Crop Production and Marketing Management Level – IV

Based on March 2018, Version 3 Occupational standards (OS).

Module Title:Applying and Develop Soil Health and Plant Nutrition Program

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Instruction sheet 1

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

- Defining goals and target site for assessment and development of program
- Accessing and reviewing relevant climate data, environmental context
- Determining soil, plant and water tests
- Developing soil, plant and water tests program
- Implementing and monitoring testing tasks
- Compiling and presenting data and readings
- Determining seasonal variations and requirements
- Characteristics, condition and nutritional status of soils and plant species

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:

- Define goals and target site for assessment and development of program
- Access and reviewing relevant climate data, environmental context
- Determine soil, plant and water tests
- Develop soil, plant and water tests program
- Implement and monitor testing tasks
- Compile and present data and readings
- Determine seasonal variations and requirements
- Characterize, condition and nutritional status of soils and plant species

Learning Instructions:

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

Information Sheet 1- Defining goals and target site for assessment and development of program

1.1. Introduction

The Growth of plants has interested thoughtful men in all ages. The first knowledge about soils was gained from farmers through trial and error. Later on, some experiments were conducted.

By trial and error practices Ancient great civilizations produce high yields. All Ancient great civilizations have in common that the exact mechanisms were not known by the "inventors" but a gradual development took place. With our present day knowledge however causes can be identified.

More than 1500 years BC (Before Christ) Ancient great civilizations were based on good soils. For example, the ancient dynasties of the Nile were dependent upon the fertile soils of Nile valley and associated irrigation systems. The Mesopotamia and Indus civilizations were also based on the fertile soils of the Tigris and Euphrates rivers. These civilizations used irrigation as an abundant source of food. But finally the civilization of Mesopotamia disappeared because of salinization.

Fallow systems were developed all over the world; in a natural way fertility was regained. In Europe around 1000 years AD (Anno Domini or after Christ or GC (Gregorian calendar)) a fallow system using legumes as a green manure was introduced.

Tillage is recognized to be beneficial; leached nutrient are brought again to the topsoil and decomposition and mineralization of organic matter is possible because oxygen is allowed to enter the soil. The practice of adding all kinds of organic matter in any form closes the leaking nutrient cycle a little bit more and makes agriculture more sustainable. Slash and burn practices provide the most limiting elements (potassium and phosphate) to the subsequently planted crops.

Soil healthy acts as a dynamic living system that delivers multiple ecosystem services, such as sustaining water quality and plant productivity, controlling soil nutrient recycling decomposition, and removing greenhouse gases from the atmosphere. Soil health is closely associated with sustainable agriculture, because soil microorganism diversity and activity are the main components of soil health.

Agricultural sustainability is defined as the ability of a crop production system to continuously produce food without environmental degradation. Arbuscular mycorrhizal fungi (AMF), cyanobacteria, and beneficial nematodes enhance water use efficiency and nutrient availability to plants, phytohormones production, soil nutrient cycling, and plant resistance to environmental stresses.

Soil health is "the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals and humans."

The soil health foundation consists of five principles:

1) Soil armor

2) Minimizing soil disturbance;

3) Plant diversity

4) Continual live plant/foot; and

5) Livestock integration. These principles are intended to be applied in a systems approach, maximizing the soil building impact.

Principle 1. Soil armo (protective covering).

In this first of five articles on soil health, Jay explains the concept of "soil armor" and why it is important for building soil health.

Soil armor or cover, provides numerous benefits for cropland, rangeland, hayland, gardens, orchards, road ditches, and more. Let's take a closer look at some of the soil armor benefits:

- **Controlling Wind and Water Erosion** – armor protects soil from wind and/or water as it moves across the soil surface. It holds the soil in place along with valuable soil organic matter and nutrients.
- **Evaporation rates** – armor reduces the soil evaporation rates, keeping more moisture available for plant use.

- **Soil Temperatures** – armor helps soils maintain a more moderate range of soil temperatures, keeping soil warmer in cold weather, and cooler in hot weather. Like us, the soil food web functions best when soil temperatures are moderate.
- **Compaction** – rainfall on bare soils is one cause of soil compaction. When rainfall hits the armor instead of bare soil, much of the raindrop energy is dissipated.
- **Suppresses Weed Growth** – limits the amount of sunlight available to weed seedlings.
- **Habitat** – provides a protective habitat for the soil food web's surface dwellers

Figure 1 shows the residual armor after corn planting was completed at the Menoken Farm

Principle 2 Minimizing soil disturbance

In this Second of on soil health explains the concept of "soil disturbance" and why minimizing soil disturbance is important for building soil health Soil disturbance can generally occur in different forms:

- **Biological disturbance**, such as overgrazing, which limits the plants ability to harvest CO2 and sunlight.
- **Chemical disturbance**, such as over application of nutrient and pesticide, can disrupt the soil food web functions.
- **Physical disturbance,** such as tillage, which we will focus on in this article.

A typical soil is approximately 45% mineral (sand, silt, and clay), 5% soil organic matter, 25% water, and 25% air. The water and air portions exist in the pore spaces between the soil aggregates. Over time, tillage implements reduce and remove the pore spaces from our soils; restricting infiltration and destroying the biological glues which hold our soils together.

Ultimately tillage results in one or more of the following:

- Water erosion; transporting soil, nutrient, and water to offsite locations, which negatively impacts water quality and quantity.
- Wind erosion; transporting soil, and nutrient to offsite locations, which negatively impacts air quality, human health, and animal health.
- Ponding water; which stays saturated on the surface for long periods of time, a result of reduced infiltration and increased runoff.
- Crusting easily, which restricts plant emergence.
- Soil organic matter depletion.

Can we reverse the impacts from tillage and improve soil function? Yes, we can. Minimizing soil disturbance is a good start to rebuilding soil aggregates, pore spaces, soil glue, and soil organic matter. This is an essential step for long term soil productivity.

Principle 3 Plant diversity

In this third of five articles on soil health, Jay explains the concept of "plant diversity" and why providing plant diversity is important for building soil health.

The Journals of Lewis and Clark describe the northern plains landscape as having abundant plant diversity. Numerous species where observed, working together as a plant community to provide forage for large herbivore populations. Our soils where built over geological time in this environment.

However, settlement of the plains brought agriculture, which resulted in the polyculture perennial landscape being replaced by a monoculture annual landscape. Where the soil food web use to receive carbon exudates (food) from a diversity of perennial plants harvesting sunlight and carbon dioxide; it now receives carbon exudates from only one annual plant at a time.

We can start to mimic the original plant community by using crop rotations which include all four crop types. Diverse crop rotations provide more biodiversity, benefiting the soil food web; which in turn improves rainfall infiltration and nutrient cycling, while reducing disease and pests. Crop rotations can also be designed to include crops which are; high water users, low water users, tap root, fibrous root, high carbon crops, low carbon crops, legumes, and non-legumes to name a few.

The following lists the four crop types with a few common crop examples of each:

- Warm Season Grass – corn, sudan, and millet.
- Warm Season Broadleaf – sunflower, and soybean.
- Cool Season Grass – wheat, oat, barley, and rye.
- Cool Season Broadleaf – flax, pea, and lentil.

Diverse crop rotations mimic our original plant diversity landscapes. They are important to the long term sustainability of our soil resource and food security.

Principle 4 continual live plant/root

In this fourth of five articles on soil health, Jay explains the concept of “continual live plant/root” and why providing a continual live plant is important for building soil health.

Our perennial grasslands consist of cool season grasses, warm season grasses, and flowering forbs. Consequently, adaptable plants are able to grow during the cool spring and fall weather, as well as the summer heat. Allowing for a continual live plant feeding carbon exudates to the soil food web during the entire growing season. .

Cover crops can address a number of resource concerns:

- Harvest CO_2 and sunlight, providing the carbon exudates to the soil food web.
- Building soil aggregates and pore spaces, which improves soil infiltration.
- Cover the soil, controlling wind and water erosion, soil temperature, and rainfall compaction.
- Catch and release of inorganic nutrients, improving water quality.
- Salinity management.
- Pollinator food and habitat.
- Weed suppression.
- Wildlife food, habitat and space.
- Livestock integration.
- Adding crop diversity
- Adjusting the cover crop combination’s carbon/nitrogen ratio, to either accelerate or slow decomposition.

Figure 2 shows Cover Crop on Pea

Principle 5 Livestock integration

In this fifth of five articles on soil health, Jay explains the concept of "livestock integration" and why animals are important for building soil health.

Animals, plants, and soils have played a synergistic role together over geological time. In recent years, animals are playing a reduced role due to being placed in confinement and fewer farms now include livestock as part of their overall operation.

Why do we want to return livestock to the landscape?

- Fall or winter grazing to convert high carbon annual crop residue to low carbon organic material; balancing the carbon/nitrogen ratio and managing our crop rotation residue for no-till seeding.

- Spring or summer grazing annual and/or perennial plants with short exposure periods followed by long recovery periods; allows the plants to regrow and harvest additional sunlight and CO_2.
- Reduce nutrient export from our cropland and hay land fields. In lieu of transporting feed to a feed lot, we can reverse the roles and have the livestock graze the material in place. Recycling the majority of nutrients, minerals, vitamins, and carbon.
- Manage weed pressure by grazing in lieu of an herbicide.
- Grazing cover crops and/or crop residues allow us to take the livestock off the perennial grasslands earlier in the fall. Extending the grass recovery period and providing a higher livestock nutritional diet.
- Grazing reduces livestock waste associated with confinement; helping manage our water quality and nutrient management concerns. Allowing cattle and sheep to be herbivores by securing their energy needs from plants.

- Winter and fall grazing cover crops and annual crop residues.
- Summer grazing a full season cover crop, allowing adequate plant recovery, followed by a second grazing during the fall or winter.
- Winter feeding on hayland fields by rolling out bales or bale grazing.
- Seed rotational perennials, graze and manage as part of the crop rotation.

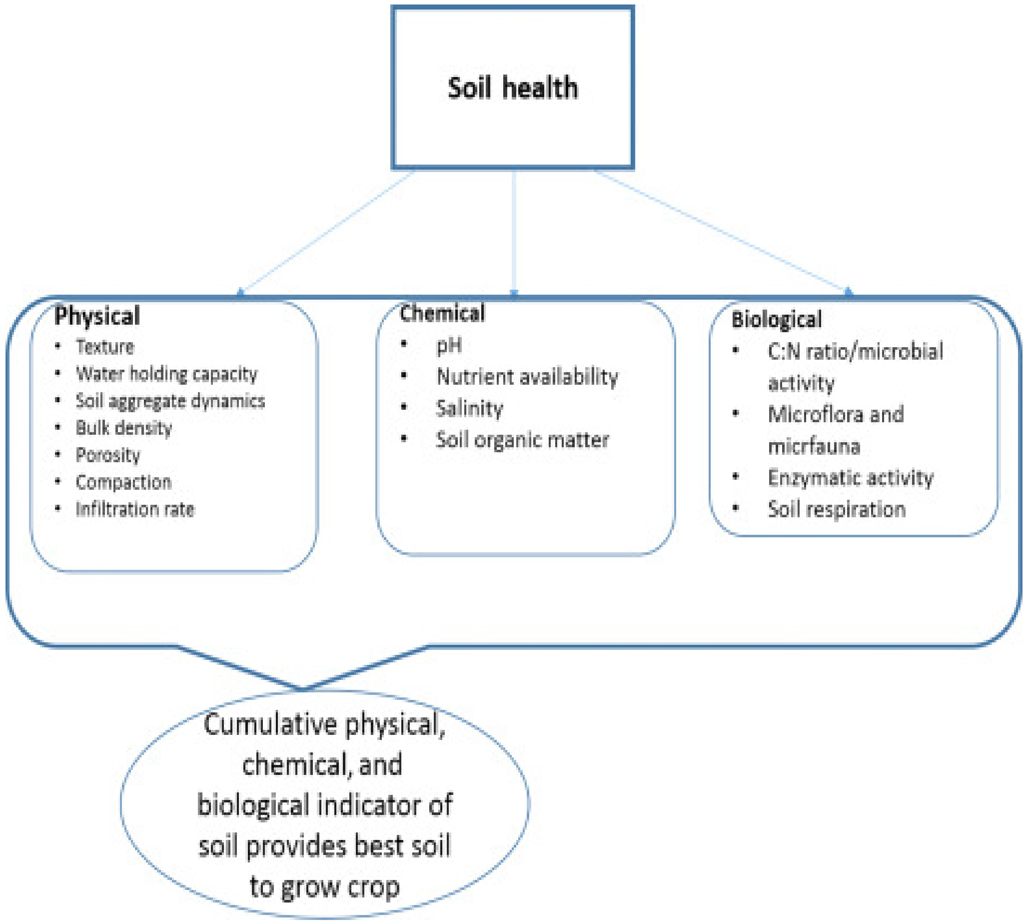

Figure 3. Indicator of soil health.

1.2 Goals and target site for assessment and development of program

Goals and target site for assessment and development of program are defined following a review of enterprise production plan and in consultation with landholder. This is the first step to take soil health development and plant nutrition program because after you defined the goals and target site for the assessment and development you can undertake the next process .For example your goals may be to achieve appropriate soil conditions and hence depending on this you have to assess the area where to be developed based on the problems of soil health around there

1.2. Determine objective and assessing soil health

Soil health assessment is a growing field of research in which the functions and complexities of soil, a vital natural resource on Earth, are quantified so that the overall health of the soil can be managed for longevity and sustainability, both for agricultural and environmental needs such as carbon sequestration.

While momentum is building behind the concept of soil health as a major driver of improved global food security and climate change mitigation, it is still unclear how we can accurately measure the health of soil for the sake of economic, political, and agriculturally applicable reasons.

Goals and target site for assessment and development of program are defined following a review of enterprise production plan and in consultation with landholder. This is the second step to take soil health development and plant nutrition program because after you defined the goals and target site for the assessment and development you can undertake the next process.

