting specific materials**
  - ✓ Composting water plants
  - ✓ Composting seaweed
  - ✓ Composting coffee pulp
  - ✓ Composting domestic waste

Self-Check – 5	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below

1. Why applying and monitoring of mulching system is important?
2. Mulching is_________________.
3. Write some important of mulching.

Note: **Satisfactory rating - 4 points Unsatisfactory - below 4 points**

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

6.1. Cropping systems

A cropping system may be defined as a community of plants which is managed by a farm unit to achieve various human goals. They are able to set, or modify, their own goals, so two farms with identical climates and soils may be managed with different aims to achieve a different mix of outputs. A cropping system refers to the type and sequence of crops grown and practices used for growing them. It encompasses all cropping sequences practiced over space and time based on the available technologies of crop production. Cropping systems have been traditionally structured to maximize crop yields.

- **Types of cropping systems**
  1. Shifting cultivation
  2. Continuous cropping
  3. Crop rotation
  4. Mono-cropping or monoculture
  5. Intercropping and sole cropping

1. Shifting cultivation

It is a primitive method of cropping system. The term was not at permanent location instead; a piece of land is cleaned and farmed continuously until low yields appear. The land in then abandoned until natural vegetation is well grown on it, due to the effect of weed, insect, disease, degradation of soil nutrients etc.

- **Types of shifting cultivation**
  - ✓ **Bare fallow**: - the land is cultivated (utilized) for two to three years for crop production and left for one year without any vegetation.
  - ✓ **Bush fallow**: - the vegetation is allow to grow over the land and it becomes fertile several years of bush fallow, the farmers return to their original location

- Activities in shifting cultivation
  - ✓ Clearing and burning of the vegetation debris
  - ✓ Hoeing with hand hoe
  - ✓

- **Advantages of burning plant debris**
  - ✓ Simple and inexpensive
  - ✓ Kills crops pests
  - ✓ Produce ash that contain Ca, and K that applied to acidic soil.
- **Disadvantage_of_burning**
  - ✓ N nitrogen and Sulphur are converted into oxides and escape to atmosphere
  - ✓ Beneficial microorganisms mat be destroyed
  - ✓ Low content of organic matter

2. Continuous cropping

It is a repeated land use that leads to low yields due to low nutrient content in the soil, disease and pests problem. This is supported by technology to solve nutrient and insect pest problem like fertilizer application, chemical application, crop selection etc.

3. Mono-cropping or monoculture

It is a continuous cropping of the same crop species on the pieces of land.

The problem of mono-cropping may be similar weed species involved, insect and diseases are created.

4. Crop rotation

- It is a system of growing different crop species in recurrent succession on the same land, season after season of year after year.
- Importance of crop rotation
- Improve soil fertility
- Reduce insects and disease infestation
- Reduce infection of some weed species.

- **Bases for farmer decision in selection crops to be grown in crop rotation**
  - ✓ Economic consideration.
  - ✓ Legume crops should be involved in the rotation program.
  - ✓ Adaptation of the crop to the altitude.
- **Factors to be considered in deciding the sequence of crops in crop rotation**
  - ✓ Botanical similarity the crops:- because crop that botanically similar , have the same pests problem. Example, Barley and wheat. Pea and bean
  - ✓ Deer rooted feeder following shallow feeder crops.
  - ✓ High feeder should be planted after pulse or left fallow.

5. Intercropping and sole cropping

Intercropping is the growing of two or more crops simultaneously on the same piece of land. It is not necessary to harvest the two crops together. It may be planted together or at different times.

Sole cropping: is the cultivation of one crop variety alone in pure stand.

- **Types of intercropping**

a. **Row intercropping**:-This follows specific arrangement (row planting) E.g. Maize and bean.

b. **Mixed intercropping**: - two or more crops are mixed up and broadcasted over the field. Example, Wheat and barley, horse bean and pea etc.

c. **Relay intercropping:** - it is the system planting of the second crop at the mid harvest of the first crops. Example, teff after mid harvest of maize.

- **Advantage of intercropping**

✓ The crop may be complement each other.
✓ The period of their peak demand for the resource may differ.
✓ An intercropped crop may be to utilize resource which the main crop may not be able to utilize.
✓ Provides shade for delicate seedling.
✓ Cereals may be benefited from pulse.
✓ Risk avoidance

- **Disadvantage of intercropping**

Mechanization problem that is application of herbicides, harvesting etc

.

Self-Check – 6	Written test

Name…………………………………………ID………………………… Date…….

Directions: Answer all the questions listed below.

1. What are the Factors that affecting crop rotation?
2. Write types crop rotation.
3. Define crop rotation.
4. Write the principles of crop rotation.
5. What is the role of crop rotation in maintaining soil fertility?

