Ethiopian TVET-System

Crop Production Level – II

Based on Version 3 March 2018 OS.

Training Module –Learning Guide 20-22

Unit of Competence: Determine Basic Properties of Soil

Module Title: Determining Basic Properties of Soil

TTLM Code: AGR CRP2 M06 TTLM 0919v1

October 2019

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This module includes the following Learning Guides

LG 21: Collect soil samples for testing

LG Code: AGR CRP2M06 LO1-LG-20

LG 22: Perform basic soil tests

LG Code: AGR CRP2M06 LO1-LG-21

LG 23: Complete soil testing operation

LG Code: AGR CRP2M06 LO1-LG-22

Instruction Sheet	Learning Guide 21

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

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

- Preparing tools and equipments for collecting soil sampling
- Identifying areas for soil sampling
- Locating services using site plans
- Identifying, assessing , controlling and OHS hazards
- Selecting, using and maintaining PPEs
- Taking and preparing soil samples for analysis
- Labelling and recording soil samples.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Prepare tools and equipments to collecting soil sampling
- Identify areas for collect soil sampling
- Locate services using site plans
- control of OHS hazards
- Select, use and maintain suitable safety PPEs
- Take and prepare soil samples
- Label and record soil samples.

Learning Instructions:

a. Read the specific objectives of this Learning Guide.
b. Follow the instructions described
c. Read the information written in the information "Sheet
d. Accomplish each "Self-check respectively.
e. If you earned a satisfactory evaluation from the "Self-check" proceed to the next or "Operation Sheet
f. Do the "LAP test" –

Information Sheet-1	Preparing tools and equipments for collect soil sampling

1.1. What is soil?

Soil can be defined in either the following three ways as

(a) “The natural medium for the growth of land plants.

(b) A dynamic natural body on the surface of the earth, in which plants grow, composed of mineral and organic materials and living forms.

(c)The collections of natural bodies occupying parts of the earth’s surface that support plants and that have properties due to the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over periods of time.” Or in general

We build on soil, as well as in it and with it. Soil is the major support systems of human life and welfare. They provide anchorage for roots, hold water long enough for plants to make use of it, and hold nutrients that sustain life. Soils are home to myriad micro-organisms that accomplish a suite of biochemical transformations from fixing atmospheric nitrogen to the decomposition of organic matter and to armies of microscopic animals as well as the familiar earthworms, ants and termites. In fact, most of the land’s biodiversity lives in the soil, not above ground.

Soil is made up of different material and organisms, including mineral matter, decayed organic matter, water, air, living plants and animals. Together they provide an environment in which plants can grow.

1.2. How is soil formed?

It is important to understand how soil is formed because this helps us to identify the ingredients or parts that make up the soil we have today.

Soil is made up of both weathered rock and organic material. Soil is formed by the weathering of the underlying rock, called the parent rock. When this rock is weathered and broken down, it becomes the parent material from which soil is formed.

Weathering of the parent rock and the formation of soil from the parent materials are influenced by environmental factors, such as the climate and surrounding animal and plant communities.

Climatic factors (such as exposure to the sun, rain and wind) result in the weathering of underlying rocks to produce the minerals found in the soil. The breakdown of the organic material on the surface of the soil by the living animals and plants produces the organic matter in the soil. This makes up a large bulk of the soil.

The constituents of soil

The ingredients or substances and materials that make up the soil are called constituents.

The major constituents include:

- mineral matter formed by the breakdown of rocks
- decayed organic matter
- water
- air
- living plants and animals

Mineral matter

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

Sand

Sand particles do not tend to stick together and this makes soils with high levels of sand easier to dig. Sand does not add much to soil fertility, but it does have an important effect on the ease with which water and plant roots may enter into the soil.

Silt

Silt is often a rich source of plant nutrients, especially potassium.

Clay

Clay is the most important mineral part of the soil. The soil's ability to hold and supply water to plants depends on the type and quality of clay present in the soil.

Organic matter

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

Soil water

Soil has spaces between the solid particles of mineral and organic matter. These spaces are called pore spaces. The pore spaces contain water and air. The water in the soil containing dissolved nutrients is called the soil solution. Without soil solution, plants cannot live.

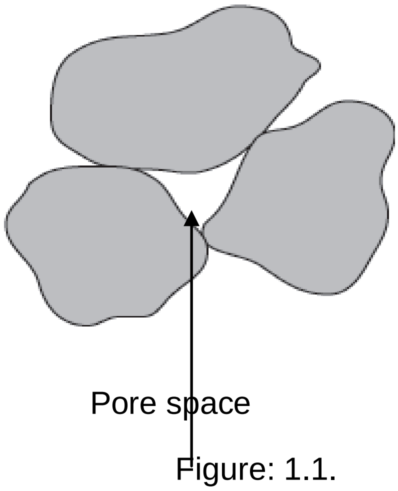


Figure: 1.1.

Air

Air fills the spaces between the soil particles that are not filled by soil solution. Without air in the soil, plants cannot survive. If the spaces between the soil particles are full of water, the soil becomes waterlogged. This can cause plant roots to die, because they cannot breathe. If there is no air in these spaces, the soil is called anaerobic and it may develop a foul smell. It is important to remember that many small organisms, both plants and animals, live in the soil. These organisms require oxygen to survive and they get this oxygen from the air trapped in the soil spaces.

Organisms

The plants and animals living in the soil (called the soil biota, because bio means living) range from small organisms, such as insects and fungi, to organisms that can only be seen under a microscope, such as bacteria. These living organisms are essential to soil fertility. Their main job is to break down organic matter and change it to a form that plants can use. The following diagram shows some of the creatures commonly seen in the soil.

Nutrients

If a plant is to grow, it requires nutrients to provide it with energy and material that it will use to increase its size and shape. Plants get their nutrients from the soil. This is where the roots of the plant are important. Plant roots cannot absorb nutrients in a solid form. Most plants can only absorb nutrients from the soil if the nutrients are dissolved in water.

What is growing media?

While many plants are grown in soils there are also many types of media that can be used to grow plants hydroponically. When plants are grown hydroponically they are grown without soil. Media is used to hold the plant in place and provide aeration for the roots. The plants are then fed a liquid mixture of nutrients and water to help them grow.

Choosing the right media will depend on what is available, the type of system you are using and the plants you are growing. As the products listed below are produced in controlled conditions, they are standardized for optimum plant growth. This means that the chemical, physical and structural properties of the media should remain constant

Soil sample

Soil sample may take in two ways, according to the kinds of test to be performed. They are:

a) Disturbed sample which do not represent exactly how the soil was in its natural state before sampling.

- Are used for the more simple tests that will be performed and particularly for those tests which you will perform you in the field.

b) Undisturbed sample which represent exactly how the soil was in its natural state before sampling.

- Undisturbed samples are necessary for the more sophisticated tests which must be performed in laboratory for more detailed physical and chemical analyses.

Why collect soil samples?

You may want to start an orchard or vegetable garden and want to be sure that you are choosing the right spot. Soils can look the same from place to place but there are many differences that cannot be detected without performing some routine tests. By taking soil samples and testing them in a variety of ways you can find out how healthy your soil is, how you can improve it and what plants will grow well in it.

1.3. Identifying tools and equipments

1.3.1. Tools and equipments for soil sampling

Tools and equipments for soil sampling include the following:-

- soil probe
- shovel/spade
- plastic bucket
- sample bags
- waterproof marker
- gloves
- ruler
- measuring tape
- camera
- soil augers
- pH field test kit
- Munsell soil color charts
- interpreting charts
- spatula/knife
- distilled water
- water bottle
- working board
- Stationery.

Fig: 1.2. Root Sampling Auger Kit; Standard Auger Handle; Beating Head Handle; Conical Screw Thread, 39.3 in (100 cm) Long Extension; Root Drilling Crown; Shock Absorbing Hammer; Utility probe, Spanner (wrench) 20x22mm; Field Data Registration set; Work Gloves pair; Maintenance Kit; Spatula bent.