For example your goals may be to achieve appropriate soil conditions and hence depending on this you have to assess the area where to be developed based on the problems of soil health around there. Since different producers will have different goals for a soil quality evaluation, ask them to clearly state what they hope to achieve.

Some producers may be seeking assistance to improve overall soil quality, because they recognize the direct impact this will have on the profitability and health of the operation. Other producers may have recognized soil quality degradation in specific fields and request assistance only in those fields. Some may require assistance in troubleshooting small problem areas.

Generally, their goals will fall into one of the following areas:

- Improve soil quality.
- Maintain soil quality.
- Stop or reverse soil quality degradation.
- Troubleshoot problem areas.

Results of comparisons of different management systems in different fields or in problem areas can often be obtained quickly. A few sets of measurements from each field or area can often provide important insight into the direct effects of management. Results of evaluations of new practices or information about long-term trends will not be available immediately.

Self-check 1	Written test

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

Directions: Answer all the questions listed below.

Test I: Choose the best answer (5 point)

1. The second step to take soil health development and plant nutrition program?

A. Identify problem B. Determine goal C. A & B

2. Identify whether producer wants to improve or maintain soil quality or to troubleshoot problem or low productivity areas.

A. Determine goal B. Identify problem C. All

Test II: Short Answer Questions

1. What is soil health (5)

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2. Soil quality is the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries to: (10 point)

____

____

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

Note: **Satisfactory rating - 15 points** **Unsatisfactory - below 15 points**

Information Sheet 2- Accessing and reviewing relevant climate data, environmental context

2.1. Introduction

Relevant climatic data, environmental context information and site data are assessed and reviewed for developing soil health and plant nutrition program. This is because while developing soil health those factors can affect the program. For example most of the time soil management or amendment under taken depending up on weather conditions. For instance it is difficult to undertake action like erosion protection during rainy season, but is possible after the rain is off

Plant growth and geographic distribution are greatly affected by the environment. If any environmental factor is less than ideal, it limits a plant's growth and/or distribution. For example, only plants adapted to limited amounts of water can live in deserts. Either directly or indirectly, most plant problems are caused by environmental stress.

In some cases, poor environmental conditions (e.g., too little water) damage a plant directly. In other cases, environmental stress weakens a plant and makes it more susceptible to disease or insect attack.

Environmental factors that affect plant growth include light, temperature, water, humidity, and nutrition. It is important to understand how these factors affect plant growth and development. Several factors can directly or indirectly affect the nutritional quality of crops. Among these are soil factors, such as pH, available nutrients, texture, organic matter content and soil-water relationships; weather and climatic factors, including temperature, rainfall and light intensity; the crop and cultivar; postharvest handling and storage; and fertilizer applications and cultural practices.

These factors are grouped in three basic categories known as technological (agricultural practices, managerial decision, etc.), biological (diseases, insects, pests, weeds) and environmental (climatic condition, soil fertility, topography, water quality, etc.). These factors account for yield differences from one region to another worldwide

2.1.1 Accessing and reviewing climatic data

- Rainfall
- Wind
- Temperature

2.1.2 Accessing and reviewing environmental context information

- Soil erosion
- Runoff
- Pollution

2.1.3 Accessing and reviewing site data

- Topography
- Soil type
- Vegetation cover
- History of site
- Site management practices
- Productive potential of site
- Fertility status
- Demography

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Self-check 2	Written test

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

Directions: Short Answer Questions.

Test I: Choose the best answer

1. Environmental factors that affect plant growth include;

A. Humidity B. Temperature C. Water D. all **(**2 point)

2. The environmental factors can be classified into (3 point)

A. Abiotic B. Biotic C. All

3. Temperature and rainfall are climate variability that affects plant growth (5 point)

A. True B. False

Test II: Description

3. The abiotic constraints include (5 point)

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2. Biotic factors include? (5point)

____

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

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

Information Sheet 3- Determining soil, plant and water tests

3.1. Soil test

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

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

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

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

3.2. Plant diagnosis/test

It is the second ways of knowing the nutrient status in the soil. Plant ability to uptake nutrients influenced by soil fertility, soil temperature, soil compaction, and soil moisture. Plant analysis can tell us the present actual nutrient up taken. Hence the amount of nutrient in the plant related to that available from soil. Generally plant analysis is made to identify deficiency and nutrient shortage and to aid nutrient supply. There are two types of plant analysis (1) green tissue and (2) total plant analysis. The plant is able for better production, to utilize the growth factor occurring in minimum amount, in proportion as the other growth factors occur at the optimum value for the plant.

Since the major nutrient elements (NPK) moves from old to new tissue the recent matured leaf is sufficient to test. Generally plant part like petiole, leaves and whole top can be taken as sample. Stage of plant sample is important in plant testing b/c nutrient status and demands change during the season. Hence critical stage for plant test is during maximum vegetative growth and reproductive stage. However; the last stage is difficult to correct the problem.

- **Total plant analysis-** obtaining the plant sample is a critical step in plant diagnosis. Not only is the physical position of the plant parts to be selected for analysis important .but also stage of development is important in its ability to reflect the nutrient needs of the plant . Ideally the sample from a normal, healthy plant should be obtained at the same time the problem plants are sampled.

When the analysis are to be used for nutritional or diagnostic purpose , it is important that the plant samples be free from disease, insect damage and physical and chemical injury.

Preparation of plant samples for analysis:-

To prevent spoilage of the plant materials, it is important that the sample be air dried for at least 1day prior to mailing into the containers, supplied by laboratory

Sample should not be mailed in poly ethylene bags or any air tight containers or the sample will spoil. Where the plant sample has been contaminated from soils ,spray ,or residues of other materials , it is imperative that it be cleaned before drying , especially when micronutrients analysis are performed.

2. Green tissue analysis is differ from total plant analysis in that the green succulent plant tissue is analyzed semi-quantatively for the concentration of soluble nutrients particularly nitrogen, phosphorus, and potassium. In the plant sap. Plants growing under adequate fertility conditions absorb more nutrients than they can actually assimilate at any one time, thus making surplus of nutrients prevent in the tissue. Test can be performed rather rapidly either in the laboratory or in the field. Where the plants are growing. For this reason plant tissue or green tissue tests are commonly referred as 'quick **tissue test'**.

In selecting the parts of the plant part to be used for green tissue analysis ,it is imperative to remember that the three major nutrient elements (NPK)move from the old to the new tissue when deficiencies of these elements develops. It is may be advantageous, therefore to sample both the old and the new tissue, but generally, attest of the old tissue is sufficient.

To obtain an accurate evaluation of the available of plant nutrients it is best to sample the tissue at regular intervals ,perhaps six time throughout growing season. If, on the other hand, only one test will be made during the growing season, it is best to make the test when the plant is under greatest stress. This will likely occur about mid-season when flowering and seed setting is initiated. There are two methods that are commonly employed for carrying out green tissue analysis:

1. The paper test for NPK.
2. The glass vial test for NPK

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

Tests for phosphate –phosphorus- can be carried out by squeezing the sap from the freshly cut plant tissue on to the paper strips(Re-agent No1,stannous oxalate ,and re-agent No2 ammonium moybdate). An adequate supply of phosphorus is indicated by a medium blue to dark blue color. Alight blue color denotes a deficiency of phosphorus.

For the potassium tests: - the plant sap is squeezed on the three tests spots containing dipicrylamine and reagent No1 is added to give an orange color. Variation in the bright nests of the color signify the amount of potassium present. The disappearance of orange color from the all three dots on the test paper signifies a very low test for potassium and orange in the middle and bottom dots indicates medium level.

3.3. Water test

Once the source of water is identified, water to be used for irrigation should be tested by a reputable laboratory to determine the quality of the water to be used for irrigation, to aid in the choice of fertilizers for optimum plant growth, and to minimize the risk of discharging pollutants to surface or ground water. Prior to new construction, potential irrigation water should be tested. Monthly analysis is recommended for new water sources. Existing greenhouse operations should monitor water quality at least twice a year (summer and winter); more frequent monitoring is needed to alter production practices in response to changes in water quality.

Use of inferior irrigation water like with high sodium or total salt or both may cause deterioration to the physical properties of the soil. Plants are adversely affected by high concentration of salts in the soil solution and by poor soil physical condition of soil. Further salts formed in situ by weathering soil materials or by salt deposition from applied tend to accumulate in the soil profile. Hence appropriate techniques are required for proper management of poor quality water.

The quality of irrigation water is determined by the following chemical characteristics:

1 .Total concentration of soluble salts or salinity

2 .Concentration of sodium relative to the actions or sodicity

3. Anionic composition of water, particularly concentration of bicarbonate and carbonate.

4. Concentration of boron, fluorine or other elements that may toxic to plant growth.

- **Total concentration of soluble salts**

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

Table 1.Quality characteristics of irrigation water based on electrical conductivity

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

Table 2 the relationship among parameters (EC, SAR and RSC) on the basis of which water quality can be characterized

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

- **Checklist of Water Analysis**

✓ Test water to be used for irrigation by a reputable laboratory to determine the quality of the water for irrigation, choice of fertilizers for optimum plant growth, and to minimize the risk of discharging pollutants to surface or ground water.

✓ Test potential irrigation water prior to new construction.

✓ When collecting a water sample, run the water at full flow for five minutes before collecting one pint of water in a tightly sealed plastic bottle.

Self-check 3	Written test

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

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. What is soil test? (2point)

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2. Describe water and plant test? (3)

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3. Write three categories plant nutrients? (5 point)

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

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Information Sheet 4- Developing soil, plant and water tests program

4.1. Soil sampling

Soil sample 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. Soil testing plays an important role in crop production and nutrient management. On farms that use commercial fertilizer as the main nutrient source, it is the best way to plan for profitable fertilizer applications.

On livestock farms, knowing how much nutrient is present in the soil to start with is critical. Only then can a nutrient management plan be developed to properly manage both the nutrients that have been generated on-farm and any nutrients that are being imported to the property as bio solids or commercial fertilizer.

Soil testing is really a three-step process: the collection of a representative sample from each field or section, proper analysis of that sample to determine the levels of available nutrients, and use of the results to determine optimum fertilizer rates. Keeping records is an integral part of the soil-testing process; they will help determine if soil test levels are increasing, decreasing or being maintained over time.

- **Soil Sampling**

The sample that is sent to the lab for analysis normally weighs about 400 gm (1 lb), but this sample must accurately represent up to 20,000 t of soil - the amount of soil in 10 ha (25 ac). Clearly, care in the sampling process is necessary.

- **Sampling Area**

Choice of the area to be included in the sample can have a large impact on the accuracy of the soil test. Where fields are small, it is relatively simple to collect a sample for each field, but larger fields must be divided into smaller sampling areas. As much as possible, ensure that each sampling area is uniform and separate from areas that are obviously different.

Variation in soil fertility can occur because of differences in the native fertility of the parent material, the texture of the soil, the amount of nutrient removal by crop growth or the position in the landscape. By far the largest variation, however, comes from past applications of nutrients, either as fertilizer or manure.

When the variation is small, include several cores in each sample; when the variation is large, sample areas separately. Where past field boundaries are known, use them to divide large fields into smaller units. Base further subdivision, or divisions where past field boundaries are not know, on soil type or topography.

The maximum area included in a single sample should be 10 ha (25 ac).There is no minimum size for the area that can be represented by a single sample, so precision sampling, site specific sampling or grid sampling are permitted but not required for nutrient management.

Any areas that have obviously different nutrient levels from the balance of the field should not be included in the composite sample for the field. This could include dead furrows, eroded areas, laneways or areas where manure or lime has been piled. If these areas are large enough to be managed separately, sample and analyze them separately.

- **Sample Depth**

The normal sampling depth for nutrients is about 15 cm (6 in.) because most plant roots grow to that depth, and tillage mixes most nutrients into the soil to about 15 cm deep. Subsoil is normally much lower in nutrient content, so sampling too deep will produce a sample that is not representative of the field.

However, when sampling for soil nitrates, a sample down to a depth of 30 cm (1 ft) will provide a more accurate indication of the amount of nitrate available to the crop, since nitrate will move more easily with soil water than other nutrients will.

Sample depth is not changed in a no-till system, even though the nutrients are no longer being mechanically mixed into the soil, with the possible exception of pH samples. It may be appropriate to collect a shallow sample (5 cm or 2 in.) to check for acidification in the surface layer if nitrogen is being surface applied. Do not use these samples for nutrient analysis, since they will overestimate the nutrient availability from the soil.

- **Sample Collection**

A representative sample from a field must include enough cores, collected randomly from across the entire area. Too few cores increase the risk that a non-representative core could skew the result for the whole field. Non-random sampling increases the risk that a bias could be introduced into the sample. The most efficient way to achieve random sampling is to follow a zig-zag pattern around the field. Collect a minimum of 20 cores to produce the composite sample and one additional core per acre for fields larger than 20 ac.

Often the most overlooked step in collecting a soil sample is the thorough mixing of soil cores before the sub-sample is collected. Sampled soil cores should be mixed in the bucket until no evidence of soil cores exist. Heavy clay soil cores sometimes need to be dried before they can be sufficiently mixed to allow for a suitable sub-sample. The sub-sample should be no more than 400 gm or about 1 cup of soil.

Store collected samples at room temperature, with the exception of soil nitrate samples, which should be kept cool (below 4°C) and delivered to the lab within one day for immediate analysis. Freeze any samples that will not be analyzed immediately as soon as possible.

- **Sampling Equipment**

While it is possible to collect samples using a shovel or spade, it is much more efficient to use a sampling probe or auger. These should be constructed of stainless steel, particularly if the samples are going to be used for micronutrient testing. Many agricultural retailers will lend sampling probes for soil sample collection.

Collect soil cores in a clean plastic pail. Galvanized pails will contaminate the samples with zinc, which will make the analytical results for micronutrients unusable. Avoid pails that have contained sanitizers or detergents, since phosphates from these materials can be carried over into the samples.

A sturdy stainless steel or aluminum trowel works well for mixing the cores before collecting a sub-sample. A screwdriver is also useful for dislodging any soil cores that might get stuck in the sampling tube.