***Note:* Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

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

Information Sheet 7- Selecting and implementing cultural practices

7.1. Cultural Practices

Conservation tillage is an important practice that can effectively reduce soil erosion. Some tillage practices are agronomic and cultural in nature. Others are structural. However, these practices are not mutually exclusive.

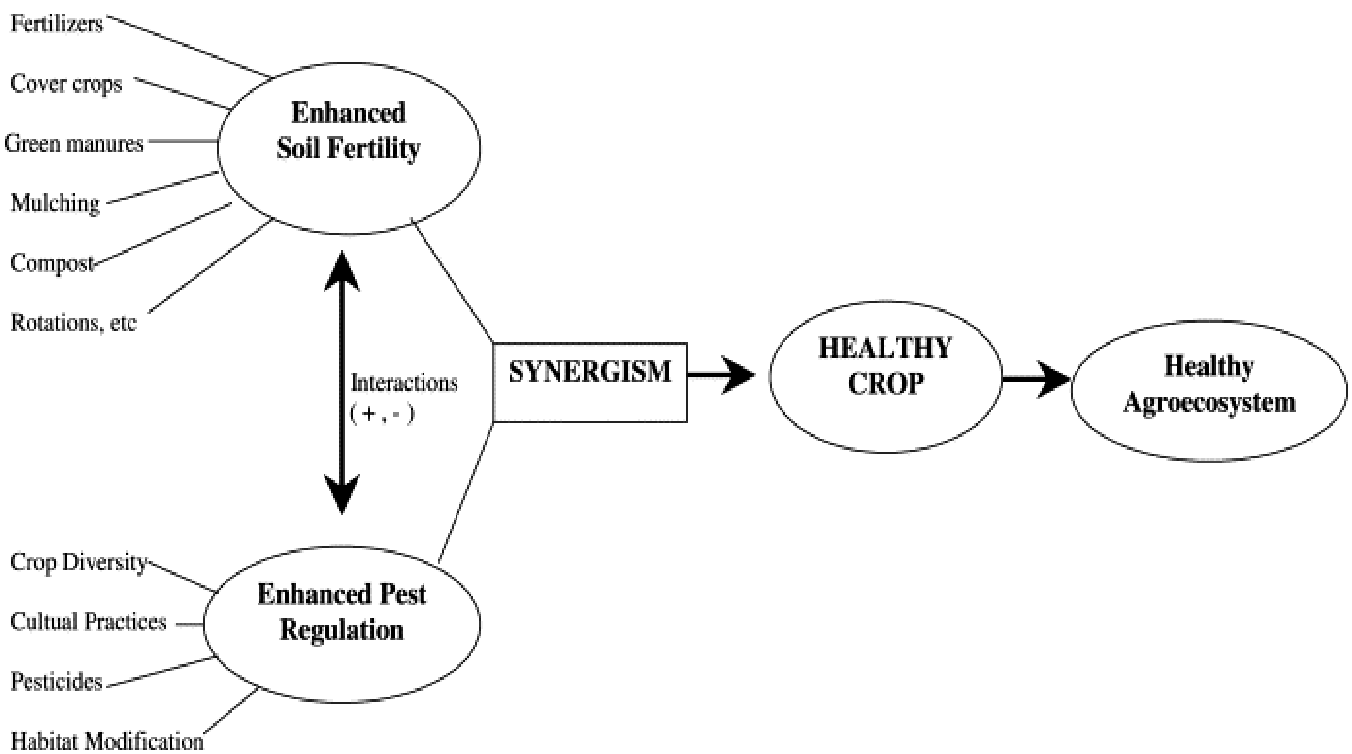
Erosion is induced by several factors, such as slope and crop rotation. On moderate slopes, the loss reduction of erosion under uphill and downhill planting is approximately 50%. On the other hand, on steep slopes, the hazard of rilling erosion is increased.

Row spacing is another practice that can be effective in reducing soil erosion on sloping areas. Reducing row spacing can provide dense surface cover and reduce the area of soil surface exposed to water or wind impacts .However, planting, cultivating, and harvesting equipment will dictate the limitation of such a practice. Strip cropping and terracing are other methods to control erosion by dividing the slope into discrete segments.

Although there is soil movement within the terrace, the majority of the detached soil stays on the terrace. Grass waterways and buffer strips are another option that can be used to receive excess surface water runoff or drain-age water from terrace channels. This practice helps remove sediment from the water before it leaves the field. The contribution of such practices to improving productivity and water quality is significant.

Crop rotations and soil fertility We will describe the use of crop rotations to improve fertility.

General cultural practices to enhance soil fertility



Self-Check – 7	Written test

Name…………………………………………… ID………………………… Date…….

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

Test I: Short Answer Questions

1) What is mulching?
2) How soil fertility will be enhanced?
3) What is the role of composting in production of horticultural crops .Explain in details.

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

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

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