Fig: 1.3. Soil core samplers

Fig: 1.4. SPLIT TUBE SAMPLER KIT Handle; short beating.; Split tube sampler; 2.08 in. (53 mm) ID x 15.74 in. (40 cm) length; Steel Hammer; w/nylon head caps 4.4 lbs. (2.0 kg) impact absorbing; Sample Liners; 1.97in. (50 mm) x 15.74 in. (40 cm) length; 10 pc; Plastic; Sample Liner retainers; Steel Lifting Jack; Lifting lever and wrap chain; Spanner .78 in. (20 mm) x 8.7 in. (22 mm) Bent Spatula; .78 in. (20 mm).

Fig 1.5. A soil probe, auger, spade and knife should be used in sampling soils

Equipments for testing used to test the physical and chemical properties of the soil.

Preoperational checkup and maintenance of tools and equipment

Check all the tools and equipment before use, are all functional and sufficient in number? Are all clean of any soil contaminants? During sampling any contaminant soil remaining on the sampling tools can affect the test of the new sample.

If any faulty tool and equipment is found, maintain it

- Shovel and spade- stiffen the handle and the head together and clean from soil remains
- Prepare the appropriate number and desired size of the paper bag
- Prepare the appropriate sieve size in diameter.

Self-Check 1	Written Test

Name: ___________________________ Date: ________________

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

1. Define soil? (5pts)
2. What is the importance of soil sampling? (5pts)
3. List tools and equipments use of soil samplings? (5 pts.)

Answer

Score = ____________
Rating: _____________

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

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

Information Sheet-2	Identifying area for sampling

2.1. Identifying the area for sampling

Use either workplace records in your organization or contact your supervisor for instructions on which areas to collect samples from. Before taking any sample the first thing to do is to delineate the area for sampling and know which area the sample represents. It is sometimes important to have topographic and soil survey map of the area to easily point the sampling areas, therefore we need to have a sampling plan.

Learning experiences must address: Appropriate selection of soil/media sampling sites according to supervisors instructions including:

- representation of soil/media type
- reference to maps
- history of area
- planned future use
- topography
- details of past soil/media test locations
- Paddock identifiers.

An awareness of poor sampling sites including:

- Roads and vehicle tracks
- Fence lines
- Unrepresentative soil/media conditions
- Drainage lines
- Boundaries between soil/media types
- Stock camps.

2.1.1. Making the site plan for soil sampling

The goal of the sampling plan is to determine where and when to collect soil samples that are representative of the field to be fertilized. If soil is submitted from only a few locations that do not represent the entire area to be fertilized, the fertilizer added may be too much or too little for the majority of the area, causing decreased yields, reduced crop quality, or wasted fertilizer. Sampling depth and timing of sampling are critical components of a well-designed sampling plan. The sampling plan may be constructed in the sampler's head, but it may be more objective to sketch out the plan ahead of time. In addition, the actual sampling areas need to be recorded or flagged, to help the producer determine where to fertilize.

Considerations in determining the sapling area

- ✓ The sample should be truly representing the field/area it belongs to.
- ✓ A field can be treated as a single sampling unit if it is uniform. Generally an area not exceeding 0.5 ha is taken as one sampling unit.
- ✓ Variations in slope, color, texture, crop growth, and management practices are the important factors that should be taken in to account for sampling. Separate samples are required from areas differing in these characteristics.
- ✓ Recently fertilized plots, bunds, channels, marshy tracts, and areas near trees, wells, compost piles or other non-representative locations must be carefully avoided during sampling.
- ✓ An area of about 3-3 meters along all the sides of the field should be left in large fields.
- ✓ Larger area may be divided in to appropriate number of smaller homogeneous units for better representations of the field.

Self-Check 2	Written Test

Name: ___________________________ Date: ________________

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

1. What is the sampling area? (5pts)
2. Which area is poor sampling area? (5 point)

Answer

Score = ____________
Rating: _____________

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

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

Information Sheet-3	Locating services using site plans

3.1. Locating services using site plans

The sites use for sampling should have the following accessibility;※If we are establishing a site for sampling especially, the site selected should be near the **water supply.**

※These should have **transport facilities**, **electricity supply** and **housing facilities** for the workers near the sampling area (if possible).

※These should have **telecommunication**, **gas** and **irrigation** for the workers near the sampling area (if possible).

※These should have storm water and drainage for the workers near the sampling area.

Self-Check 3	Written Test

Name: ___________________________ Date: ________________

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

1. What is the importance locating service using site plan? (5pts)

Answer

Score = ___________
Rating: ____________

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

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

Information Sheet-4	Identifying, assessing and controlling OHS hazards

Definition: Occupational health and safety is concerned with health and safety in its relation to work the working environment.

Aims of occupational health

Occupational health should aim at:-

1. The promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupation
2. The prevention amongst workers of departures from health caused by their working conditions.
3. The protection of workers in their employment from risks resulting from factors adverse to health.
4. The placing and maintenance of workers in an occupational environment adapted to his physiological and psychological capabilities and
5. To summarize the adaptation of worker to man and of each man to his job.

- ✓ **Hazards**

These may be introduced into fresh fruit and vegetable products at numerous points in the production chain as a result of bad agricultural practices.

Hazards associated with production flow that could be harmful to the consumer

There are three main types of hazards associated with fresh produce:

- ❖ Biological
- ❖ Chemical
- ❖ Physical

Biological hazards

- ➢ **Food-borne micro-organisms**, such as **bacteria, viruses and parasites**, are often referred to as biological hazards. Some fungi are able to produce toxins and also are included in this group of hazards.
- ➢ **Micro-organisms** able to cause human disease may be found on raw produce. Sometimes they are part of the fruit or vegetable micro flora as incidental contaminants from the soil, dust and surroundings. In other instances they get introduced onto the produce through poor production and handling practices, such as the use of untreated manure, the use of contaminated irrigation water or unsanitary handling practices.
- ➢ **Pathogenic bacteria**

Microbiological Risks Reason for occurrence

- Slurry spread
- Pathogens present (or numbers too high)
- Contamination from livestock and human sewage
- Water, Salmonella, Poor quality control at harvest
- Inadequate pre-harvest container and equipment cleaning
- Harmful and domestic animals
- Inadequate temperature control during storage
- Decaying matter, Poor stock management
- Parasitism
- Poor waste management

Chemical hazards

- Chemical contaminants in raw fruits and vegetables may be naturally occurring or may be added during agricultural production, post-harvest handling and other unit operations. Harmful chemicals at high levels have been associated with acute toxic responses and with chronic illnesses.
- Examples of chemical hazards:
  - Pesticides
  - Fertilizers
  - Antibiotics
  - Heavy metals
  - Oils and grease

Chemical hazards Risks Reason for occurrence

- Residues of non-approved pesticides
- Wrong pesticide selection
- Incorrect dosage/concentration
- Harvest interval not observed
- Poor calibration of sprayer
- Sprayer drift
- Inadequate cleaning between uses
- Contamination of produce due to pesticide storage conditions
- Spillage of pesticides on produce
- Use of contaminated water to mix spray
- Oils, grease and fuel contamination
- Inappropriate use of produce containers to store pesticides, fertilizers or oil
- Lack of inspection and servicing equipment

- Heavy metals

Physical hazards: foreign bodies

- Examples of physical hazards include:
  - Residual soil and **stones f**ound on fruits and vegetable
  - Packaging remaining from harvesting (**wood, metal**, etc.)
  - Packing materials and storage facilities, e.g. packaging plastics and cardboard
  - Foreign matter collected during harvesting
  - **Glass and sharp objects**
  - Personal effects: **jewels, hair, pens**.

Physical hazards risk reason for occurrence

- Soil Presence in finished products
- Machinery
- Dirty packaging materials
- Inadequate inspection of field equipment and packing facilities
- Inadequate maintenance of containers and machinery
- Discarded rubbish, e.g. bottles, cigarette butts
- Inadequate cleaning schedule
- End product contains: jewelers and pieces of clothing
- Staff untrained in personal hygiene
- Inappropriate working clothes

Self-Check 4	Written Test

Name: ___________________________ Date: ________________

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

1. What is occupational health and safety? (3pts)
2. List the aims of occupational health? (2pts)
3. Identify physical, chemical and biological hazards? (5)

Answer

Score = ____________
Rating: _____________

Note: Satisfactory rating – 7 points Unsatisfactory - below 7 points

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

Information Sheet-5	Selecting, using and maintaining PPEs

Personal protective equipment

Personal protective equipment is to include that prescribed under legislation, regulations and enterprise policies and practices. Face masks are available for rubbing back and painting.