- **Sample Frequency**

Collect samples frequently enough to detect changes in the soil test for a field, before they become large enough to significantly affect crop yields or fertilizer requirements. For most farms, once every three years is adequate for this purpose, and this often works out to once in the rotation, at the same point in the rotation.

Rapid changes in soil test values can occur where the soil has a low capacity to hold nutrients or when crops that extract large amounts of a particular nutrient are grown. More frequent sampling will be necessary on coarse-textured soils or where crops that remove large quantities of potassium are grown such as alfalfa, corn silage or processing tomatoes.

Soils are sampled to determine physical conditions, fertility (nutrient) status, and chemical properties that affect their suitability as plant growing media

A sample of soil should be analyzed from a particular field every 3-4 years, this is an Important procedure that should be carried out with care and precision because the Productivity of the land is dependent on the farmer ensuring that the land has the Correct nutrient level. Being aware of the soil chemical composition will allow the Farmer to adjust the composition to meet the production potential

Taking a soil sample

It is important to ensure that the sample taken is representative of the whole field as The chemical properties of the soil can vary from point to point in the same field. This Can be achieved by taking a number of sub-samples from different areas and Combining them to create one sample. If there are obvious differences in the soil Composition within the same field e.g. a badly drained area, then a separate sample Should be taken for each area. Soil sub-samples dug out via a hollow circular corerto avoid sample contamination should be taken from the topsoil at a depth of about15cm for arable land and about 10cm for grassland. A large number of sub-samples will reduce variability and provide a more reliable representation of the field as a whole.

- **Three Types of Soil Samples**

1. Undisturbed Soil Samples.
2. Representative or Disturbed Soil Sample.
3. Non-representative Soil Sample

Analyzing the soil sample

A sample is taken to a laboratory to be analyzed. It is air-dried, crushed (not Breaking the stones) and then passed through a 2mm sieve. The analysis is carried

Out on the ‘fine earth’ fraction to determine the following:

Instruments to analyze soil samples

- Atomic absorption spectrophotometers;
- Inductively Coupled Plasma Spectrometers (ICPs);
- Lachat Flow Injection Analyzer;
- Colorimeters; and.
- general laboratory equipment

4.2. Plant Tissue Analysis

Tissue analysis is perhaps the most important tool that growers have in assessing the nutritional status of crops and should be done every 1-3 years. A tissue analysis provides the grower with chemical analysis of the concentration of individual nutrients in a growing crop. This can provide a more accurate understanding of nutrient status than visual diagnosis and can identify low nutrient levels before any significant crop impact occurs. Tissue analysis is typically done late in the season and is therefore used to inform nutrient management decisions for the following season.

4.3. Visual Symptoms

There is really no ‘test’ that can replace the value of walking your rows and spending some one-on one.

Time with your crop. Nutritional deficiencies or toxicities often exhibit subtle symptoms early on that require close attention…things you may not see from the seat of the tractor! While visual monitoring is important, there are disadvantages to only using this approach. The first is that many

Symptoms of nutrient deficiencies (or toxicities) can look very similar and can even be confused with disease, insect or environmental stresses, therefore it can be difficult to identify the primary problem. The second is that by the time the symptoms are noticed, there has usually been some impact on the crop.

- **Several technologies are commonly employed to assess the nutrient status of the soil:**
  - ✓ Nutrient deficiency symptoms of plants
  - ✓ Analysis of tissue from plants growing on the field
  - ✓ Biological tests in which the growth of either higher plants or certain microorganisms is used as a measures of soil fertility
  - ✓ Soil analysis
- **Interpretation of plant tissue test**

Important factors in sampling and interpreting results

- ✓ General performance and vigor of the plant
- ✓ Levels of other nutrient in the plant
- ✓ Incidence of insects or disease
- ✓ Soil condition ,such as moisture ,aeration, structure and so on
- ✓ Climatic condition

If plant appears to be discolored or stunted and tissue tests high for NPK, then some other factor is limiting the growth.

Interpretation of soil tests

Soil test interpretation involves on economic evaluation of the relation between the soil test value and nutrient response. However the response may be vary due to several factors, including soil, crop. Expected yield, level of management and weather.

Many laboratories make one recommendation, assuming best,,,production practices for the region, and the grower may make adjustments as necessary

.

Self-check 4	Written test

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

Directions: Answer all the questions listed below.

Test I: Choose the best answer

1. ______________is an example of physical soil test? (5)

A. soil PH B. soil structure C. soil moisture D. all E. none

Test II: Short Answer Questions

2. Write two types of soil test? (10 point)

____

3. Write an example of chemical soil test? (5)?

____

____

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

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

Information Sheet 5- Implementing and monitoring testing tasks

5.1 Monitoring testing tasks

During monitoring of soil test the following tasks will be considered and followed to check some features of good soil

- Drains well and warms up quickly in the spring
- Does not crust after planting
- Soaks up heavy rains with little runoff
- Stores moisture for drought periods
- Has few clods and no hardpan
- Resists erosion and nutrient loss
- Supports high populations of soil organisms
- Does not require increasing fertilizer for high yields
- Has earthy smell
- Produces healthy, high quality crops

All these criteria indicate a soil that functions effectively today and will continue to produce long into the future. Creating soils with these characteristics can be accomplished by utilizing management practices that optimize the processes found in native soils.

Assess Soil Health and Biological Activity on Your Farm

A basic soil audit is the first and sometimes the only monitoring tool used to assess changes in the soil. Unfortunately, the standard soil test done to determine nutrient levels (P, K, Ca, Mg, etc.) provides no information on soil biology and physical properties. Yet, most of the farmer-recognized criteria listed on the first page of this publication for healthy soils include, or are created by, soil organisms and soil physical properties.

Monitoring for Crop lands

Simple measurements can help to determine the health of croplands in terms of the effectiveness of the nutrient cycle, water cycle, and the diversity of some soil organisms. Some of the assessments you can make using this guide are living organisms, aggregation, water infiltration, ground cover, and earthworms. The monitoring guide is easy to read and understand, and comes with a field sheet to record observations.

Direct Assessment of Soil Health

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

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

Maintaining and improving soil quality

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

1. Physical degradation such as wind and water erosion and compaction;

2. Chemical degradation such as toxification, salinization, and acidification; and

3. Biological degradation, which includes declines in organic matter, carbon, and the activity and diversity of soil fauna. Slowing down or stopping these processes will help maintain soil quality. Reversing the processes will improve soil quality over time.

Physical degradation. Erosion has long been considered the major agent of soil degradation worldwide. Another form of soil degradation is compaction, typically caused by heavy machinery and cattle trampling. Mineralogy are determining factors of vulnerability to compaction.

Chemical degradation. While salinity problems are often associated with irrigation, they can also occur in dry land areas where rainfall is insufficient to leach salts from the soil. Acidification, another chemical degradation process, can occur when bases (such as calcium, magnesium, potassium and sodium) are leached from the soil.

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

5.1. Test monitoring

Soil Test monitoring in test execution is a process in which the testing activities and testing efforts are evaluated in order to track current progress of testing activity, finding and tracking test metrics, estimating the future actions based on the test metrics and providing feedback to the concerned team as well as stakeholders about current testing process. Test Control in test execution is a process of taking actions based on results of the test monitoring process. In the test control phase, test activities are prioritized, test schedule is revised, test environment is reorganized and other changes related to testing activities are made in order to improve the quality and efficiency of future testing process. No matter how much and carefully we plan, something will go wrong. We need to actively monitor the project to:

- Early detect and react appropriately to deviations and changes to plans

- Let's you communicate to stakeholders, sponsors, and team members exactly where the project stands and determine how closely your initial plan of action resembles reality
- It will be helpful for the Manager to know whether the project is going on the right track according to the project goals. Allows you to make the necessary adjustments regarding resources or your budget.

Monitoring will allow you to make comparisons between your original plan and your progress so far. You will be able to implement changes, where necessary, to complete the project successfully. You should monitor the key parameters as below:

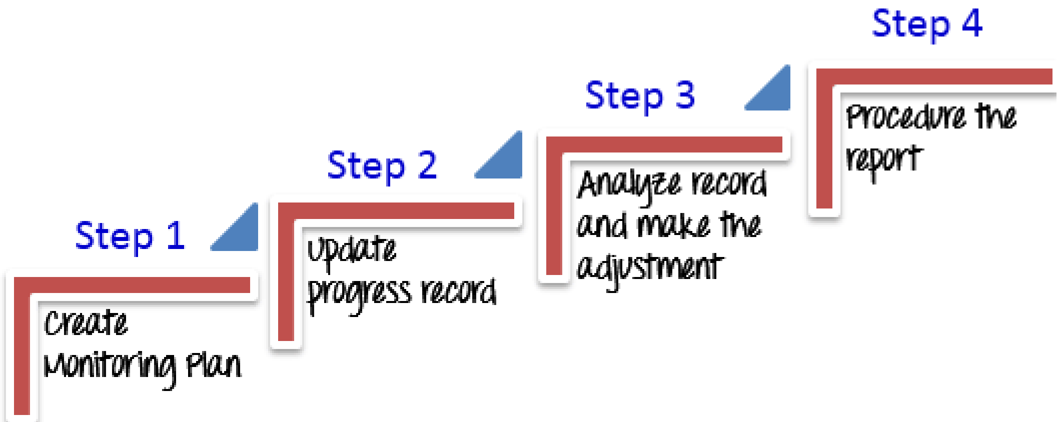
Step 1 Create Monitoring Plan

You cannot monitor progress unless you have a plan to monitor progress with defined metrics. Similar to Test Plan, Monitoring Plan is the first and one of the most important steps in progress monitoring.

Step 2 Update progress record. With time, your team member will be making progress on their project task.

Step 3 Analyze record and make the adjustment

Step 4. Produce the report



Best Practices in Test monitoring and control

- Follow the standards: One important consideration of project planning is to ensure standardization. It means that all the project activities must follow the standard process guideline.
- Documentation: You may forget them and lose many things. You should write down discussions and decisions at the appropriate place, and establishing a formal documentation procedure for meetings.
- Proactivity: Issues occur in all projects. The important thing is that you have to adopt a proactive approach to solve issues and problems that arise during project execution. Such issues could be budget, scope, time, quality, and human resources

5.2. Test Implementation

Implementation is the stage where all the planned activities are put into action. Before the implementation of a project, the implementers (spearheaded by the project committee or executive) should identify their strength and weaknesses (internal forces), opportunities and threats (external forces). The strength and opportunities are positive forces that should be exploited to efficiently implement a project. The weaknesses and threats are hindrances that can hamper project implementation. The implementors should ensure that they devise means of overcoming them. As such, the monitoring activities should appear on the work plan and should involve all stake holders. If activities are not going on well, arrangements should be made to identify the problem so that they can be corrected.

To implement soil test:

- Thoroughly clean the tools you're using to collect the soil sample.
- In the planting area, dig five holes 6 to 8 inches deep.
- Take a 1/2-inch slice along the side of a hole and place it in the bucket. ...
- Collect samples from different areas that'll be growing similar plants.
- Mix the soil in the bucket.

For plant test: It shows what nutrients are being taken up by the plant at that moment in time. It won't actually tell you what levels of micronutrients are needed, but simply whether or not they are there it's very important that tissue testing is used in conjunction with field soil tests. The following tips for getting the best possible results from plant tissue testing:

1. Time it right. To have an effect on this growing season, corn plants should be in the 8- to 12-leaf stage, soybean plants can be submitted from 4-8 inches tall and alfalfa from 6 inches to flowering.

2. Select the best, most representative samples. Never select diseased, drought stressed or damaged plants. Pick plants that most closely represent actual field conditions.

3. Collect the proper plant part and amounts. Pick at least half a lunch bag full of plants and choose leaves from the middle of the plant. Never send bottom leaves or immature leaves.

Self-check 5	Written test

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

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Write the monitor key parameters? (2 point)

____

____

2. What is soil monitor? (5 point)

____

3. Write the best possible results from plant tissue testing? (3)

____

____

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

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

Information Sheet 6- Complying and presenting data and readings

6.1. Compiling and presenting data and readings

In order to easily understand soil, plant and water testing data has to be prepared in the form of reading. In this all materials used and appropriate procedure followed are to be written clearly.

6.2. Presentation of data

Graphs and diagrams may also be used to give the data a vivid meaning and make the presentation attractive.

Data are presented in the tabular or graphical or diagrams form of presentation large data will be presented in tables in a very summarized and condensed manner

6.2.1 Tabular method of data presentation

- The row data which have been collected and edited will not usually give you sufficient information unless they are put in to a form that will make them eases to understand and interpret.
- Raw data are better understood if they are summarized in same defines order or sequence.

6.2.2. Graphical methods of data presentation

Presenting data in charts and graphs is important in that it helps you:

- To has a clear idea about the nature of the data
- To easily understand patterns & trends of grouped data
- To facilitate comparisons between two or more sets of data

The most commonly used charts are: Bar charts and Pie charts. Similarly graphs that are most commonly used are: Histogram, Frequency polygon and Cumulative Frequency Curve (give). We usually use charts (diagrams) to illustrate data which are discrete while we use graphs to represent data which are of continuous nature. Graphs are simply visual aids for thinking about and discussing statistical problems.

- **Charts (Diagrams)**

✓ **Bar Charts**

Bars are vertical lines, where the lengths of the bars are proportional to their corresponding frequencies or numerical values. Bar charts are called one-dimensional. This means only the length of the bar (rectangle) is important not the width.

There are three types of bar charts

❖ Simple bar chart

❖ Component bar chart

❖ Multiple bar charts

✓ **Pie Chart**

A pie chart is a circle divided from its center into several component parts to show how the whole is divided up. It is called "pie" because the entire chart looks like a pie and its components resemble slices cut from it. The size of a slice represents the proportion of the component out of the total

Self-check 6	Written test

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

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Soil testing is used to assess what soil nutrients are present or may be needed for optimum plant growth and yield potential (5)?

   A. True B. False

2. Computer processing offers the advantage of (5 point)

____

____

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

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

Information Sheet 7- Determining seasonal variations and requirements

7.1. Introduction

Seasonal variations and requirements are determined from published data on species, historical records or from management practices

Understanding the seasonal fluctuations of soil test measurements during the year can aid in the understanding and in interpretation of soil test results that vary from year to year or samples taken within the same year. Many factors can cause soil results to vary from year to year, with seasonal fluctuations being one of them.

Seasonal fluctuations are mainly controlled by the uptake and release patterns of nutrients by the crop and by environmental conditions. If soil samples are taken from a field the same way and the same time each year and the results are higher or lower than expected, seasonal fluctuations can sometimes explain these results.

A spring soil sample gives a more accurate picture of what will be available to the plant that year. However, a fall soil sample offers many advantages to the producer such as sampling during good weather, allowing time for planning of the coming crops, and giving lime time to react prior to spring planting.

Understanding the seasonal fluctuations of soil tests will allow a producer to take fall soil samples that better represent the fertility in the soil and obtain a more efficient lime and fertilizer recommendation. Of the commonly reported soil test measurements, phosphorus (P), potassium (K), and pH are the most affected by seasonal fluctuations.

Seasonal fluctuations in pH are not unusual. They are affected by fertilizer rate, time of fertilizer application, organic matter, and root and bacterial activity as well as soil moisture. The pH is usually lower during the summer and early fall and then increases as the soil moisture increases. The reduction in soil pH during this time is generally attributed to soil drying, root and bacteria activity, and nitrification of nitrogen fertilizers. Nitrogen fertilizers containing ammonium are changed to nitrate (nitrified); this process releases acidity (hydrogen ions).

The roots and bacteria in the soil produce carbon dioxide that temporarily lowers the pH during the height of their activity. The salts in the soil (natural and added as fertilizers) can concentrate near the soil surface as the soil dries and displace hydrogen ions (acidity) from the cation exchange complex into the soil solution that also lowers the pH.

Seasonal fluctuations in soil test Potassium (K)are seen almost yearly and can be large. As the crop grows and matures, uptake lowers the soil-available K. Large amounts of K are taken up by the plant, about 160 lb/ac of K2 0 in a 150 bu/ac corn crop.

For corn, wheat, and grain sorghum, most of the K is in the vegetation with only about 25 to 30% in the grain. Once the grain is harvested, the K in the residue is washed back into the soil.

The net effect is that soil test K drops until the crop reaches physiological maturity and then increases slowly as the K is leached from the residue. However, soybean grain contains about 60% of the total K taken up by the crop, so removal is higher, and the soil test K does not rebound to the same extent as other grains.

Seasonal fluctuations of soil tests for Phosphorus (P) are smaller than for pH and K. The quantity of crop P uptake is much lower than K, with most of the P ending up in the harvest grain. The smaller amounts left in the residue are not easily leached from the plant and require microbial decomposition for release (a much slower process). The soil is also a great buffer for P. Fertilizer P is converted to chemical compounds in the soil that greatly reduces its solubility, and it also stabilizes the soil test P and prevents rapid fluctuations.

Self-check 7	Written test

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

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Soil test measurements that are most affected by seasonal fluctuations were:

(5 point)

____

____

2. Seasonal fluctuations are mainly controlled by the: (5)?

____

____

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

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

Information Sheet 8- Characteristics, condition and nutritional status of soils and plant species

8.1 Soil characteristics

Basically soil is the rooting medium and a store house for nutrients and water. Hence it is essential that the roots fully exploit the soil to obtain the nutrient s and reduce water stress. The yields of the crop is often directly related to the availability of stored soil water. The tillage system affects root distribution with depth. When soil is cultivated manually ,for instance corn root develop more extensively below 10cm than with no tillage system, while intermediate root distribution occur with roto till and chase. Hence under production of an agricultural crops it is important to take in to consideration soil characteristics while developing soil health and plant nutrition.

8.1.1 Physical properties

Refers to the function and management of the soil in an ecosystem in determining the success or failure of agricultural crop production based on soil texture, structure, consistence and color.

8.1.2 Chemical properties

Deal with the nature of colloids (organic and in organic). It mainly focuses on the mineral and chemical composition, charges and exchange of ions, salinity, and alkalinity and acidity of the soil. It is important from the point of view of nutrient availability for agricultural crops.

The most chemical characteristics of soils are:

- Its content of essential nutrients and their availability to plants
- The exchange capacity
- The buffer capacity (the ability of soil to resist change in PH of the soil solution if acid or base is added).

- Acidity or alkalinity and
- Content of organic and in organic colloids (humus).

8.1.3 Biological properties

Soil abounds in the following various types and forms of plant and animal life:

8.1.3.1. Classification of Soil Organisms

Soil organisms can be classified based on their life form, size, and energy source

1. Life form

Although recent classification systems classify living organisms into five kingdoms for sake of simplicity here soil organisms are grouped into either to the animal (fauna) or plant (flora) kingdoms.

2. Size

Based on size soil organisms are categorized as:

- **Macroflora**: size greater than 2 mm. Ex. Plant roots, mosses
- **Mesoflora**: size ranging between 0.1 – 2 mm. Ex root feeders
- **Microflora**: size less than 0.1 mm. Ex. Root hairs, algae, fungi, bacteria,
- **Macrofauna**: Ex. gophers, mice, mole, ants, beetles, earthworms, snails
- **Mesofauna**: Ex. mites, springtails
- **Microfauna**: Ex. Nematodes, amoebae

3. Energy source

Two types of soil organism based on their energy source

- **Autotrophic** soil organisms: obtain energy from CO_2 of the atmosphere. Ex. higher plant and some bacteria
- **Heterotrophic** soil organisms: obtain the energy requirement from the breakdown of organic materials. Ex. Fungi, actinomycetes, and most bacteria

Examples of Some Common Soil Organism

1. Earthworms

- ✓ More than 7000 species
- ✓ Common macro fauna in most soils
- ✓ Eat detritus and microorganisms on detritus.

- ✓ Do not eat living plants, hence are not crop pests
- ✓ Earthworms eat everything in their way through the soil. On doing so they create extensive systems of pores and channels – Biopores
- ✓ The soil ingested is thoroughly mixed with organic matter, and expelled in form of stable cast.
- ✓ Earthworms enhance soil fertility by decomposing soil organic matter, distributing organic mater evenly within the profile, and concentrating nutrients in their bodies
- ✓ The burrowing action of soil organisms also increases soil aeration, drainage, and infiltration.

2. Termites

- ✓ More than 2000 species
- ✓ They are abundant in grassland and forestland regions of the tropics, particularly in semiarid climates
- ✓ Most termites eat rotting woody materials and plant residues, and some others use these materials to grow fungus as their main source of food
- ✓ Termites are social animals. They build mounds and channels both above and below ground ("termite cities")
- ✓ Upon the construction of their homes, termites transport the finer soil fraction and organic matter from the subsoil and surrounding area. Due to this vast area near termite mounds will be depleted of organic matter
- ✓ The "termites cities" also take a considerable space, hence reduce farm size
- ✓ Termites do also devastate woody farm infrastructures
- ✓ However, termites can be beneficial in helping the fast decomposition of dead trees and tree trunks

3. Roots of higher plants

Plant roots of different size are considered as soil organisms as they grow and die in the soil. The roles of plant root as soil organism are:

- Profile mixing by physically moving the soil as they grow and extend

- Encourage soil aggregation (physical binding, increase organic matter content, secreting sticky exudates, increase the shrink-swell cycle by removing water from the soil)
- Root exudates (chemical secreted by roots meant for lubrication, protection, or used as allelochemicals) are food for some organisms

4. Soil Fungi

- ✓ Several thousand species identified so far
- ✓ Smaller in numbers but have higher biomass and activity than bacteria in soil ecosystems
- ✓ Soil fungi are heterotrophs, hence they depend on both living and dead organic materials for their survival
- ✓ They are very strong decomposers and almost attack every kind of soil organic matter even the most resistant one. Therefore, they are the most important ones in humus formation
- ✓ Fungi are resistant to soil acidity
- ✓ For their competitive advantages fungi produce antibiotics and mycotoxins in soils
- ✓ Some fungal species form a symbiotic association with higher plants.
  - ❖ **Mycorrhizae** – which literally mean "fungus root" is the most economical symbiotic association of some fungal species with roots of higher plants. Under this relationship the mycorrhizal fungi gets photosyenthates direct from the plant and the plant will have increase efficiency of nutrient and water absorption (increased root surface, fungal hyphae is able to reach very small micropores, protection for roots from foreign microbial invasion, etc)
  - ❖ M**ycorrihizal** infection takes place under natural environments for most cultivated crops. Artificial inoculation might be useful in highly disturbed cultivated soils.

5. Soil Bacteria

- ✓ Very small, single celled organisms
- ✓ present in a very large number in soils

- ✓ Few soil bacteria are autotrophs, while most are heterotrophs
- ✓ Bacteria are also efficient decomposers and attack resistant hydrocarbon compounds such as gasoline, and diesel oil. Very important in bioremediation of oil-spill areas
- ✓ Soil bacteria have profound influence on plant growth, soil and environmental quality. Some examples are:

Nitrifying bacteria: change NH_4^+ - N in the soil to NO_3^- - N

Denitrifying bacteria: change NO_3^- - N into free atmospheric N_2

Nitrogen fixing bacteria: fix atmospheric N_2 into usable form of N (NH_4^+ or NO_3^-- N). Genus Rhizobium establishes symbiotic association with legumes where the rhizobia enclosed in root nodules supply the usable N to the plant and the plant provide photosynthates in the return. Because of this reason legumes get more than 80 % of their N requirement from the association

8.2 **Determining conditions of soil and plant species**

Soil condition including texture, fertility, depth, alkalinity, salinity, soil reaction, chemical content, drainage, and water logging which influence the growth and development of agricultural crops must also be considered while selecting a suitable site for agricultural crops.

- **Range of conditions that affect crop nutrition may include**:
  - ✓ Crop load
  - ✓ Crop quality requirements
  - ✓ Cropping and fertilizer history
  - ✓ Grazing intensity
  - ✓ Growth media characteristics
  - ✓ Irrigation methods and scheduling
  - ✓ Seasonal influences
  - ✓ Soil management practices

- ✓ Spraying program
- ✓ Weather

8.3. Nutritional Status of the soil

The nutritional requirements of the crop are dependent on factors such as soil fertility, weather, planting age and crop load, all of which change over time. Therefore, the amount of nutrients the grower needs to provide the crop may also change over time. As the soil is the 'storehouse' for nutrients, the best approach to meeting the nutritional requirements is to establish your crop in fertile, well drained soils with the appropriate soil pH. Once the crop is planted, routine evaluation of plant nutrient status and soil composition are essential to developing sustainable nutrient management practices.

Many soils have vast reserves of plant nutrients but only a small portion of these nutrients becomes available to plants during a year or cropping season. Nutrients are present in both organic and mineral forms. However, all forms must change themselves

to specific mineral ionic forms in order to be usable by plant roots. Thus, in order to become available to plants, nutrients must be solubilized or released from mineral sources and mineralized from organic sources including SOM. Although nutrient mobilization is a rather slow process, it increases sharply with temperature.

A temperature increase of 10 °C doubles the rate of chemical reactions. Consequently, the 20–30 °C higher temperature in tropical areas results in chemical transformations (e.g. nutrient mobilization or humus decomposition) at 4–6 times higher the rate in temperate areas.

About 1–3 percent of SOM is decomposed annually and this is a key determinant of N supply. As crop yields have increased over the years as a result of technological changes, few soils are able to supply the amounts of nutrients required to obtain higher yields without external inputs. An ideal soil is rich in mineral and organic sources of plant nutrients.

Many people confuse plant nutrition with fertilization. Plant nutrition refers to the needs of the plant and how a plant uses the basic chemical elements. Fertilization is the term used when these elements are supplied to the soil as amendments. Of these nutrients, three are found in air and water: carbon (C), hydrogen (H), and oxygen (O). Combined, C, H, and O account for about 94% of a plant's weight.

The other 6% of a plant's weight includes the remaining 14 nutrients, all of which must come from the soil. Of these, nitrogen (N), phosphorus (P), and potassium (K), the primary macronutrients, are the most needed. Magnesium (Mg), calcium (Ca), and sulfur (S), the secondary macronutrients, are next in the amount needed. The eight other elements—boron, chlorine, copper, iron, manganese, molybdenum, nickel, and zinc—are called micronutrients because they are needed in much smaller amounts than the macronutrients.

1. **Major non-mineral macronutrients**: these are 90 – 95 % of dry-plant weight, and are supplied to the plant by water absorption and photosynthesis, i.e., carbon (C), hydrogen (H), and oxygen (O);
2. **Primary macronutrients**, i.e., nitrogen (N), phosphorus (P), potassium (K);
3. **Secondary macronutrients,** i.e., calcium (Ca), magnesium (Mg), sulfur (S); and
4. **Micronutrients**, i.e., boron (B), chloride (Cl), cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), zinc (Zn).

Three major factors contributing to plant nutrition are:

- The amount of available nutrients in the soil;
- The soil's ability to supply the nutrients to plants; and
- Environmental factors that affect nutrient availability and plant absorption.

Measurements which involve characterization of the soil solution, and its constituents and of the composition of the inorganic and organic phases in soil are broadly termed chemical. This encompasses all nutrient elements and soil components which directly or indirectly influence such elements or components.

- In addition, it has the following characteristics:
  - ✓ It has a strong capacity to mobilize nutrients from organic and inorganic sources.
  - ✓ It stores both mobilized and added nutrients in forms that are available to plant roots, and protects them against losses.
  - ✓ It is efficient in supplying all essential nutrients to plants according to their needs.

- **Practical importance of nutrients**

A number of plant nutrients are of large-scale practical importance for successful crop production in many countries. Prominent among these are N, P, K, S, B and Zn. This means that their deficiencies are widespread and external applications are necessary to augment soil supplies for harvesting optimal crop yields while minimizing the depletion of soil nutrient reserves.