5.1. Selecting personal protective clothing and equipment

Suitable personal protective clothing and equipment is selected, used, maintained and stored in accordance with Occupational Health and Safety requirements.

Select PPE based on the PPE Hazard Assessment

Consider these factors when selecting PPE:

- ⇨ Type of hazardous materials, processes, and equipment involved
- ⇨ Routes of potential exposure (ingestion, inhalation, injection, or dermal contact)
- ⇨ Correct size for maximum protection
- ⇨ Minimal interference with movement

Personal protective clothing and equipment may include:

- Hoots
- Hat/hard hat
- Overalls
- Gloves
- Protective eyewear
- Hearing protection]
- Respirator or face mask
- Sun protection, e.g., sun hat, sunscreen

Different types of PPE are described below

Foot protection

Workers must wear closed-toe shoes at all times to protect feet from chemical spills and sharp objects. Steel-toed footwear and puncture-resistant soles. Slip-resistant shoes for anyone who works in wet environments.

Eye protection: Use safety glasses for minor splash hazards, goggles for moderate hazards, and goggles combined with a face shield for severe hazards.

Hand protection: Hand protection is indicated for the possibility of severe cuts, lacerations, or abrasions, punctures, temperature extremes, and chemical hazards. (Nit rile loves are usually a good choice for general use.) Use heavy-duty gloves for non-incidental contact and gross contamination.

Body protection: Protective clothing includes lab coats, smocks, scrub suits, gowns, rubber or coated aprons, coveralls, uniforms, and pierce-resistant jackets and vests.

Head protection: Hard hats must be worn by electricians, construction workers, and any other workers when there is a danger of objects falling from above.

Self-Check 5	**Written Test**

Name: ___________________________ Date: ________________

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

1. List the factors considering when selecting PPE?(3)
2. List different types of PPE? (3pts)

Answer

Score = ____________

Rating: _____________

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

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

Information Sheet-6	Taking and preparing soil samples for analysis

6.1. Importance of sampling

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

- collecting,
- preparing,
- packaging and labeling soil samples for off-site testing and/or on-site testing and
- Analysis.

6.2. Soil sampling techniques

Before sampling, study the history of the area,

The sample must truly represent the field it belongs to.

Afield can be treated as a single sampling unit if the area is less than 0.5 ha

Collect soil samples (15-20) from each transect at least every 2-3 years.

Soil samples should be randomly selected avoiding fence lines, waterlines and animal matter.

When collecting samples it is important that each sample is kept separate and stored in a clean container to reduce the chance of cross-contamination.

Do not sample within 2-3 months following fertilizer application.

Collect samples at the same time each year.

Collect at least 10 soil cores for small areas and up to 30 cores for larger fields.

Take the soil cores randomly throughout the sampling area and place them in the bucket.

Recently fertilized plots or fields must be avoided carefully

Do not sample from:
- Back furrows or dead furrows,
- Old fence rows,
- Areas used for manure or hay storage and livestock feeding, and
- Areas where lime has been piled in the past.

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

For cereals, vegetables and other seasonal crops, the sample should be drawn from 0 -15cm

For deep rooted crops like sugar cane or under dry farming condition sample should be drown from different depth based on individual situation

For plantation crops the sample must be drawn from 0-30, 30 -60 and60-90cm

For saline and alkaline soils the sample must be drawn up to 15 cm depth

6.3. Soil sampling method

Area (cell) sampling

The sampling pattern should be selected to best represent the field, accounting for known sources of variability (major soil type changes, past cropping patterns, etc.). A grid pattern is usually the best way to be sure the entire field is represented, but with the possibility of patterns developing from past nutrient applications, cropping effects and other uniform patterns, it is advisable to use a sampling scheme that avoids arranging sampling points in a straight line.

This area sampling method provides for fairly complete sampling of the field and a good estimate of the needs for a single uniform application rate to be applied to the entire field.

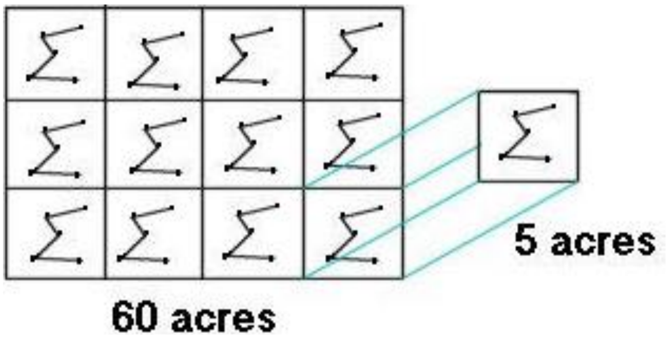


Figure 6.1: Area (Cell) Sampling Technique - Soil Test Values Represent an Area.

Grid point sampling

To better characterize the field for site-specific management and variable-rate application, point samples can be used to measure the variability across the field.

Dividing the field into 2 ½ acre grids and collecting a sample for each cell, the grid lines help ensure a good spatial representation of the field that can be used to develop a nutrient map. Again, 5 cores should be collected, but they should be within a 10-foot radius of the center point for the sample. This provides nutrient information for the point, and the collection of data for all points in the field provides the basis of nutrient variability maps. Several different interpolation schemes are used to estimate the nutrient levels across the field based upon the sample points.

It follows that uniform interval is used to locate the sampling points; Distance between sampling locations can be greater on homogenous fields than on variable fields. Separate soil samples should be collected from areas or fields that have had different crop history, yield, and fertilizer treatments, or that vary substantially in slope, texture, depth, or soil color.

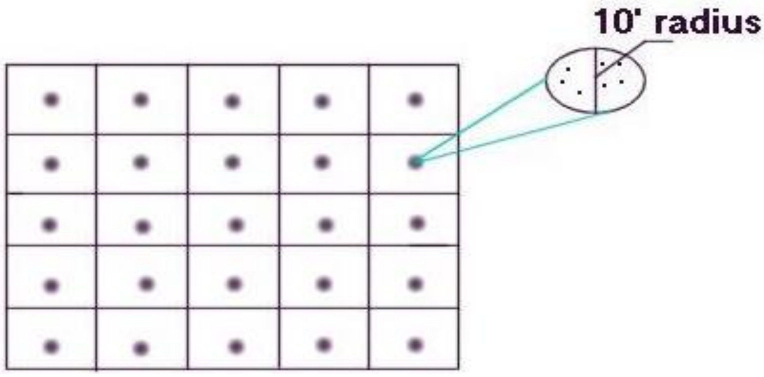


Figure 6.2: Grid Point Sampling Technique - Soil Test Values Represent a Point (Stratified Systematic Square Grid).

Stratified systematic sampling

To avoid sampling bias caused by patterns in the field due to tillage, crop residue, fertilizer application, and other patterns associated with crop production, a staggered pattern can be used. It helps avoid the pattern bias, yet provides an organized sampling scheme to represent the entire field. This pattern can be set up by counting rows, using a measuring wheel or using a global positioning satellite (GPS) navigation system.

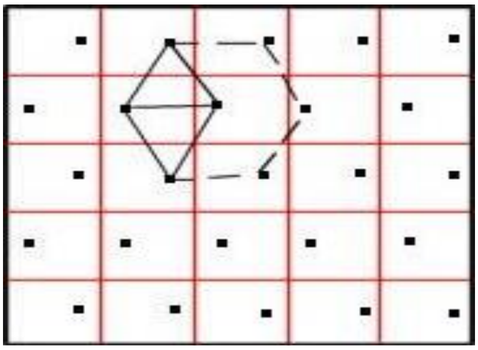


Figure 6.3: Stratified Systematic Sampling Triangle, Diamond, or Hexagon.

6.4. Sample Preparation for analysis

After all cores for an individual sample are collected

Placed in the bucket,

Dry the sample,

Crush the soil material,

Discard any plant residues and other materials if present

Sieve with 2mm diameter sieve and mix the sample thoroughly.

For certain types of analysis grind the soil further so as to pass through 0.2 -0.5mm sieves.

Remix the sieved sample before analysis.

Allow the sample to air dry in an open space free from contamination.

Do not dry the sample in an oven or at an abnormally high temperature. When dry, fill the sample container with the soil.

Break up clods while a sample is moist, and spread out to air dry in a clean area.