- ✓ **N deficiency** is widespread on almost all soils, especially where they are low in organic matter content and have a wide C: N ratio. Rare exceptions are soils with very high N-rich organic matter content during the first years of cropping, e.g. after clearing a forest.
- ✓ **P deficiency** was serious before the advent of mineral fertilization because the native soil phosphate was strongly absorbed in very acid soils or precipitated as the insoluble calcium phosphate in alkaline soils.
- ✓ **K deficiency** is most strongly expressed in acid red and lateritic soils or on organic soils that have few K-bearing minerals. Soils rich in 2:1-type clays and those in arid or semi-arid areas are generally better supplied with K than soils in humid regions because of lower or no leaching losses in the former. Ca supply is abundant in most neutral–alkaline soils and, hence, field-scale Ca deficiencies are rare.
- ✓ **Ca deficiency** occurs, it is mainly in acid soils or because of insufficient uptake and transport of Ca within the plant.
- ✓ **Mg deficiency** can be widespread in acid soils as a consequence of low supply and leaching losses.

- ✓ **S deficiency** was of little practical importance decades ago because of considerable supply from the atmosphere, and widespread use of S-containing fertilizers such as single superphosphate (SSP) and ammonium sulphate. However, S deficiency has developed rapidly in recent years as the atmospheric inputs have declined and high-analysis S-free fertilizers have dominated the product pattern used.

Micronutrient deficiencies are common because of certain soil conditions and have developed at higher yield levels and on sensitive crops. Fe and Mn deficiencies frequently occur on calcareous soils or on coarse-textured soils with neutral or slightly alkaline reaction and rarely on acid soils. On strongly acid soils, there may even be problems of micronutrient toxicities.

- **Available nutrients in soils**

Out of the total amount of nutrients in soils, more than 90 percent is bound in relatively insoluble compounds or is inaccessible within large particles and, therefore, is unavailable for crop use. Only a very small proportion is available to plants at any given point of time. To assess the nutrient supply to crops, it is important to know the amount of available soil nutrients either actually present or likely to be accessible to the plant during a cropping season. All available nutrients must reach the root zone in ionic forms that plant roots can take up.

In order for plants to acquire available nutrients, plant roots must intercept them in the soil or they must move to the root either with the water stream or down a chemical concentration gradient.

Moreover, available nutrients in soils are not a specific chemical entity or a homogeneous pool, but consist of three fractions. In terms of decreasing availability, these are:

- Nutrients in the soil solution
- Nutrients adsorbed onto the exchange complex
- Nutrients bound in water-insoluble forms but easily mobilizable nutrient sources.

8.4. Characteristic of soil test

Soil test results include the amount of macronutrients nitrogen (N), phosphorus (P), and potassium (K); secondary macronutrients sulfur (S), calcium (Ca), and magnesium (Mg); and micronutrients copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), boron (B), chloride (Cl), nickel (Ni), and molybdenum (Mo) in the soil. Other soil characteristics that may be included in soil test results are organic matter (OM) content, soil pH, soluble salts (salinity), and cation exchange capacity. In addition to each element level that will be reported back, you will also receive a few other important soil characteristics as well:

Nitrogen - An adequate supply of N is associated with high photosynthetic activity, vigorous growth, and dark-green plant vegetation. There are two forms of plant available N: nitrate (NO_3^-) and ammonium (NH_4^+). Nitrate is measured most often in soil tests. Soil test results report nitrate-N in lb/acre.

It is important to remember that nitrate levels on a soil test reflect what is immediately available and not what will be available in the future from mineralization of organic matter or lost from leaching or denitrification.

Phosphorus – Phosphorus is needed by the plant to store energy created from photosynthesis and carbohydrate metabolism to be used for plant growth and reproductive processes. Phosphorus is not as naturally abundant in the soil as other macronutrients and is relatively immobile. The amount of plant available P in the soil solution is related to soil pH. Different P extraction methods are used depending on the soil pH.

Potassium - Potassium helps plants activate enzymes, draw water into roots, produce phosphate molecules and CO2, translocate sugars, and uptake and assimilate N. Most soils contain K in large quantities, although it is not always available.

Sulfur - Sulfur has many important functions in plant growth and metabolism. Only a small fraction of the total soil S is readily available to plants and that form is sulfate

(SO_4^{2-}). Sulfur can be mobile or immobile in soil depending on microbial activity and the quantity of carbon (C), N, and P. S-deficient soils have soluble SO_4^{2-} concentrations less than 5-10 ppm.

Calcium and Magnesium - Calcium enhances nitrate-N uptake and also regulates the uptake of cations, such as K+ and sodium (Na+). High Ca concentrations typically result in low concentrations of undesirable cations, but a low Ca content can contribute to soil acidity. Magnesium is needed for photosynthesis and in many other physiological and biochemical functions within the plant. Both Mg and Ca ions can easily be exchanged or removed from negative soil colloids.

Micronutrients - Although many of the micronutrients are reported on soil test reports, their levels do not currently affect fertilizer recommendations; with the exception of Zn.

Organic Matter - Organic matter affects many soil biological, chemical, and physical properties that influence nutrient availability. A general guideline is to reduce N recommendations by 20 lb/acre for soils with >3% OM and increase N recommendations for soils with <1% OM. Consult your regional guidelines for a more precise influence of OM on nutrient availability.

Soil pH- Soil pH is an indicator of the level of acidity or alkalinity of the soil, ranging from 0-14. A reading of 7 is neutral; crops typically grow best when pH is between 6 (slightly acidic) and 7.5 (slightly alkaline). Results of soil pH are reported on a logarithmic scale; a soil with a pH of 6 is 10 times more acidic than a soil with a pH of 7, and a pH of 5 is 100 times more acidic than a pH of 7. Nutrient availability may be hindered if soil pH is not within the optimum range. A buffer pHtest is used to determine lime rate requirements. The amount of lime needed to increase soil pH to a desirable level can be estimated by mixing a buffer solution (with a known pH) to soil and then measuring the change in ph. If the change in pH is large after the buffer is added, the soil pH is easily changed and a low lime rate will be recommended, but if the change is small it means the soil ph is difficult to change requiring a larger rate of lime.

Cation Exchange Capacity (CEC) - The CEC is not always part of a soil analysis. If it is included on a lab result, a CEC above 10 milli-equivalents per 100 grams (10 meq/100 g) is considered adequate. A high CEC is sought because it indicates a high capacity for the soil to hold cations (positively charged particles) such as K^+, NH_4^+, Cu^{2+}, Fe^{2+}, and Mn^{2+}.

Many minerals in soils are negatively charged and, as a consequence, can attract and retain cations such as potassium (K), sodium (Na), calcium (Ca), magnesium (M), ammonium (NH4), etc.

Cation exchange is a reversible process. Thus, elements or nutrients can be held in the soil and not lost through leaching, and can subsequently be released for crop uptake. Certain organic compounds contribute to cation exchange capacity (CEC). Also, the presence of high concentrations of Ca, especially in the form of gypsum, interferes with the determination of CEC, which is an important parameter for soil fertility and mineralogical characterization.

Additionally, CEC is influenced by soil pH. A certain portion of the total negative charge is permanent, while a variable portion is pH-dependent.

Several methods are available for CEC determination. Most methods involve saturation of the soil with an index cation (NH4), removal by washing of excess cation, and subsequent replacement of the adsorbed index cation by another cation (Na) and measurement of the index cation in the final extract. Modified procedures have been introduced because of high Ca solubility in calcareous and gypsiferous soils.

Cation exchange capacity is reported as centimoles of positive charge per kg of soil (cmol (+)/kg).

The old unit milli-equivalents per 100 g (meq/100g), whereas **1 meq/100 g = 1 cmol (+)/kg**), should no longer be used. Values of CEC are in the range of 1.0 to 100 cmol (+)/kg, least for sandy soils and most for clay soils. Similarly, higher CEC values reflect the dominance of 2:1 clay minerals, and lower values reflect the presence of 1:1 clay minerals.

Self-check 8	Written test

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

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Soil test results include the amount of macronutrients; write an example of macro nutrient? (5 point)

____

____

2. Write the difference between macro and micro nutrient? (5)?

____

____

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

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

Operation Sheet -1	Soil sample analysis

Material required
Augers
Procedure

1. Take eight sub-samples per hectare (ha) in a diagonal pattern for obtaining one composite sample.

2. Plans range from 5 to 25 borings or sub-samples per composite sample

3. Use Fewer sub-samples needed where little or no fertilizer.

4. Correspond, more sub-samples are needed where fertility is variable due to hand broadcasting

5. Take number of sub-samples by farmers should be realistic, considering the particular field situation.

Operation Sheet -2	Determination of soil PH

Material required

1. Magnetic stirrer
2. Spade
3. Sample bag
4. Sensitive balance/analytical balance
5. Beaker
6. Watch
7. PH meter

Procedures

1. Collect a soil sample approximately 10grams from field
2. Place a soil sample in a 50ml beaker
3. Add 10ml distilled water to a beaker.
4. Stir the soil and the water for an hour
5. Then read the value of the PH from PH-meter and glass electrode

Operation Sheet -3	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. Observe the color changes and report to your instructor

LAP TEST	Performance Test

Name………………………………. ID…………………………

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 8hrs . The project is expected from each student to do it.

Task-1.perform

Task-2 perform

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

LG #71	LO# 2- Determining the requirements for plant production.
Instruction sheet 2	

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

- Identify nutritional requirements of plant during growth cycle and range of conditions
- Develop program to achieve appropriate soil conditions and nutrient availability
- Determine soil amendment, management practices and fertilizer requirements
- Identify and cost resources, tools, equipment and machinery required for program
- Determine cost-effect approach to soil amendment and management
- Identify OHS hazards
- Identify environmental implications of program

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 during growth cycle and range of conditions
- Develop program to achieve appropriate soil conditions and nutrient availability
- Determine soil amendment, management practices and fertilizer requirements
- Identify and cost resources, tools, equipment and machinery required for program
- Determine cost-effect approach to soil amendment and management
- Identify OHS hazards
- Identify environmental implications of program

Learning Instructions:

1. Read the specific objectives of this Learning Guide.

2. Follow the instructions described below.

3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.

4. Accomplish the "Self-checks" which are placed following all information sheets.

5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

6. If you earned a satisfactory evaluation proceed to "learning guide.

Information Sheet 1- Identifying different nutritional requirements of the plant

1.1**. Nutritional requirements of plant**

Nutrients in the soil are lost through harvested crops, water and wind erosion, leaching and volatilization. Therefore nutrients need to replaced and available to next crops. This can be achieved by the application of chemical (inorganic) fertilizers, organic fertilizers or with organic manure such as FYM and slurry. The elements required for plant to complete their life cycle is called essential elements. Plant needs 13 essential element and 3 beneficial elements (Na, Si, and Co).

Arnon and stout in 1939 proposed the following three criteria that must be met an element before it can be classified as essential.

1. A deficiency of elements makes it impossible for the plant to complete the vegetative or reproductive stages of its lifecycle.
2. The symptom resulting from deficiencies of specific element can be prevented or corrected only by applying this elements.
3. The elements are directly involved in the nutrition of the plant, quite distinct m from its possible effect in correcting some micro biological or chemical condition of the external medium. Using these criteria, 16 elements are considered as essential.

Out of these 17 elements, carbon (C) and oxygen are obtained from the gas CO2, and hydrogen (H) is obtained from water (H2O).

These three elements are required in large quantities for the production of plant constituents such as cellulose or starch. The other 14 elements are called mineral nutrients because they are taken up in mineral (inorganic) forms. They are traditionally divided into two groups, macronutrients and micronutrients, according to the amounts required.

Regardless of the amount required, physiologically, all of them are equally important. Oxygen, C and H make up 95 percent of plant biomass, and the remaining 5 percent is made up by all other elements. The difference in plant concentration between macronutrients and micronutrients is enormous. The relative contents of N and molybdenum (Mo) in plants is in the ratio of 10 000:1. Plants need about 40 times more magnesium (Mg) than Fe. These examples indicate the significant difference between macronutrients and micronutrients.

- **Beneficial nutrients**

Several elements other than the essential nutrients have beneficial functions in plants. Although not essential (as the plant can live without them), beneficial nutrients can improve the growth of some crops in some respects. Some of these nutrients can be of great practical importance and may require external addition:

- ✓ Nickel (Ni): a part of enzyme urease for breaking urea in the soil, imparts useful role in disease resistance and seed development.
- ✓ Sodium (Na): for beets, partly able to replace K (uptake as Na^+).
- ✓ Cobalt (Co): for N fixation in legumes and for other plants (uptake as Co^{2+}).
- ✓ Silicon (Si): for stalk stability of cereals particularly rice (uptake as silicate anion).
- ✓ Aluminium (Al): for tea plants (uptake as Al^{3+} or similar forms).

- **Other important nutrients**

As humans and domestic animals require several nutrients in addition to those required by plants, these additional nutrients should also be considered in food or feed production, and their deficiencies corrected by appropriate inputs. In addition to plant nutrients, the elements essential for humans and domestic animals are: Cobalt (Co), selenium (Se), chromium (Cr) and iodine (I).

The nutrients required by crops can be split into *major elements* and *trace Elements*

- **Major elements**
  - ✓ Nitrogen
  - ✓ Phosphate
  - ✓ Potassium
  - ✓ Sulphur
  - ✓ Magnesium
  - ✓ Calcium

- **Trace elements**
  - ✓ Boron
  - ✓ Copper
  - ✓ Iron
  - ✓ Manganese
  - ✓ Molybdenum
  - ✓ Zinc
  - ✓ Cobalt

Methods of plant mineral nutrient absorption

The mechanism of plant nutrient mineral absorption may be grouped into **passive** and **active absorption**.

1.Passive absorption:-It has been assumed that ions are taken up by the roots along with mass flow of water under the influence of transpiration pull. Generally the salt content of the plants differ from that solution in which roots grow and hence this concept was disordered. It takes place when rate of transpiration is high. In this there is no energy loss.

2. Active absorption: - The transpiration of ions with the aid of metabolic energy has been termed as active absorption. It occurs due to activities of roots particularly root hair. It takes place when rate of transpiration is low and quantity of water in the soil is high. In this mechanism there is energy loss.

Self-check 1	Written test

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

Directions: Answer all the questions listed below.

Test II: Short Answer Questions

1. Write essential nutrients used for plant (2)?

____

____

2. What the essential criteria are required plant nutrient? (5 point)

____

____

3. Plant nutrients may be composed both; (3 point)?

____

____

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

Note: **Satisfactory rating - 5 points   Unsatisfactory - below 5 points**

Information Sheet 2- Developing program

2.1 soil conditions and nutrient availability

Plant nutrients, which come primarily from chemical fertilizers, manure, and in some cases sewage sludge, are essential for crop production. When applied in proper quantities and at appropriate times, nutrients (especially nitrogen, phosphorus, and potassium) help achieve optimum crop yields. However, improper application of nutrients can cause water quality problems both locally and downstream**.** Nutrient management is the practice of using nutrients wisely for optimum economic benefit, while minimizing impact on the environment.

More and more, producers understand that healthy soils are more productive and lead to healthier crops. Dig into this interactive info graphic to learn more about sustainable production practices that can help build healthy soil. Explore the on-farm benefits of using cover crops, crop rotation, manure amendments, composting and more on the complex web of life below the surface of the soil. Plant nutrients, which come primarily from chemical fertilizers, manure, and in some cases sewage sludge, are essential for crop production. When applied in proper quantities and at appropriate times, nutrients (especially nitrogen, phosphorus, and potassium) help achieve optimum crop yields. However, improper application of nutrients can cause water quality problems both locally and downstream**.**

Nutrition program in the horticultural or agricultural industry and defines the standard required to: recognize a range of common causes of nutrient deficiency; prepare fertilizers and other products for application to plants; apply fertilizers and other products; clean up and maintain tools and equipment; record work. Nutrient management is the practice of using nutrients wisely for optimum economic benefit, while minimizing impact on the environment.

To develop plant production the following are the most important:

- Signs of Nutrient Deficiencies: Describe nutrient deficiency symptoms and recognize environmental causes of nutrient deficiencies. Understand the interdependence of nutrients and their uptake.
- Soil Test and Analysis: Interpret soil test results based on macronutrients (N-P-K) and other characteristics. Example: pH, cation exchange capacity, drainage, structure.
- Fertilizer Labels: Understanding the information provided on a standard fertilizer label.
- Fertilizer Calculations: Calculate the amount of fertilizer to be applied and calibrate equipment to apply the prescribed amount of fertilizer.of the soil.

Self-check 2	Written test

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

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. To develop plant production what are the most important? (5 point)

____

____

2. What are critical factors regarding water for irrigation purposes are (5 point)

____

____

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

***Note:* Satisfactory rating - 5 points Unsatisfactory - below 5 points**

Information Sheet 3- Soil amendments, management practices and fertilizer requirements

3.1Soil amendments

Only very few soils are “by nature” ideal substrates for plant growth. Much effort has been devoted to improving “problem” soils. Generally, the chemical properties of soils are easier to improve than are the physical ones. With increasing intensity of cropping, many methods of soil improvement have become available and proved profitable.

Of the chemical soil properties, the soil reaction (pH) of many soils must be optimized in order to create favorable conditions for plant growth, nutrient availability and to eliminate the harmful toxic substances.

Optimizing soil pH is a precondition for the success of nutrient management for crop production. It entails either raising the pH of acid soils or lowering the pH of alkaline soils. Among the soil physical properties, the improvement of soil structure is of great concern to farmers. The texture of sandy, clayey or stony soils may also be improved but to a very limited extent.

- **Amendments for raising the soil reaction (liming)**

Soil acidity is reflected primarily in an increase in H+ ions and a corresponding decrease in the basic cations. Carbonates (lime), hydroxides and some other basic acting substances are able to neutralize soil acids. The purpose of liming is primarily the neutralization of the cause of soil acidity (H+ ions and Al3+ in very acid soils), thus raising the pH value.

Ca and Mg compounds are mainly used for the amelioration of acid soils. Most liming materials are obtained from limestone deposits that were formed in seas of earlier geological periods. The resulting limestone may be from inorganic precipitates or from carbonate shells. It can range from physically very soft material to very hard rock. Limestone reserves are immense in the form of calcitic and dolomitic mountains.

- ***Liming materials* Common liming materials are:**
- ✓ **Calcium carbonate**. It generally contains 75–95 percent $CaCO_3$, corresponding to 42–53 percent CaO (the reference basis for lime effect).

- ✓ A **magnesium carbonate** ($MgCO_3$) concentration of more than 5 percent is useful. The particle size of hard limestone must be less than 1 mm and that of soft material (chalk) less than 4 mm.
- ✓ **Calcium and magnesium carbonate** (dolomite). Its different types contain 15–40 percent $MgCO_3$ and 60–80 percent $CaCO_3$. These products are suitable for acid soils that are also Mg deficient.
- ✓ **Quicklime** (CaO) and slaked lime $Ca(OH)_2$. These are quick-acting amendments for the neutralization of soil acidity, but they are generally more expensive than natural limes. They have a special role in certain applications, e.g. creating a well-structured soil surface layer for sowing sugar-beet seeds.

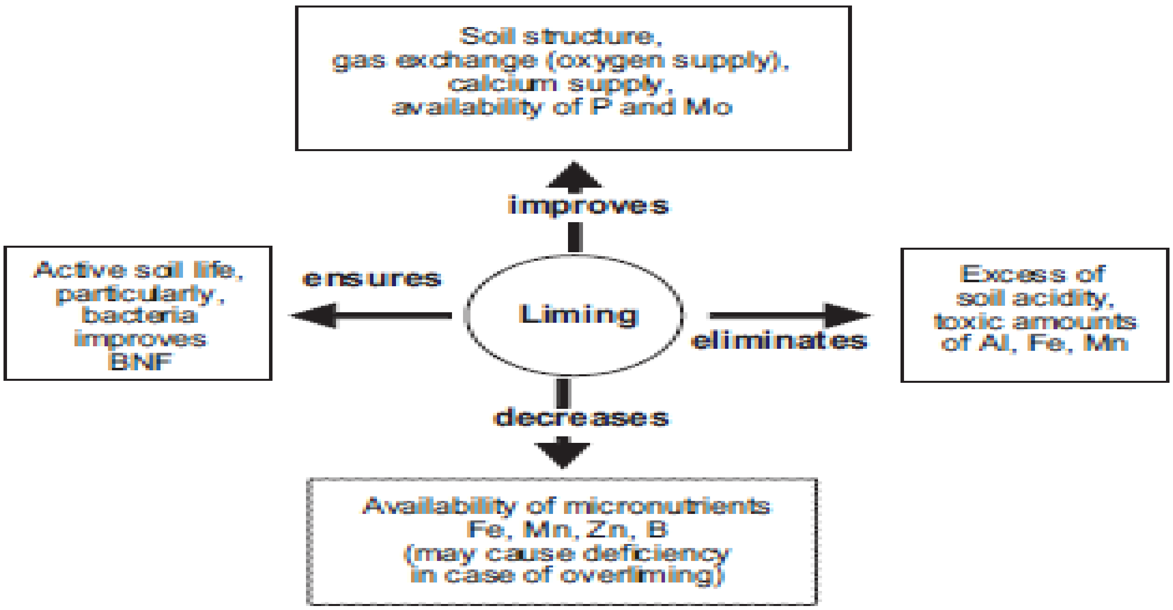
The most common liming material is ground natural limestone ($CaCO_3$) with a definite fineness, depending on the hardness of the rock. The harder the rock is, the finer is the grinding needed to obtain equal efficiency.

- **Selection of liming materials**

In principle, all liming materials can be applied on all soils, but the choice of a material depends mainly on soil texture, local availability and cost. Medium to heavy soils (texture of loam and clay) can be neutralized rapidly with quicklime.

However, to maintain the optimal reaction, slow-acting carbonates are more suitable. In coarse-textured soils (sand and loamy sand), carbonate lime is preferable because of the lower risk of over liming where an excessive amount is applied or where the distribution is not uniform. Another aspect of the choice is the presence of by-products. Some limes also contain nutrients other than Ca, some clay minerals, organic matter or micronutrients, which makes them more valuable for sandy soils.

Effects of liming on soil properties



- **Amendments for alkaline and alkali soils**

Intentional acidification to lower the soil pH may be required on alkaline soils for various reasons. These include removal of negative factors such as micronutrients deficiencies, and removal of excess Na. Soils that have been over limed may require acidification to improve the availability of Fe, Mn and Zn.

- **Amendments for effective acidification** are either acids or those that produce acids after decomposition in soil. The most effective substance is diluted sulphuric acid, but its use is technically difficult, costly and inconvenient. In alkali (sodic) soils, the objective is to remove excess exchangeable sodium ions (Na^+) from the root zone and the undesirable soil dispersion in order to create a favorable environment for plant growth.
  - **Common amendments are**:
  - ✓ ferrous sulphate ($FeSO_4$), which yields acid after hydrolysis with water
  - ✓ Elemental S, which yields acid after oxidation by bacteria to sulphate
  - ✓ Iron pyrite (FeS_2), which yields sulphuric acid after decomposition (also used for alkali soils)
  - ✓ Calcium sulphate or gypsum ($CaSO_4.2H_2O$), for alkali soils.
  - **Amendments for improving soil texture and structure**

In addition to adequate nutrient supplies, a precondition for optimal plant growth is an optimal water supply, adequate aeration of the soil and root penetrability, both in the topsoil and subsoil. Soil physical properties can be improved by creating better soil structure as a precondition for optimal water supply and aeration, and a more favorable soil texture for water retention, root growth and proliferation.

- **Amendments for soil texture improvement**

Light sandy soils lack adequate fine clay particles, whereas heavy clay soils lack enough coarse particles. The consequences of extremely coarse or fine particle sizes are a low potential for natural structure formation. The obvious measures for altering the particle size composition of soils are to supply clay particles to light soils, and sand particles to heavy soils.

- **Amendments for soil structure improvement**

An important measure for improving the structure and opening up the subsoil is correct tillage. However, this results in only temporary improvement, and it should be supplemented by creating favorable conditions for the structure-forming processes in the soil. Several amendments have been developed specifically to improve soil structure. These are usually called soil conditioners and are applied to increase the WHC and resistance to erosion of soils. In fine-textured heavy soils, these are used for creating a crumb structure, chiefly for better aeration.

Many commonly used materials, such as lime and organic manures, improve soil structure indirectly. The following substances contribute to the bonding of the soil particles (which creates good crumb structure):

- **Inorganic or mineral matter**: oxides, lime, silicate coatings, and gypsum;
- **Organic materials**: slimy "glues" (polysaccharides, especially polyuronides) produced by microbes, the hyphae of fungi and humic substances derived from the formation of clay humus complexes (the conditions for which are especially favorable in the intestines of small soil animals, particularly earthworms).
- **Management practices and fertilizer requirements**

Fertility of the soil is important for proper plant growth.

- **Cow manure -**Contains the greatest fertility value when it is fresh: this means that manure should be applied to the land as soon as possible after it is produced.
- **Care of manure**

Manure is difficult to use without waste because it is bulky and perishable Water tight glitters , adequate bedding reinforcement with super phosphate (if possible) and the spreading of the manure on the fields each day all aid in reducing losses of nutrients from manure. To conserve as many plant nutrient as possible manure should be spread daily.

- **Farm yard manure (FYM)**

The manure is produced in the farm chiefly with animal excreta**.** It is also called as stable manure, barn manure, dung and cattle manure. The manure consists of a mixture of cow dung , the liquid excreta or urine , the bedding materials used in the stable and any remnants of straw and plant stalks fed to the cattle .

The quantity of the dung excreted by an animal depends on several factors, such as age, breed and condition of the animal and the nature of food eaten by it

Besides supplying plant nutrients, farm yard manure application to the soil also improves the physic –chemical and biological properties of the soil. Application of farm yard manure along with the recommended levels of fertilizers enables to maintain the organic matter in the soil compared to fertilizer application alone.

- **Compost:**

Compost is one the best friends a gardener can have. Just about all vegetation (tress, fruits, vegetables, shrubs, etc.) thrive on compost or mulch. Most gardeners have a compost pile where we throw anything and everything from the plant world. Most of us are not picky at what we throw in there and most vegetation are perfectly fine to include in our compost pile.

It is difficult to make a long term mistake with the compost pile. If you do not turn it and keep it moist, it will still decompose. It will just take a little longer and may smell a lot more along the way. A common error is to pile the grass clippings too thickly. This result is a strong odor, but does not affect the eventual decomposition.

- **Leaves and Leaf Mulch (Black Gold):** Leaves are a frequent additive to the garden. Most (but not all) leaves are fairly neutral in pH, and overall are healthy for the soil and plants. Not all leaves are good for your garden. Eucalyptus for example, emits the toxin allele chemical which is harmful to plants.

There are other mulches as well. These include pine mulch and wood chips. The drawback to some of these are acidic pH levels, little nutrient value, or raw compost which can result in burning your plant if piled too thickly. It worked great to keep the weeds down.

- **Cover Crops**

Professional growers will grow a "cover crop" in their field. The most common crop is an annual or winter rye grass. Alfalfa is also good. The grass sowed in the fall and plowed or roto-tilled in the spring. Cover crops benefit the field in two ways. First the grass adds nitrogen into the soil. Second, it can reduce soil erosion due to wind, rain and runoff during the long off season.

This concept is commonly practiced in professional farming and is easily practiced in smaller home gardens. However, most home gardeners do not practice this.

- **Crop Rotation:**

Crop rotation means moving your crop from one area of your garden or field to another. This is an important concept for home gardeners as well as professional farmers in order to maintain the health of your soil. Rotating your crops helps to avoid depletion of nutrients and minerals in the soil. And, very importantly, it minimizes insect and disease as both of these can overwinter in your soil.