6.5. Procedures

6.5.1. Prepare soil sampling materials

- Divide your farm according to the kind of crops grown or to be grown, type of soil (sandy, clayey or loamy) and topography (level, flat, sloping or hilly).
- Collect soil samples separately from the different soil unit areas and place them in separate containers.
- Brush away stone, rubbish, trash or grass on the surface of the land.
- Using the shovel, push it down the surface or topsoil to a depth of approximately 15 cm and get a slice of soil sample and Place this in a container.
- Get similar samples at random from as many as 10 sites and mix them in a container.
- Get a composite soil sample of about 1 kilo to represent the soil unit area.
- To do the soil sampling activity you will go to field and choose a non- cropped field of about 1hectar. Apply a systematic sampling technique
  - 1st step _ prepare your tools and equipments that are needed for soil sampling
  - 2nd step _ make the sampling plan in the chosen field of about one hectare
    - Is there any variability on the field in terms of slope, soil color, depth and texture?
    - Consider also any other variability such as cropping history, fertilizer application
  - 3rd step_ Following the variability you observed divide the one hectare field in to homogenous sampling units
  - 4th step _ taking one sampling unit area for one group, then locate the sampling points on you sampling unit.
    - Choose a large distance/interval to locate the sampling points as your area is approaching to homogeneity
    - In your group, if you approximately get about 0.25ha plot, then locate your sampling points in 15 meter intervals (Systematic sampling) or use other method
  - 5th step _ Using the auger take at least 9 samples (or your own sample numbers) from the located points
    - Put the soil sample you take in paper bag first and
    - Then composite the nine paper bag samples in to one clean bucket
  - 6th step _Finally take your composite sample to laboratory for preparation.

Composite soil/average soil = A collection /mixture of individual samples.

Self-Check 6	Written Test

Name: ____________________________ Date: _________________

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

1. What is composite sample?(3)
2. List soil sampling methods?(4)

Answer

Score = ___________
Rating: ____________

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

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

Information Sheet-7	Labeling/recording soil sample

7.1. Labeling information

Why label samples?

When taking soil samples it is important to keep clear records of what you do for a number of reasons:

• You may be carrying out tests on a number of different soil samples in an area.

• You may be carrying out some tests in the field while further tests will require special equipment and need to be carried out off-site under laboratory conditions.

• Soil samples may be stored over long periods as part of a monitoring program for your land.

In each of these cases there may be more than one person handling the soil samples. To avoid confusion it is important to make sure that the correct information is attached to each sample. It is also a good idea to standardize your recording technique so that it is easier to compare results from different samples.

7.2. Recording samples

Each container should be marked clearly with the following information:

Requirements for labeling soil/media sample include:

• sampling date and location

• Details about person collecting the sample

• Depth of sample

• Description of soil type and surrounding vegetation

• Topography of sampling site (geographical district)

• Soil parent material

• History of area sampled.

A record-keeping system doesn't need to be complicated, although some systems are.

- ✓ Information should be organized by date or time, because every observation will have a time associated with it.
- ✓ A paper-based record-keeping system can be just as useful.
- ✓ A soil sampler should try to keep track of the following information from observation to observation. This is not an exhaustive list, nor is it necessary to record all of these items for every observation. Generally, with more information available, better sampling decisions can be made.

Records that need to be taken during sampling

- Sampling Date
- Sampler
- Name
  - Address
  - City
  - Phone number
  - Email address
- Sample location
  - Farm
  - Home
  - Orchard
  - Field ID
  - Geographic location
- Sample Depth
- Last season/year crop
- Organic amendments
  - Liquid
  - Solid
- Irrigation system
  - Drip
  - flood
  - sprinkler
- Depth to ground water
- Water Nitrate-N credit

Location: (Be specific, use Global Positioning System (GPS) or photo points)

____

Date: ____

Collector: ____

Horizon: ____

Depth from which soil was taken: ______________________________

Self-Check 7	Written Test

Name: ___________________________ Date: ________________

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

1. List the importance of record soil sample?(3)

Answer

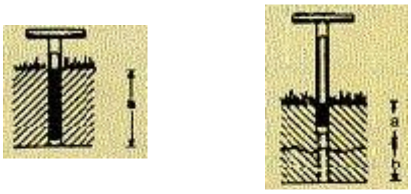
Score = ___________
Rating: ____________

Note: Satisfactory rating – 2 points Unsatisfactory - below 2 points

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

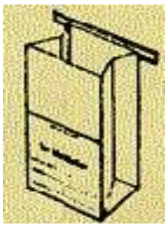
Operation Sheet 1	Procedures of soil sample preparation

- The purpose of sampling such the different plant nutrients and to determine the number of samples, depth of sampling and which soil groups to composite.
- To take soil sample you make ready a sampling tube, auger or spade, and a clean plastic pail. Get sample containers from the lab where you are standing the samples for analysis
- Sample different soils, or areas treated differently in the past. Get equal sized acres or slices from 15 or more places in each sampling area using probe, auger or spade. Do not mix light-and dark-colored soils together.
- Take samples for P, K, and lime from the top 0-8inches in tillage systems such as moldboard plow, chisel, and or disk. Take samples for P and K from. Take samples from the top 0-4 inches for lime only in no till fields. But, take samples for P, K, from the top 0-8inches in no till fields. No till fields which will be plowed periodically should be sampled to plow depth.



Left tilled field sampled 0-8inches; right no till soil 4inc pH, 0-8 to P,K

- Place cores or slices in a clean plastic pail. Mix them together thoroughly, breaking up the cores or slices. If soil is muddy, dry it before mixing. If soil crumbles easily, dry after mixing
- Spread mixture out on clean paper to dry. Do not heat in the oven or on the stove. Do not dry in places where fertilizer or manure get in to the sample
- Fill the sample bag to the line with air dry soil, discard the rest. Label and number the sample container



Filling the bag to the line

- Identify the sample and record the cropping the fertilizer information required using a field and cropping information sheet provided by the lab doing the analysis.

- Draw a field sketch or farm map on a separate sheet and keep it in your records, and to assist in developing your management plan.

After taking the samples use the procedures in the information sheet 2 and dry the sample, winnow it grind and sieve for different testes, then subdivide pack and label the sample for physical and chemical tests.

Operation Sheet 2	Soil sampling

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

Apply a systematic sampling technique

- ***1st step*** _ prepare your tools and equipments that are needed for soil sampling
- **2nd step** _ make the sampling plan in the chosen field of about one hectare
  - Is there any variability on the field in terms of slope, soil color, depth and texture?
  - Consider also any other variability such as cropping history, fertilizer application, etc.
- **3rd step_** Following the variability you observed divide the one hectare field in to homogenous sampling units
- **4th step _** taking one sampling unit area for one group, then locate the sampling points on you sampling unit.
  - Choose a large distance/interval to locate the sampling points as your area is approaching to homogeneity
  - In your group, if you approximately get about 0.25ha plot, then locate your sampling points in 15 meter intervals (Systematic sampling) or use other method
- **5th step** _ Using the auger take at least 9 samples (or your own sample numbers) from the located points
  - Put the soil sample you take in paper bag first and
  - Then composite the nine paper bag samples in to one clean bucket

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

Instruction Sheet	Learning Guide 22

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

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

- Determining soil profiles
- Testing soil physical properties
- Testing soil chemical properties
- Recording results.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Determine Soil profile.
- Test soil physical properties
- Test soil chemical properties
- Records results

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 5.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4”.
4. Accomplish the “Self-check 1, Self-check 2, Self-check 3 and Self-check 4” **in page -38, 46, 53 and 56** respectively.
5. Do the “LAP test”

Information Sheet-1	Determining soil profiles

1.1. Determining soil profile

A vertical section exposing a set of horizons in the wall of soil pit is termed as soil profile. Rod cuts and other ready-made excavation can expose soil profile and several windows to the soil. In an excavation open for some time, horizons are often obscured by soil material that has been washed by rain from upper horizons to cover the exposed face of lower horizons. To represent an individual soil, profile, the pit has to be wide enough to show lateral variation and deep enough the underlining the unconsolidated or consolidate layers that influence the behavior of the soil. Soil profile shows layers approximately parallel to the soil surfaces, soil horizons. The sub division of layers of soil develop due to soil forming processes (weathering) are called soil horizons (it is designated as O, A, E, B, and C system i.e. the five master soil horizons).