- **Saw dust –**as a mulch is **usually** a good practice if certain precautions are used to decrease the tie up of available soil nitrogen N-should be mixed with dry saw dust.
- **Soil management strategy:** The main objective of management for agriculture is to create favorable conditions for good crop growth ,seed germination ,emergence of the young plant , root growth and plant development ,grain formation and harvest

Self-check 4	Written test

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

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Define soil amendments? (5 point)

____

____

2. Soil amendments include? (10 point)

____

____

3. Write the principle of soil management practice? (5)?

____

____

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

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

Information Sheet 4- Identifying resources, tools, equipment's, and machinery for program

4.1. Introduction

Agricultural machinery and equipment help farmers produce the goods that consumers want and need. Without the proper machinery and equipment, farmers would not be efficient enough to provide the food, clothing, and shelter that we need. Resources, tools, equipment's and machinery required during soil amending are:

Resources, tools, equipment and machinery may include:

- Aerial photographs, charts and tables of soil characteristics and plant soil parameters
- Application equipment and machinery such as:
  - ✓ Air blowers
  - ✓ Backpack spray equipment
  - ✓ Irrigation systems set up for fertigation
  - ✓ Pumps and pump fittings
  - ✓ Rippers and spray equipment
  - ✓ Seeders
  - ✓ Tractors and trailed or three-point linkage spreaders
  - ✓ Backhoe
  - Charts and illustrations of symptoms of plant nutrient deficiencies and toxicities
  - ✓ Hand-held salinity or electrical conductivity meter
  - ✓ Hand or powered auger
  - ✓ PH test kit or electronic pH testing device
  - ✓ Plastic overlays
  - ✓ Sample bags
  - ✓ Tape measure

Are may be needed at a time of soil amendment, management practice .Some of their picture is given below. To be effective, an amendment must be thoroughly mixed into the soil not merely buried, lumped in or placed on the soil surface.



Figure: tools and equipment's of machinery

The backhoe is a piece of heavy construction machinery made out of 3 main parts: a tractor, a front loader and a backhoe. It is generally used to move earth and dig trenches. In this room the more traditional analytical processes are carried out, e.g., pH, electrical conductivity, and anions and cations.

Self-check 4	Written test

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

Directions: Answer all the questions listed below.

Test I: choose the best answer

1. Without the proper machinery and equipment, farmers would not be efficient enough to provide the food, clothing, and shelter that we need? (5 point)

   A.True B. False

2. Which one of the following is tools and equipment is used for soil health?

A. GPS B. GIS C. machinery D. all

Test II: Short Answer Questions

3. Write the equipment's and machinery required during soil amending? (5 point)

____

____

***Note:* Satisfactory rating - 5 points Unsatisfactory - below 5 points**

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

Information Sheet 5- Cost-effective approach to soil management, soil amendment

5.1. Cost-effective approach to soil management, soil amendment

Soil amendment includes all inorganic and organic substances mixed into the soil for achieving a better soil constitution regarding plant productivity. Soil amendment does not include mulching, which includes substances lying on top of the soil. There are different substances for different soils and plants to optimize the soil conditions. A very common amendment is the addition of organic matter like compost, due to its low production costs. Soil amendments improve the physical properties resulting in better conditions for water storage, root development and soil ecosystems, Soil amendments enhances soil aeration, Soil amendments can be produced locally, especially organic amendments (e.g. compost), which are cheap to produce and Soil amendments can be applied almost everywhere by almost anybody.

- **Cost-effective approaches to soil amendments are:**

✓ Use of manure
✓ Use of farm yard manure
✓ Proper incorporation of crop residues in to the soil
✓ Use of cover crop
✓ Inter cropping
✓ Crop rotation
✓ Fallowing and etc

Self-check 5	Written test

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

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. What is cost effective approach of soil amendment? (5 point)

____

____

2. Cost-effective approaches to soil amendments were (5)?

____

____

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

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

Information Sheet 6- Identifying OHS hazards

6.1 Identifying OHS hazards

Many people believe that soil sampling contains little risk, but this is not true. Some of the potential risks include sampling in areas containing buried utilities, pit cave in, equipment failure, dehydration, muscle skeletal injury, and allergic reactions to plants and insect stings.

OHS hazard may include:

- **OHS hazards associated with soil amendment include:**
  - ✓ Chemical and hazardous substance
  - ✓ Dust
  - ✓ Machinery and machinery parts
  - ✓ Sharp hand tools and equipment's
  - ✓ Slippery and uneven surfaces
  - ✓ Soil and water borne micro organisms
  - ✓ Solar radiation
  - ✓ Incorrect manual handling and etc.
- **Control measures**
  - ✓ Appropriate use of personnel protective equipment including sun protection. e.g. hats and other
  - ✓ Appropriate use of safety equipment's
  - ✓ Assessing and reporting risk
  - ✓ Basic first aid available on site
  - ✓ Correct manual handling(i.e. Read, understand follow manufacturer's instructions before using any machinery, tools equipment's and chemicals)
  - ✓ Identifying hazards
  - ✓ Maintaining personal hygiene
- **To protect those hazards, the followings are the most important one**:

- ✓ Appropriate use of PPE, including sun protection
- ✓ Appropriate use of safety equipment,
- ✓ Assessing and reporting risks
- ✓ Basic first aid available on site
- ✓ Cleaning, maintaining and storing tools, equipment and machinery
- ✓ Correct manual handling
- ✓ Identifying hazards
- ✓ Maintaining personal hygiene
- ✓ Reporting problems to supervisors
- ✓ Safe handling,
- ✓ Safe operation of tools, equipment and machine
- ✓ Body Protection
- ✓ Hand Protection
- ✓ Dust Mask
- ✓ Eye Protection
- ✓ Full Face Shield

Self-check 6	Written test

Name…………………………………………… ID………………………… Date……
Directions: Answer all the questions listed below.

Test I: Choose Answer Questions

1. OHS hazard include one of the following? (1 points)

A. Soil and dust B. Solar radiation

C. Chemicals. D. Soil and water born microorganism. E. All

2. One of the following is tools and equipment of soil health? (1 points)

A. PPE B. Dust protection C. Eye protection D. All

Test II: Short Answer Questions

3. What are the most important to protect hazards? (5 point)

____

____

4. Write tools and equipment's of soil health? (3 point)

____

____

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

***Note:* Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Information Sheet 7- Identifying Environmental implications of program

7.1. Introduction

Adequate plant nutrition is essential for commercial crop production. Nutritional programs commonly used commercially prepared inorganic fertilizers applied to the soil by broadcast, through the irrigation system or by foliar sprays. Application of fertilizers and soil amendments are subject to a number of different regulatory schemes. Nutrient content of soil amendments may vary and should be documented.

Fertilizer budgets based on expected plant nutritional needs for each growing season should be assessed to insure that fertilizer applications are within plant needs. Excessive application of nutrients is uneconomical, can lead to lush growth that is more susceptible to disease and pests, and can cause ground and surface water pollution. Manure has historically been used as a source of plant nutrients and soil amendment in many agricultural systems. When based upon a sound waste management program, land application of manure can be an economically sound agricultural decision. However, if not managed properly, waste application can be an environmental hazard.

Environmental implications May include:

- Beneficial impacts, including minimization of nutrient
- Run-off and toxic side effects in soil and surrounding environment achieved by:
  - ✓ Improved application techniques and rates
  - ✓ Improved assessment and targeting of nutrient requirements
- Reduction of toxic side effects of applied nutrients in crop plants
- Negative impacts, including over-spraying or run-off into external environment resulting in nutrient overload or excess water affecting things such as:
  - ✓ Loading atmosphere with greenhouse gas
  - ✓ Mining native soil fertility
  - ✓ Native plants
  - ✓ Natural waterways

- ✓ Salinization
- ✓ Water erosion
- ✓ Water logging
- ✓ Water tables and ecosystems

- Methods which may aid in reversal of environmental degradation include:
  - ✓ Allowing natural recovery and regeneration of native ecosystems
  - ✓ Responsible fertilization and watering practices.

On-farm impacts due to the loss of soil and nutrients include:

- Lower fertility levels
- Development of rills and gullies in the field
- Poorer crop yields
- Less water infiltration into the soil
- More soil crusting
- More runoff in the spring and after storms

7.2. Factors to Consider When Choosing an Amendment

There are at least four factors to consider in selecting a soil amendment:

- how long the amendment will last in the soil,
- soil texture,
- soil salinity and plant sensitivities to salts, and
- salt content and pH of the amendment

Soil Texture: Soil texture, or the way a soil feels, reflects the size of the soil particles. Sandy soils have large soil particles and feel gritty. Clay soils have small soil particles and feel sticky. Both sandy soils and clay soils are a challenge for Gardeners. Loam soils have the ideal mixture of different size soil particles. When amending sandy soils, the goal is to increase the soil's ability to hold moisture and store nutrients. To achieve this, use organic amendments that are well decomposed, like composts or aged manures. With clay soils, the goal is to improve soil aggregation, increase porosity and permeability, and improve aeration and drainage.

Soil Salinity and Plant Sensitivity to Salts: Some forms of compost and manures can be high in salts. Avoid these amendments in soils that are already high in salts (above 3 mmhos/cm) or when growing plants that are sensitive to salts. Raspberry, strawberry, bean, carrot, onion, Kentucky bluegrass, maple, pine, viburnum and many other landscape plants are salt sensitive.

Salt Content and pH of the Amendment: Always beware of salts in soil amendments. High salt content and high pH are common problems in soils. Therefore, avoid amendments that are high in salts or that have a high pH. Amendments high in salts and/or pH include wood ash. Ask for an analysis of the organic amendments that you are considering, and choose your amendments wisely. If no analysis is available, test a small amount of the amendment before purchasing a large quantity.

Wind erosion: Is particularly a problem in windy areas when the soil is not protected by residue cover. Wind erosion in the United States is most widespread in the Great Plains states, as can be seen in the map at right. Wind erosion is a serious problem on cultivated organic soils, sandy coastal areas, alluvial soils along river bottoms. **Impacts of soil erosion**: Soil erosion has both on-farm impacts (reduction in yield and farm income) and off-farm impacts (contaminated water due to the sediment and associated contamination from nutrients and pesticides carried on the soil particle).
On-farm impacts due to the loss of soil and nutrients include:

- lower fertility levels
- development of rills and gullies in the field
- poorer crop yields
- less water infiltration into the soil
- more soil crusting
- more runoff in the spring and after storms

When fertile topsoil is lost, nutrients and organic matter needed by crops often are removed along with it. Erosion tends to remove the less dense soil constituents such as organic matter, clays, and silts, which are often the most fertile part of the soil.

Self-check 7	Written test

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

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. What are factors to consider in selecting a soil amendment? (5 point)

____

____

2. Write on-farm impacts due to the loss of soil and nutrients? (5 point)

____

____

***Note:* Satisfactory rating - 5 points Unsatisfactory - below 5 points**

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

LG #72	**LO # 3- Document the soil health and plant nutrition program and specifications**

Instruction sheet
This learning guide is developed to provide you the necessary information regarding the following content coverage and topics: • Establishing detailed plan, objectives, specifications and associated costs • Developing and documenting detailed on-site procedures and schedules 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: • Establish detailed plan, objectives, specifications and associated costs • Develop and document detailed on-site procedures and schedules
Learning Instructions:
1. Read the specific objectives of this Learning Guide. 2. Follow the instructions described below. 3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them. 4. Accomplish the "Self-checks" which are placed following all information sheets. 5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks). 6. If you earned a satisfactory evaluation proceed to "learning guide.

Information Sheet 1- Establishing detailed plan, objectives, specifications and associated costs

1.1. Introduction

Detailed plan, objectives, specifications and associated costs are established based on program requirements and are presented to land manager. To document the soil health and plant nutrition program and specifications it is important to establish the detail plan on soil health and plant nutrition program and this plan must have objective which indicates or answers the question why the plan is under taken and this objectives also have specifications which is describes the aim of your objectives and associated cost to undertake soil health development and plant nutrition program in terms of man power, equipment required, machinery required etc.

Soil health is not an end in itself. Soil, water, sunlight and air are the primary natural resources for agricultural production. Of these four, soil is the most complex component and is also highly sensitive to management. The term soil health conjures up the sense of soil as living, productive and, by implication, something that can at times be unhealthy, incapacitated and unproductive. Soil is a finite resource on the farm. The farm enterprise is adapted to this resource in terms of the total land area of the farm and soil quality. These factors combine with season temperatures and water availability to determine the choice of produce, the production system, and the productive potential of the enterprise.

Soil health is important for sustainable farming because a healthy soil performs the functions that are expected of it. Annual maintenance costs to restore soil to a functionally healthy state can be avoided - e.g. changing from cultivation practices to zero tillage and controlled traffic systems reduces fuel costs and maintains soil structure. The costs of substituting management interventions for services that soil could provide can also be reduced or eliminated - e.g. soil borne disease management. There is also a bigger picture, beyond the farm.

Environmental impacts of inadequate soil management include groundwater contamination, surface water quality degradation (nutrients and turbidity), and destruction of infrastructure (e.g. erosion and deposition). On the positive side, a soil health management plan for a farm potentially enhances property value, provides evidence that can be used in environmental accreditation for 'clean and green' products. Objective procuring entities when procuring goods, services or works should consider long term economic viability, minimizing any adverse environmental impact arising from procurement performance, as well as improve social conditions and stimulate the market to further innovate sustainable production.

Environmental performance criteria in purchasing decisions may relate to maximum energy efficiency, minimum use of toxic chemicals and other pollutants, maximum use of products based on recycled materials and/or minimum use of unnecessary packaging and other superfluous material.

Costs Associated with soil test and plant nutrient program were:

The costs of a facility to the owner include both the initial capital cost and the subsequent operation and maintenance costs. Each of these major cost categories consists of a number of cost components. The capital cost for project includes the expenses related to the initial establishment of the facility:

- Land acquisition, including assembly, holding and improvement
- Planning and feasibility studies
- materials, equipment and labor
- Field supervision
- n financing
- Insurance
- Owner's general office overhead
- Equipment and furnishings not included in construction
- Inspection and testing

Self-check 1	Written test

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

Directions: Answer all the questions listed below.

Test I: Choose the best answer (5 point)

1. Detailed plan, objectives, specifications and associated costs are established based on program requirements**.**

A. True B. False C. A&B

Test II: Short Answer Questions

2. Write the primary natural resources for agricultural production.

____

____

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

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 point

Information Sheet 2- Developing and documenting detailed on-site procedures and schedules

2.1. Introduction

Detailed on-site procedures and schedules required for program are developed and documented. In this the description of on-site procedures which explain in detailed and the schedule required for program are developed and clearly documented

The idea that one could test or analyze a soil and obtain some information about properties especially its acidity or alkalinity and its nutrient status is long established, and can be traced back to the beginning of scientific inquiry about the nature of soil.

Analyses of plants to reflect the fertility status of the soil in which they grew is more recent, although visual crop observations are as old as the ancient Greeks, if not older. In the last few decades, spurred on by commercialization of agriculture and the demands for increased output from limited and even diminishing land resources, both soil and plant analysis procedures have been developed, and are still evolving.

With the advent of chemical fertilizers, the need to know nutrient status of a soil in order to use such expensive and limited inputs more effectively became all the more crucial. However, if soil testing is to be an effective means of evaluating fertility status of soils, correct methodology is absolutely essential. A soil or a field may be assessed for its **capability of providing a crop with essential nutrients in several ways**:

- Field plot fertilizer trials,
- Greenhouse pot experiments
- Crop deficiency symptoms
- Plant analysis
- Rapid tissue or sap analysis
- Biological tests
- Soil testing prior to cropping

While all these approaches can be used in research, the latter one is most amenable, and one upon which recommendations for farmers can be based. Detailed on-site procedures and schedules required for program are developed and documented. In this the description of on-site procedures which explain in detailed and the schedule required for program are developed and clearly documented.

Remark: 1.The air-dry moisture in a soil sample taken straight from a hot and humid storeroom (or a very cold one) may be different from that in a similar sample kept in an air-conditioned laboratory; both may be weighed for analysis at the same time as “air-dry’ samples.

2. The tap water supplied to a laboratory should be entirely free of pollution, as free as possible from insoluble matter, and under good and steady hydrostatic pressure. It may be necessary to filter the supply to certain pieces of equipment.

3. Drainage should be to a main drain if possible or to good-sized “soak-away”. Effluents from soil laboratories contain considerable quantities of waste soil in addition to acid and alkaline liquids. The facilities should be provided in the design of the drainage system for periodic cleaning and removal of solid matter.

At the end of the working day, wash the pipette with tap water and then several times with distilled water, Dry the pipette in an oven, Keep the pipette upside down in a special clamp.

Self-check 2	Written test

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

Directions: Answer all the questions listed below.

Test I: True or false (4 points).

1. Air-dry moisture in a soil sample taken straight from a hot and humid storeroom may be different from that in a similar sample.

2. Soil or a field may be assessed for its capability of providing a crop with essential nutrients using scheduling and documenting.

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

LG #73	LO# 4- Monitor production and evaluate the program.

Instruction sheet 4

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

- Monitoring program implementation and results
- Reviewing and refining Program
- Identifying Non-compliance with documented objectives and specifications
- Implementing remedial actions
- Incorporating agreed changes

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:

- Monitor program implementation and results
- Review and refine Program
- Identify Non-compliance with documented objectives and specifications
- Implement remedial actions
- Incorporate agreed changes

Learning Instructions:

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

Information Sheet 1- Monitoring program implementation and results

1.1. Monitoring

Program implementation and the results of the program are monitored by testing soil and plant to ensure requirements of our objective plan are achieved according to enterprise production requirements.

Monitoring is the continuous collection of data on specified indicators to assess for a development intervention (project, programme or policy) its implementation in relation to activity schedules and expenditure of allocated funds, and its progress and achievements in relation to its objectives.

Degradation issues such as erosion, loss of organic matter, compaction and contamination, all which affect soil functions, are common around the world and will continue to grow as the need for food and fiber increases. Maintaining soil productivity while ensuring environmental health is an ongoing issue which requires soil quality to be defined and evaluated. Monitoring of the soil is essential to assess the sustainability of the soil resource in response to human induced pressures such as land use and soil contamination.
Monitoring is defined as the repeated inventory of an item to determine trend and status. One method of monitoring soils is benchmark sampling. The basic principle of benchmark sampling is to sample at the same location each year.

Benchmark sites are representative of larger areas and are usually about a quarter acre (0.1 ha) in size. Sampling with this method is less expensive and time consuming than traditional grid sampling and is more consistent because it assumes the benchmark area is less variable than the larger area which it represents.

Monitoring can be carried out at the project, programme or policy levels. Monitoring provides managers and other stakeholders with regular information on progress relative to targets and outcomes. It is descriptive and should identify actual or potential successes and problems as early as possible to inform management decisions.

A reliable flow of relevant information during implementation enables managers to keep track of progress, to adjust operations to take account of experience and to formulate budgetary requests and justify any needed increase in expenditure. Indeed, an effective management information system that performs these functions is an essential part of good management practice.

Monitoring systems provide managers and other stakeholders with regular information on progress relative to targets and outcomes. This enables managers to keep track of progress, identify any problems, alter operations to take account of experience, and develop any budgetary requests and justify them. This enables the early identification of problems so that solutions can be proposed. It is considered to be a critical part of good management.

The key reasons for monitoring can be summarized under four headings.

1.For accountability: demonstrating to donors, taxpayers, beneficiaries and implementing partners that expenditure, actions and results are as agreed or can reasonably be expected in the situation.
2. for operational management: provision of the information needed to co-ordinate the human, financial and physical resources committed to the project or programme, and to improve performance
3. for strategic management: provision of information to inform setting and adjustment of objectives and strategies.
4. for capacity building: building the capacity, self-reliance and confidence of beneficiaries and implementing staff and partners to effectively initiate and implement development initiatives.
Soil Quality Program was established to determine the state of soil quality to determine the risk of change in soil quality with various management practices. The Soil Quality Program realized that soil quality models (i.e. crop growth models and soil degradation models) would need to be employed because of limited resources, a large diverse farming area and the time required observing measured changes in soil parameters. Consequently, a need for a monitoring network of sites to provide data to test and validate these models was identified.

Soil quality program were established with the following objectives in mind:

- provide a dataset to test and validate simulation models
- provide baseline soil information
- evaluate landform effects on soil quality
- monitor changes in soil quality over time on a field landscape basis

Self-check 1	Written test

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

Test I: Short Answer Questions

1. What is monitoring? (5 point)

____

2. Write the key reasons for monitoring? (3 point)

____

____

____

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

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

Information Sheet 2- Reviewing and refining program

2.1. Introduction

Effective collaboration is characterized by dense, frequent sharing of knowledge among participants, with the aim of addressing the identified challenges. Members of highly effective groups interact frequently among themselves, focusing on refining and consolidating professional practice. They also connect outwards to gain new knowledge that will complement what they already know and to maintain connections with, and participate in, larger networks.

A review is a structured opportunity for reflection to identify key issues and concerns, and make informed decisions for effective project/programme implementation. While monitoring is ongoing, reviews are less frequent but not as involved as evaluations. Reviews as an internal exercise, based on monitoring data and reports.

They are useful to share information and collectively involve stakeholders in decision-making. They may be conducted at different levels within the project/programme structure (e.g. at the community level and at headquarters) and at different times and frequencies. Reviews can also be conducted across projects or sectors. It is best to plan and structure regular reviews throughout the project/programme implementation.

- **Review techniques:**
  - ✓ Re-read to the original assignment to be certain your test addresses all of the requirements. Then read your paper section by section to make sure you're on target. If you're not, be prepared to add or delete large portions of text.
  - ✓ Use the power of peer-review: find a classmate, a friend, or a writing tutor to review the paper with you and look for weaknesses and errors.
  - ✓ If you finish in ample time, ask you person (expert) if he or she is willing to give.

Refining can be used the strategy he had refined during the turnover at Temple, which was writing and rewriting concepts until they lodged in his brain.

To ensure soil and plant nutrient program that you have planned, to implement it is necessary to review and refine as if it is responsive to changing conditions. You may simply ask your self-question like:

To ensure soil and plant nutrient program that you have planned, to implement it is necessary to review and refine as if it is responsive to changing conditions. You may **simply ask your self-question like:**

- Is the plan bringing change or not?
- Is the plan improving the soil health problems?
- Is the plan solving plant nutrition problem?
- Is the plan appropriately meeting our objective requirements?

By answering that question you can review and refine the program.

To ensure soil and plant nutrient program that you have planned, to implement it is necessary to review and refine as if it is responsive to changing conditions. You may simply ask your self-question like:

Self-check 2	Written test

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

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Write review techniques for soil monitoring (5 point)

____

____

2. What is refining? (3 point)

____

____

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

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

Information Sheet 3- Identifying Non-compliance with documented objectives and specifications

3.1. Non-compliance

While reviewing and refining the program, it is important to identify non-compliance with documented objectives and specification and take remedial action to alleviate or overcome identified short coming of the program

Non-compliance is defined as failure or refusal to comply with something (such as a rule or regulation) or a state of not being in compliance. Noncompliance is commonly identified in the following ways: A report or complaint received from a participant, research team member, or others. A report initiated by the Investigator through a Reportable Event Form.

Information provided in a Continuing review. Human behavior, particularly compliance, is a central component of conservation program. Compliance with conservation rules (e.g., no hunting, no firewood extraction) is critical to the success of any conservation project, regardless of the scale of the conservation actions, the categories of biodiversity the project focuses on, or the means of conservation governance.

Non-compliance with conservation rules (i.e., rule violations) can undermine conservation goals, and have wide-ranging impacts on the social–ecological systems in which all conservation actions are embedded.

Non-compliance in biodiversity conservation is a global challenge, one that is growing increasingly complex and attracting the attention of a wider array of scholars and practitioners from the conservation field.

While reviewing and refining the program ,it is important to identify non-compliance with documented objectives and specification and take remedial action to alleviate or overcome identified short coming of the program.

- **Remedial actions contain**

- ✓ Adjustments to soil amendments
- ✓ Changes to fertilizer application and soil management practices
- ✓ Irrigation scheduling
- ✓ Nutrient application rates and methods
- ✓ Use of foliar sprays

Self-Check – 3	Written test

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

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. While reviewing and refining the program, it is important to identify_______________________ with documented objectives and specification? (5 points)

2. How noncompliance is commonly identified? (2 points)

____

____

3. Define noncompliance?(3) ____

Note: **Satisfactory rating - 5 points Unsatisfactory - below 5 points**

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

4.1. Introduction

A remedial action is a change made to a nonconforming product or service to address the deficiency. This also can refer to restoration of a landscape from industrial activity. Rework and repair are generally the remedial actions taken on products, while services usually require additional services to be performed to ensure satisfaction.

Plant nutrient improvement (remedial action) may include:

- Adjusting to soil amendment
- Changing to fertilizer application and soil amendment
- Nutrient application rates and methods
- Use of foliar spray if other methods

Integrated nutrient management

Adequate plant nutrient supply holds the key to improving the food grain production and sustaining livelihood. Nutrient management practices have been developed, but in most of the cases farmers are not applying fertilizers at recommended rates. They feel fertilizers are very costly and not affordable and due there is a risk particularly under dry land conditions.

Therefore, INM plays an important role which involves integrated use of organic manures, crop residues, green manures, Bio fertilizer. with inorganic fertilizers to supplement part of plant nutrients required by various cropping systems and thereby fulfilling the nutrient gap.

- The basic concept underlying the principle of integrated nutrient management is to maintain or adjust plant nutrient supply to achieve a given level of crop production by optimizing the benefits from all possible sources of plant nutrients. The basic objectives is to reduce the inorganic fertilizer requirement, to restore organic matter in soil, to enhance nutrient use efficiency and to maintain soil quality in terms of physical, chemical and biological properties. Bulky organic manures may not be able to supply adequate amount of nutrients, nevertheless their role becomes important in meeting the above objectives.

- **Increase the soil cover-is the most important principles for sustainable soil management as it brings multiple benefits:**

- ✓ Reduction of water and wind erosion
- ✓ Increase of the infiltration rate
- ✓ Reduction of moisture loss and increases moisture availability
- ✓ Reduction of soil temperature
- ✓ Improvements of conditions for germination
- ✓ Increase organic matter contain of surface
- ✓ Stimulation of biological activities in the soi
- ✓ Keeping water free of harmful bacteria (disinfection)
- ✓ Minimizing harmful disinfection by-products
- ✓ Eliminating lead from pipework
- ✓ Preventing pesticides from entering our waters
- ✓ Managing risks to water supplies
- ✓ Ensuring all water treatment plants are effective

Self-Check – 4	**Written test**

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

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Write factors, which influence the cost of an inventory?

____

____

2. Identify cost and benefit in forest intervention?

   ----

3. List the remedial action has to be under taken to improve plant nutrition

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

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

Information Sheet 5- Incorporating agreed changes

5.1. Standardization Method

Once the soil health and plant nutrition program is developed, then it is important to see its profit concerning to production. If the program is sounded to be good and solve the objective ,then it is appreciated and document is kept for future analysis and use ,but if not it will be incorporated to another plan.

Results can only be validly compared to one another when they have been obtained using standardized methods. Collaboration between laboratories can be improved by exchanging reference materials and then comparing their results. Such materials are referred as External References. An example of such standardization is the exchange network of International Soil Reference and Information Center in the operating international soil and plant analytical exchange programs. Most external reference samples are costly, and their frequent use increases operating costs of the laboratory. Internal reference samples are usually much less expensive.

Thus, if a relationship between external and internal reference samples can be firmly established, frequent use of internal reference sample, with occasional use of the external reference sample, can reduce costs, while still providing acceptable quality assurance.

Self-Check – 5	Written test

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

Directions: Answer all the questions listed below.

Test I: True or False

1. Collaboration between laboratories can be improved by exchanging reference materials.2 points

2. Relationship between external and internal reference samples can be firmly established. 2 points

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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