O Horizons

The O group is comprised of organic horizons that generally form above the mineral soil or occur in an organic soil profile. The derived from dead plant and animal residues. O horizons found only in forest areas and are communally referred to as forest floor.

A Horizons

The top most mineral horizons generally contain enough partly decomposed (humified) organic matter to give the soil a color darker than that of the lower horizons. This horizon is coarser in texture.

E Horizons

These are zones of maximum leaching or elevation of clay iron and aluminum oxides, which leaves a concentration of resistance materials. These horizons found underneath of A horizons and generally lighter in color.

B Horizons

These horizons develop or fund below O, A or E horizons and have undergone sufficient changes during soil formation processes (soil genesis). In humid regions, B horizons are the layers of maximum accumulation of materials like iron and aluminum oxides and silicate clays in which some of them illuviated from the upper horizons and others formed in a place.

C Horizons

It there un-consolidated material underlying the soil (A and B horizons). It may or may not be the same as the parent material from which the soil formed.

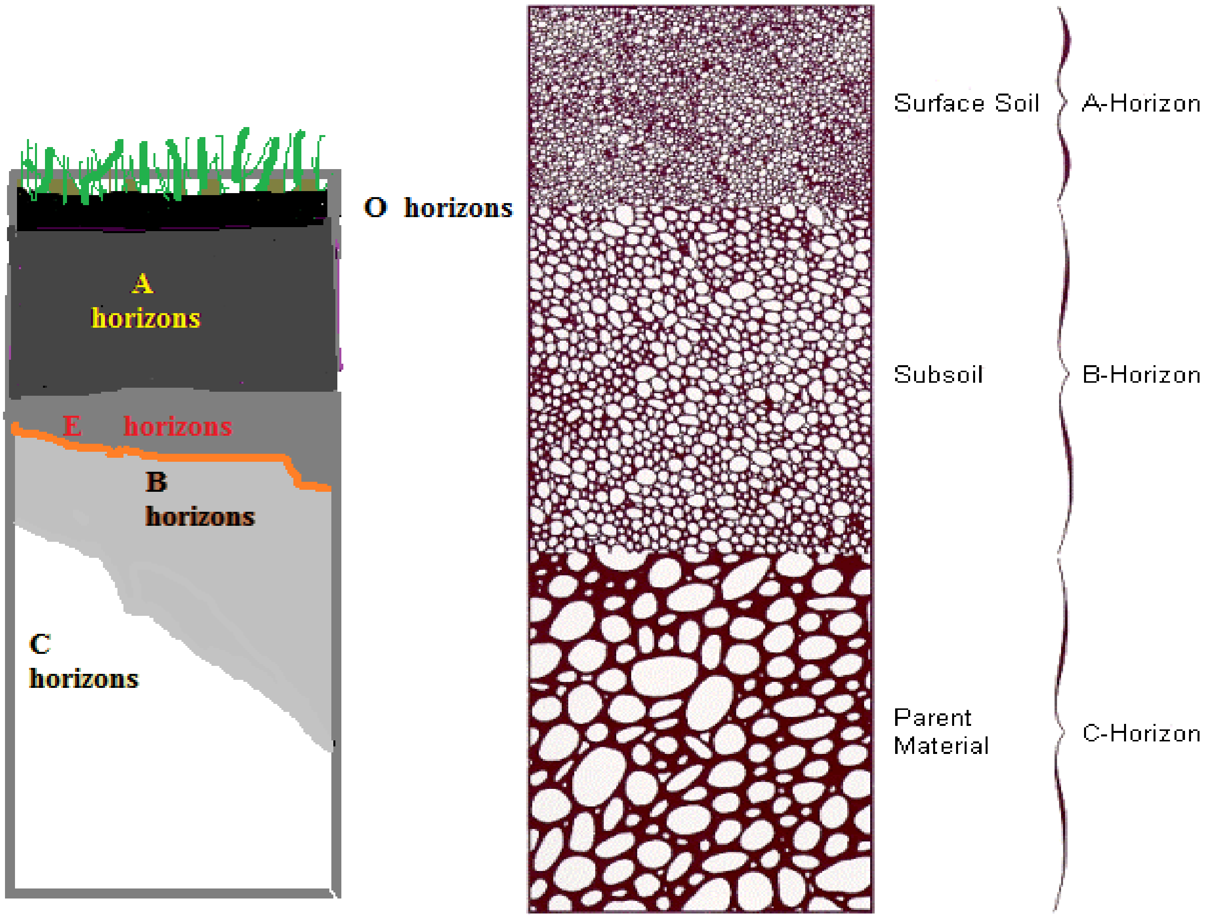


Figure showing soil profile

1.2. Soil profile description

The soil profile description/sampling point should be located as close as possible to the station.

The purpose of the soil profile description is to:

- Characterize the properties of each soil horizon classify the soil profile
- Group classification for later analysis of soil type
- Collect data required for soil structure and erode ability assessments
- Collect samples for laboratory analyses to determine other soil parameters
- Comply with soil survey sampling standards.

Self-Check 1	Written Test

Name: ___________________________ Date: ________________

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

1. What is soil profile?(3)
2. List five master soil horizons?(5)

Answer

Score = ___________
Rating: ____________

Note: Satisfactory rating – 6 points Unsatisfactory - below 6 points

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

Information Sheet-2	Test soil physical property

Soil is characterized by its physical, chemical, biological and mineralogical properties. The focus of this topic is based on the physical and chemical property of the soil.

2.1. Physical property of the soil

Physical property of the soil refers to the function and management of soil in an ecosystem in determining the successes or failure of agriculture crop production based on the soil texture, Structure, Consistence &Color. Soils are porous and open bodies, yet they retain water. They contain mineral particles of many shapes and sizes and organic material which is colloidal (particles so small they remain suspended in water) in character. The solid particles lie in contact one with the other, but they are seldom packed as closely together as possible. Permeability (the rate at which water moves through the soil) and Water-Holding Capacity (WHC; the ability of a soils micro pores to hold water for plant use) of the soil is affected by

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

A. SOIL TEXTURE:

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

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

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

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

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

Particles of 2 to 0.05 mm diameter are called sand;

those of 0.05 to 0.002 mm diameter are silt; and

<0.002 mm particles are clay. Therefore the texture of soils is usually expressed in terms of the percentages of sand, silt, and clay.

Some characteristics soil texture

- ➢ Sands are the largest particles and feel gritty
- ➢ Silts are medium-sized and feel soft, silky, or floury
- ➢ Clays are the smallest sized particles and feel sticky and are hard to squeeze.

Relative size perspective: Sand (house) > Silt > Clay (penny)

Soil textural class determination is important in determining the physical property of a soil. There are different methods to establish the soil sample's textural class.

Method 1: Rapid Feel method

- ❖ **Graininess test**: Rub the soil between your fingers. If sand is present, it feels "grainy". Determine if the sand constitutes more or less than 50%. oist cast test: Compress some moist soil by clenching it in your hand. If the soil holds together, toss it from hand to hand. The more durable it is, the more clay is present.
- ❖ **Stickiness test:** Moisten the soil thoroughly and compress it between thumb and forefinger. Determine degree of stickiness by noting how strongly the soil adheres to the thumb and forefinger when pressure is released, and how much it stretches. Stickiness increases with clay content.
- ❖ **Worm test:** Roll some moist soil between the palms of your hand to form the longest and thinnest worm possible. The longer, thinner and more durable worm contains more clay.
- ❖ Taste test: Work a small amount of moist soil between your front teeth. Silt particles are distinguished as fine grittiness, sand is distinguished as individual grains and clay has no grittiness.

  Soapiness test: Work a small amount of wet soil between your thumb and fingers. Silt feels slick and not too sticky (=clay) or grainy (=sand). The slicker it feels, the higher the silt content. Generally, we can say that sand feels gritty, silt feels smooth and silky and clay feels sticky.

Method 2: On Field analysis

- ❖ A field analysis is carried out in the following way: a small soil sample is taken and water is added to the sample.
- ❖ Place the soil in your palm and knead it to break up aggregates
- ❖ Place a ball of soil between your thumb and forefinger. Push the ball with your thumb, squeezing it upwards into a ribbon. Allow the ribbon to emerge and extend over the forefinger. It should break from its own weight.
- ❖ saturate a small pinch of soil in palm and rub with forefinger.

Data analysis

- ❖ If the soil does not remain in a ball when squeezed the soil is sand
- ❖ If the soil remains in ball when squeezed continue with the formation of ribbon. If the soil does not form a ribbon the soil has Loamy – Sand texture
- ❖ If the ribbon is less than 2.5 cm long before breaking and feels gritty, the texture class is
  - o Sandy – Loam
- ❖ If the ribbon is less than 2.5 cm long before breaking and feels smooth, the soil is
  - o Silt – Loam
- ❖ if the ribbon is less than 2.5 cm long before breaking and does not feel gritty and smooth, the texture is a Loam
- ❖ If the ribbon is 2.5-5.0 cm long before breaking and feels very gritty the texture class is Sandy – Clay – Loam
- ❖ If the ribbon is 2.5-5.0 cm long before breaking and feels smooth the soil is a Silty
  - – Clay – Loam
- ❖ If the ribbon is 2.5-5.0 cm long before breaking and does not feel gritty and smooth, the texture is a Clay - Loam
- ❖ If the ribbon is strong, equal or more than 5.0 cm long before breaking and feels gritty, the texture class is Sandy – Clay
- ❖ If the ribbon is strong, equal or more than 5.0 cm long before breaking and feels smooth, the soil is a Silty – Clay
- ❖ If the ribbon is strong, equal or more than 5.0 cm long before breaking and does not feel gritty and smooth, the texture is a Clay

B. SOIL STRUCTURE

It is a field term descriptive of the gross, over all aggregation, or arrangement of the primary soil separate. Anyone who has ever made a mud ball knows that soil particles have a tendency to stick together. Attempts to make mud balls out of pure sand can be frustrating experiences because sand particles do not cohere (stick together) as do the finer clay particles. The nature of the arrangement of primary particles into naturally formed secondary particles, called aggregates, is soil structure. A sandy soil may be structureless because each sand grain behaves independently of all others. A compacted clay soil may be structureless because the particles are clumped together in huge massive chunks. In between these extremes, there is the granular structure of surface soils and the blocky structure of sub soils. In some cases sub soils may have platy or columnar types of structure.

Structure may be further described in terms of the size and stability of aggregates. Structural class is based on aggregate size, while structural grade is based on aggregate strength.

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

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

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

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

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

Properties of soil particle size.

	Sand	Silt	Clay
Porosity	mostly large pores	small pores predominate	small pores predominate
Permeability	Rapid	low to moderate	Slow
Water holding capacity	Limited	Medium	very large
Soil particle surface	Small	Medium	very large

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

Add organic matter

Make fewer trips across area

Practice reduced-till or no-till systems and harvest when soils are not wet.

D. Consistence

Consistence is a description of a soil's physical condition at various moisture contents as evidenced by the behavior of the soil to mechanical stress or manipulation. Descriptive adjectives such as hard, loose, friable, firm, plastic, and sticky are used for consistence. Soil consistence is of fundamental importance to the engineer who must move the material or compact it efficiently.

The consistence of a soil is determined to a large extent by the texture of the soil, but is related also to other properties such as content of organic matter and type of clay minerals.

E. Color

The color of objects, including soils, can be determined by minor components. Generally, moist soils are darker than dry ones and the organic component also makes soils darker.

Thus, surface soils tend to be darker than sub-soils. Red, yellow and gray hues of sub-soils reflect the oxidation and hydration states or iron oxides, which are reflective of predominant aeration and drainage characteristics in subsoil. Red and yellow hues are indicative of good drainage and aeration, critical for activity of aerobic organisms in soils. Mottled zones, splotches of one or more colors in a matrix of different color, often are indicative of a transition between well drained, aerated zones and poorly drained, poorly aerated ones. Gray hues indicate poor aeration. Soil color charts have been developed for the quantitative evaluation of colors.

The first test that we have to make is to register the color of the soil. This process does not require any sophisticated technique. It is usually described from the Munsell color chart. For our purposes, the simple identification of the main color of the soil is sufficient. Notice that wet soil looks darker than when it is dry.

Step 1: Take some soil ped from each soil horizon

Step 2: Break the ped

Step 3: Check the color of the ped according to the Munsell color chart. If the ped shows more than one type of color, indicate the dominant and the sub-dominant color. Key to use the Munsell

Soil Color Chart:

The Munsell Color Chart shows the different colors and a code

The code below each color indicates the Hue, Value and Chroma, which belong to each color.

The Hue is the first set of numbers and the letter indicates the position of the color on the color wheel. The symbol indicates the following: Y=Yellow, R=Red, G=Green, B=Blue, YR=Yellow Red, RY=Red Yellow

The number of Value indicates the lightness of the color (ranging from 0 to 10).

Chroma indicates the intensity of the color from 0 onwards. There is no arbitrary end on the scale to determine the maximum value.

Data analysis: Soil can be categorized in six groups according to the color and tone of the sample. Brown to Dark Black, Black for surface horizon, Dark Grey to Bluish, White to Grey, Dark Red and Yellow to Reddish.

Bulk Density Test

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

Method 1 Volumetric displacement

Using spatula make a small whole to specified depth of the soil in target

Carefully take all the soil from the whole in to a sampling bag

Place a plastic sheet fixed on a ring and then insert in to the whole and add water from a graduated cylinder in to the plastic sheet

Once you measure the volume of the whole by the above method

Dry up the soil sample, taken from the whole in an oven at 105^{O}C for 24hrs or until the soil attains a constant weight

Measure the weight of dry soil and calculate the dry bulk density

Equations: calculate the dry bulk density using the following formula

Step 1: Soil sample volume = volume of water filled using graduated cylinder

Step 2: Bulk density = Dry soil weight / Soil sample volume (g/cm3 or g/ml)

Method 2 core sampling of undisturbed soil

This method uses samples collected in a metal can (core sampler) with a specific volume. Instead of collecting soil samples to fill up the can, the can is pushed into the soil horizon to obtain the sample.

Take a soil sample by pushing the core sampler in to the soil without disturbing the pores

Take out the core (cup) from the sampler and put it in an oven dry at 105OC for 24hrs

After measuring the weight of dry soil sieve the soil to remove stones and particles larger than 2mm

After removing larger rock contents measure the weight again and keep separately

Take a graduated cylinder and fill it with water, then place the rock contents in to the cylinder and measure the volume of water displaced from the graduated cylinder

Equations: Calculate the bulk density using the following equations

Total Bulk density = Dry soil sample / Volume of can (g/cm3 or g/ml)

Volume of rock content = Rock and water volume – water volume (cm3 or ml)

Soil Bulk density = Dry soil weight – Rock content weight/Can volume – Rock content volume

Measuring unit: g/cm3 or g/ml

Particle Density (Real density) Test

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

Method: Volumetric displacement

First take a graduated glass container and measure its weight.

Then place 25 g of a soil sample inside the container.

Measure and register the weight of the soil together with the container.

With some water added, boil the mixture for 10 minutes to remove all air bubbles.

Once the container has cooled, place it in a cup and let it sit for 24 hours.

After 24 hours, fill up the container with water to a total volume of 100 ml and measure the weight and temperature of the mixture.

Equations: calculate the particle density

Mass of soil = Mass of soil and container – Mass of empty container (g)

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

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

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

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

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

Method 1: The measurement procedures include two tests:

Measure Bulk density as above and Measure Particle density as above then

Equation: Calculate the porosity as follows

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

Self-Check 2	Written Test

Name: ___________________________ Date: ________________

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

1. List the physical characteristics of the soils?(3)
2. List classification of the soil based on soil textures gives?(3)
3. Define Soil porosity?(3)

Answer

Score = ____________

Rating: _____________

Note: Satisfactory rating – 6 points **Unsatisfactory - below 6 points**

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

Information Sheet-3	Test soil chemical property

3.1. Chemical property of soil

Chemical property of soil deals with the nature of colloids (organic and inorganic). It mainly focuses on the mineral and chemical composition, charges, and exchange of ions, salinity, and alkalinity and acidity of soil (PH). It is important from the point of view of nutrient availability for agricultural crops or plants.

The most important chemical characteristics of a soil are:

- its content of essential nutrients and their availability to plants;
- the exchange capacity;
- the buffering capacity(the ability of a soil to resist change in PH of the soil solution if acid or base is added)
- acidity or alkalinity; and
- Content of inorganic and organic colloids (humus).

Perhaps the state of oxidation or reduction of the soil should be mentioned; this is ordinarily not of major importance but may be if a waterlogged or poorly-drained soil is under consideration.

3.1.1. Soil pH Test

Method 1: pH Test

Soil pH analysis test uses the pH scale numerical system to measure the acidity or alkalinity of the soil.

- After filling the test tube with an indicator solution,
- Add some soil sample to the indicator.
- Cap the tube and gently mix the soil and indicator solution for 1 minute.
- After 10 minutes of waiting, match the color of the solution with pH Color Chart.

Data analysis

The color chart indicates the pH numeric value of the sample. It is not indicated by decimal values. According to obtained color, the soil sample belongs to one of the three main groups: alkaline, neutral or acidic. The Neutral point is 7.0 and the neutral range is between 6.0 and 8.0 (With other pH test methods, which are able to indicate decimal values, this range would be considerably less). pH value less than 7.0 are considered acidic and values higher than 7.0 are considered to be an alkaline.

Method 2: pH in soil-water suspension (pH meter method)

The pH may be determined in soil water suspension of varying ratios but the results should be expressed along with the ratio adopted. Conveniently, the suspension is prepared in 1:2 or 1:2.5 ratio.

1. Take 10 g of soil sample in 50 or 100 ml beaker.
2. Add 20 or 25 ml of distilled water, stir well for about five minutes and keep for half an hour.
3. Again stir just before immersing the electrodes and take the pH meter reading.

3.1.2. Available Phosphorus Test

Available Phosphorus analysis measures the available phosphorus in the soil sample. First, fill up the tube with phosphorus extracting solution. Then add the soil sample to the solution and cap. After gently mixing the soil with the extracting solution, wait until the soil settles down in the tube. From the clear liquid, transfer some of the sample into the other test tube and add six drops of Phosphorus indicator to the sample.

Data analysis

The Phosphorus Color Chart allows soil samples to be classified into four groups based on the phosphorus content of each group. The four categories are as follows:

- Trace: Indicates very low available phosphorus content in the soil
- Low: Indicates low available phosphorus content in the soil
- Medium: Indicates optimum level of available phosphorus content in the soil for production
- High: Indicates high available phosphorus content in the soil. The plant does not need additional phosphorus fertilizer application.

3.1.3. Available Nitrogen Test

Available Nitrogen analysis uses a preparation method similar to the phosphorus test.

- First, mix the Nitrogen Extracting Solution with the soil sample for one minute and wait until the soil settles in the test tube.
- When the liquid is clear, pour part of it into another test tube and add to it 0.5 g Nitrogen Indicator Powder.
- After mixing the tube content, wait another 5 minutes before the solution color can be compared with the Nitrogen Color Chart.

Data analysis

The color chart shows a similar four categories, as opposed to the Phosphorus Color Chart. According to the chart:

- The available nitrogen in the soil sample can be quantified as trace, low, medium and high levels.

3.1.4. Available Potassium Test

Available Potassium analysis differs a little bit from the previous testing methods.

- After mixing the soil sample with the Potassium Extracting solution, vigorously shake the test tube for one minute.
- Remove the cap and allow soil settle down.
- When the liquid becomes clear, pour part of it into another test tube and add one Potassium Indicator tablet to the soil extract in second tube.
- Shake the tube until the tablet completely dissolves.
- Finally, add Potassium Test Solution, two drops at a time, keeping count.
- Stop adding drops when the color changes from purplish to blue.

Data analysis

The Potassium End Point Color Chart indicates only two colors:

- Before: Means before we added the Potassium Test Solution to the extract and this is a purplish color
- After: When the color of the extract changes from purplish. The color it changes to is blue and the accurate count of the number of drops until the color of the extract change will indicate the potassium level in the soil sample:
- 0-8 drops: Very high level of potassium
- 10 drops: High level of potassium
- 12 drops: Medium to high level of potassium
- 14 drops: Medium level of potassium
- 16 drops: Medium to low level of potassium
- 18 drops: Low level of potassium
- more than 20 drops: Very low level of potassium

3.1.5. Soil Conductivity and Salinity Test

Soil conductivity and salinity test easily can be measured with twin Cond B-173 conductivity instrument. First, perform an aqueous extraction from the sample.

- Crush the sample
- Weigh a quantity of soil, e.g. 10g into a suitable container
- Add distilled water or de-ionized water with the ratio of 5ml water to each gram of soil. Thus, if you have 10g soil, add 50mL water
- Shake the container to thoroughly mix the soil and water
- Allow the soil to settle.

To calibrate the instrument, drop 1.41 standard solutions onto the sensor cell. After pressing the CAL/MODE button, the window will display the CAL mark and 1.41. When the mark disappears, the calibration is finished and sensor can be washed. For conductivity, the mark should be mS/cm or µS/cm. For salinity, the mark should be in % on the window screen. Now, drop the sample solution onto the sensor cell or immerse the sensor into the sample until the indicated immersion level line is reached.

Data analysis: Record in a table the two readings, one for conductivity and one for salinity.

3.1.6. Organic matter of the soil

Organic matter of the soil is highly important for agricultural production hence knowing the level of organic matter is crucial for amendments to produce high and quality product

Procedure in testing organic matter content

Walkley-Black Method of determining organic matter content of soil

- Weigh 1.0 g of mineral soil into a 250-mL wide mouth graduated Erlenmeyer flask.
- Titrate two blank samples (no soil) before proceeding with any unknown samples in order to standardize the Ferrous Sulfate solution. If the difference between the two blanks is not within 0.2 mL of Ferrous Sulfate solution, clean the burette and associated tubing. Reanalyze two more blanks to determine if the problem has been eliminated.
- Pipet 10.0 mL of the Potassium dichromate solution into each flask containing unknown soil and mix by carefully rotating the flask to wet all of the soil.
- Under a fume hood, carefully add 20 mL of concentrated Sulfuric Acid to each flask and mix gently.
- Allow flasks to stand for 5 min under the fume hood.
- Add pure water to each flask such that the final volume is approximately 125-mL. Mix by swirling gently.
- Add 5 or 6 drops of Phenanthroline complex and immediately titrate with the Ferrous Sulfate solution. As the titration proceeds, the solution will take on a green color that will change abruptly to reddish-brown when the endpoint of the titration is reached.
- Record each volumetric reading to the nearest X.X mL.
- The % OM is calculated as follows: $(1 - S / B) \times 10 \times 0.68$ = organic matter (%) of sample where: S = Volume of Ferrous Sulfate solution required to titrate the sample, in mL. B = Average Volume of Ferrous Sulfate solution required to titrate the two blanks, inmL.

Conversion factor for units 0.68 = a factor derived from the conversion of % organic carbon to % organic matter (1.724), the fraction of Organic Carbon oxidized to CO_2 (0.76) and the milliequivalent weight of carbon (0.003 g).

3.2. Apply techniques to ameliorate the soil

Definition: Soil amelioration is the process of modifying soils to provide what the native or existing soils do not naturally provide. The amelioration required can vary depending upon the existing soil and the traits of the soil that require alteration, be it improving the drainage of a heavy clay soil, increasing the nutrient holding capacity of a highly sandy soil or repelling the negative effects of a saline soil near the coast with the application of calcium.

Considerations before amelioration

To decide what is required prior to modifying a soil there are a number of steps that need to be considered. Initially, the palette of plants needs to be decided upon as each species of plant prefers certain soil conditions, of which an experienced and qualified horticulturalist will be aware. Secondly, the soil where the landscape will be planted should be inspected and basic information such as whether the soil is clay, loam or sand based can be determined, as can the moisture holding ability of the soil. The climatic conditions of the planting site as well as the irrigation source should be understood thoroughly and preferably soil and water tests performed.

How to ameliorate the soils

The process of soil amelioration varies from site to site, and plant to plant. It is however almost always beneficial to ameliorate the soils in some way. The major ameliorations performed are:

- Pre-plant fertilization – either an organic or slow release elemental form placed into the planting hole or pot.
- Soil structure modification – the addition of a peat type product to a sandy soil to increase moisture and nutrient holding abilities or the addition of sand or gravel to a highly clay soil to improve drainage and pore spaces to the root zone.
- Soil importation – where the site to be planted does not have suitable soil and a prepared and suitable soil is imported to the site.

Pre-plant fertilizer

Prior to planting provides a unique opportunity to apply nutrients directly to the rootzone of the plant. For this reason pre-plant fertilizer is usually spread directly into the excavated hole or pot to be planted. When applying pre-plant fertilizer care should be taken to provide nutrients in a controlled manner, which release at the rate that the plant can uptake. This is vital as excessive fertilizer can have potentially fatal results for the plant.

Fully composted organic nutrient sources are preferred as they take longer to break down and are slowly released to the plant over a period of time. Recently “Controlled Release” elemental fertilizers are also being manufactured which can also be used very successfully where available. Depending upon soil test results, gypsum or other sources of calcium are also sometimes applied directly into the soils prior to planting.

Soil structure modification

This process is basically limitless depending upon the climatic conditions and usage of the area to be planted and the requirements of the plant. Generally in Asia, a significant annual rainfall is present and one of the major modifications required is to increase the drainage of a soil to remove sitting water and the potential for root-rot or similar. This process is usually performed by the addition of a sand or gravel product, along with sub-surface drainage if required, to allow both sufficient water holding capacity for the root zone and the free-draining of the moisture through the soil profile.

The opposite is true on naturally sandy soils, however, where the soil can be amended with a clay, peat or zeolite product to increase the soils natural nutrient and moisture holding abilities.

Amending existing soils

Generally, when amending the existing soils on site the amendments will be added to the surface and thoroughly mixed into the existing soil until the desired soil results. Whilst often performed manually in Asia, this process is most efficient and the results the best when a rotary hoe or roto-tiller is utilised. Generally a depth of ameliorated soils in excess of 100 millimeters (4 inches) for shrubs, groundcovers and grasses is desired. When planting larger trees and palms the soils are usually amended after the excavation of the desired root-zone, with the removed soil being ameliorated and backfilled into the hole following planting.

Imported soils

When preparing a soil to be imported an opportunity exists to choose and create the perfect soil required for the locale. The amelioration can be performed either with a tractor mounted loader mixing a variety of bulk elements for large projects or a cement mixer or shovel and wheelbarrow for smaller jobs. For a standard soil for use in Asia, typically a mixture of 40 percent coarse sand and fine gravel, 30 percent clay, 20 percent mulch and 10 percent organic fertilizer provides a suitable soil to be imported to a site.

Self-Check 3	Written Test

Name: ___________________________ Date: ________________

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

1. List the chemical characteristics of the soils?(3)
2. Describe soil amelioration?(3)
3. Define soil pH?(3)

Answer

Score = ___________
Rating: ____________

Note: Satisfactory rating – 7 points Unsatisfactory - below 7 points

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

Information Sheet-4	Recording results

Recording results

Table4.1: Soil Testing Record (prepared record keeping formats)

Field ID	Lab	Date Sampled	Soil Test Levels			Soil Test Report Levels 1 (If not in ppm)	
			pH	ppm Mehlich-3 P	ppm K	Phosphorus (lbs P or lbs P_2O_5)	Potassium (lbs K or lbs K_2O)

Table4.2: Manure Sampling Record

Manure Group	Lab	Date Sampled	Total Nitrogen (N)	Ammonium N (NH_4-N)	Total Phosphate (P_2O_5)	Total Potash (K_2O)	Percent Solids	P Source Coefficient Value
			Note lb/ton or lb/1000 gal	Note lb/ton or lb/1000 gal				

Table 4.3: Manure Group/Fertilizer Application Record format

Manure Group		Date		Manure Source/Location	
Spreader ID 1		Spreader Calibrated Rates			
Temperature 1		Wind Speed & Direction 1		Weather Conditions 1	
Applicator 1			Notes		

Field Information			Manure Application Information			
Field ID	Field Acres	Acres Covered	Application Rate	Application Method	Days to Incorporation (if < 7 days)	Total Amount Applied

Self-Check 4	Written Test

Name: ___________________________ Date: ________________

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

1. What should be included in the soil test record keeping format? (3 points)

Answer

Score = ___________
Rating: ____________

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

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

Instruction Sheet	Learning Guide 23

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

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

- Cleaning equipments
- Disposing all containers, leftover fluids and wastes safely

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Clean equipment
- Dispose all containers, leftover fluids and waste

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information "Sheet 1 and Sheet 2".
4. Accomplish the "Self-check 1, and Self-check 2 " **in page -61 and 63** respectively.
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1" **in page - 64**.
6. Do the "LAP test

Information Sheet-1	Cleaning equipments

1.1. Cleaning laboratory equipment

The major steps in cleaning are

- ✓ Washing
- ✓ Rinsing and
- ✓ Drying and
- ✓ Finally storing

- Many precipitates can be removed from the filter surface simply by rinsing from the reverse side with water
- Drawing water through the filter from the reverse side with a vacuum pump is also effective. Some precipitates tend to clog the pores of a fritted filter and may require special cleaning solutions

1.2. Cleaning and decontamination of work site and equipments

- Establish decontamination areas for "dry" and/or "wet" decontamination, depending on the decontamination needs at the site.
- Decontamination, place clean plastic sheeting on the ground or inside the solids containment vessel to collect material removed from the equipment.
- Place an equipment table covered with clean plastic sheeting near the dry decontamination area to facilitate disassembly of the contaminated sampling equipment.
- Place drums nearby to contain waste material.

Use a liquid containment vessel to contain wet decontamination waste use

- ✓ Tubs
- ✓ Buckets
- ✓ Brushes and
- ✓ Spray bottles to wet decontaminate hand augers or other small equipment.

- Establish the decontamination area downwind of site personnel whenever possible, giving consideration to the following:
  - the anticipated contaminants
  - detection of airborne contaminants above background
  - wind and weather conditions and
  - Other site considerations (e.g., site layout, access, and other site activities).

* Do not locate the decontamination area downwind of dust-producing site operations that could contaminate the equipment.
* Locate the decontamination area adjacent to the designated and secured drum storage area to reduce the need to move drums around the site.

Self-Check 1	Written Test

Name: ___________________________ Date: ________________

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

1. What is importance of cleaning? (5 point)
2. Explain the importance documentation?(5)

Answer

Score = ____________
Rating: _____________

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

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

Information Sheet-2	Disposing all containers, leftover fluids and wastes safely

All waste should be disposed of in an environmentally responsible way. It is the responsibility of the generator of chemical waste to consider how it will be disposed of prior to conducting any experimental work and manage it until the waste collects and disposes of it or it is treated in-house as appropriate.

Risk assessments should include procedures for disposing of all chemical waste and ensure that all waste is properly labeled, in a suitable container and stored appropriately.

It should not be assumed that all chemical waste can be disposed of by contractors. They may not have the relevant license and/or facilities. Therefore the generator must investigate alternative ways to dispose of the material – if this cannot be done the experiment should not be performed.

Under no circumstances should containers of liquid waste be left open in a fume-cupboard (other than when in use – i.e. during experimental work) to evaporate. This is environmentally unsound and potentially hazardous.

Self-Check 2	Written Test

Name: ___________________________ Date: ________________

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

1. Explain the importance of waste disposal?(5)

Answer

Score = ____________
Rating: _____________

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

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

Operation Sheet 1	Procedures for cleaning, storing equipment and waste disposal mechanisms

In the information sheets 1 and 2 the procedures how to clean/disinfect equipment in lab as well as in field and store them safely were already mentioned. It is also mentioned how to store wastes and finally dispose them safely.

- Use procedures mentioned for cleaning tools and equipment as well as working area for cleaning
- And store cleaned tools and equipment properly in their place
- Finally dispose of different wastes safely from lab or field safely according to procedure below

Waste disposal procedures step by step

- Find an appropriate container for your waste (containers are available for purchase from the Faculty Store)
- Label your waste as outlined in this document (labels are available for purchase from the Faculty Store)
- Check that you list of waste corresponds with the list the Store have generated
- Contact available stores for you waste to be disposed of safely

LAP Test	Practical Demonstration

Name: _______________________________ Date: _________________

Time started: __________________________ Time finished: _________________

Instructions:

1. You are required to perform any of the following:

    Task1. Take soil sample

    Task.2. Prepare soil sample

    Task.3. Clean and dispose materials