AGRICULTURALTVET COLLEGE

SMALL SCALE IRRIGATION DEVELOPMENT LEVEL-II

Model TTLM

Learning Guide #03

UNIT OF COMPETENCE: Assist in determining basic properties of soil

Module Title: Assist in determining basic properties of soil

LG Code: AGR SSI2 M03 LO1-LO2

TTLM Code: SSI2 TTLM

Nominal Duration: 40 Hours

Instruction Sheet	Learning Guide 03

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

- ✓ Collect soil samples for testing
- ✓ Collect soil sample for testing

This guide will assist trainees to attain the learning outcome stated in the curriculum guide. Specifically, upon completion of this Learning Guide, trainees will be able to:

- ➢ Identify the required materials, tools, and equipment
- ➢ Identify soil samples area
- ➢ Locate Soil sample area using site plans
- ➢ Identify OHS hazards reported to the supervisor
- ➢ Select and checking Suitable personal protective equipment (PPE).
- ➢ Take samples from the designated area
- ➢ Labelle samples accordingly
- ➢ Determined soil profile
- ➢ test soil physical property
- ➢ test chemical property of soil
- ➢ check the result

Learning Activities

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the "Information Sheets"
3. Accomplish the "Self-check" questions
4. If you earned a satisfactory evaluation, you will proceed to the next "Information Sheet." However, if your rating is unsatisfactory, see your teacher for further instructions.

5. Submit your accomplished Self-check.
6. Follow the steps and procedure list on the operation sheet
7. Do the “LAP test” and Request your teacher to evaluate your performance

InformationSheet-1	Collect soil sample for testing

1.1 preparing Tools and materials for collecting soil samples

Soil: is a mixture of organic matter, minerals, gases, liquids, and organisms that together support life. Earth's body of soil is the pedosphere, which has four important functions: it is a medium for plant growth; it is a means of water storage, supply and purification; it is a modifier of Earth's atmosphere; it is a habitat for organisms; all of which, in turn, modify the soil.

Soil testing is an essential component of soil resource management. Each sample collected must be a true representative of the area being sampled. Utility of the results obtained from the laboratory analysis depends on the sampling precision. Hence, collection of large number of samples is advisable so that sample of desired size can be obtained by sub-sampling. In general, sampling is done at the rate of one sample for every two hectare area. However, at-least one sample should be collected for a maximum area of five hectares. For soil survey work, samples are collected from a soil profile representative to the soil of the surrounding area.

Materials required
1. Spade or auger (screw or tube or post hole type)
2. Core sampler
3. Sampling bags
4. Plastic tray or bucket

- Equipment for collecting soil samples
  - clean, residue-free plastic pail
  - soil probe, shovel, or trowel
  - permanent marking pen

• sample boxes* or plastic bags

• *Field Soil Submission Forms* from Laboratory Services*

- **Standard Augers** – Used for sampling most soil types, standard augers have an open bit design, and are available in 3in (76mm) and 4in (102mm).
- **Clay Augers** – Like the standard augers, clay augers have an open bit design and work well in cohesive soils. Available in 3in (76mm) and 4in (102mm).
- **Sand Augers** – Designed for looser, granular soils, sand augers have closed bits to retain cuttings and are available in 3in (76mm) and 4in (102mm).
- **Mud (Dutch) Augers** – Best-suited for muck-like, boggy and root-bound soils, the mud auger offers an open design and is available only in 3in (76mm).
- **One-Piece Soil Samplers** – Available in 11in (279mm) or 14in (360mm) lengths, these units have a T-handle and steel construction that allows penetration into tougher soils.
- **Adapter for Quick-Connect Augers** – These adapters required to connect augers and older-model extensions with threaded connections to quick-connect components.
- **Quick-Connect Pins** – These pins are required parts for connecting Augers and Extensions in quick-connect configurations.
- **Handles & Extensions** – Used for connecting to augers, extensions help achieve greater depth penetration into the soil, and come in 2, 3, 4 and 5ft (610mm, 914mm, 1,219mm and 1,524mm). Handles have a T-design to help more easily guide the extensions deeper.

Standard Augers Clay Augers Sand Augers Mud (Dutch) Augers Handles & Extensions

One-Piece Soil Samplers Quick-Connect Auger Adapter Quick-Connect Pin

Figure 1.1 Equipment of soil sampler

1.2 Identifying the area of soil samples to be collected

- **Where should you sample?**
  - ✓ If using the composite method, take a number of samples over the entire field. Choose a W, S, or zigzag pattern when walking through the field to take subsamples that represent the entire field.
  - ✓ Take10 to 20 subsamples per field (depending upon field size) and mix thoroughly in the plastic bucket.
  - ✓ If using the grid method, keep subsamples separate and properly labeled with the grid points.
  - ✓ Sample depth varies with the type of crop. Sample most crops to the plow layer which is about 15 centimeters (6 inches) deep. In permanent sod or minimum or no till conditions, sample 5 to 8 cm (2 to 3 inches) deep.
  - ✓ Areas within the same field can have different slope, color, texture, drainage, and cropping practice. Sample these areas separately, as well as areas that are managed differently.
  - ✓ If there is an abnormal area which may have poor crop growth, take separate soil samples.
  - ✓ Name and record these special samples and areas on a field map.
  - ✓ Don't sample
    - field entrances, edges, depressions, and hill tops

- near water ways, old burn sites, and areas where animals congregate

✓ Remove all non-soil particles from the sample, such as grass, thatch, leaves, and rocks.

➢ Don't use a metal pail to mix the subsamples because it can contaminate the results collecting samples the right way you must take soil samples the right way or test results won't be accurate. Correct test results mean you can make the appropriate choices for liming and fertilizing your land. To get the most from your soil test, make sure the sample ,

  • Accurately represents the field

  • is handled and packaged properly

  • has enough information on the field submission forms so Laboratory

  Services can make appropriate recommendations

  Test your soil at least every three years to ensure your crop is getting the right amount of nutrients. Annual tests are even better.

Remember -A soil test is only as good as the sample it was taken from. Taking a poor quality sample is a waste of your time and money.

➢ **When should you sample?**• Always soil test at the same time, preferably the spring or the fall. Soil test levels change throughout the year, tending to be higher in the spring and lower in the fall. Sampling during the growing season can give unreliable results due to crop uptake. Fall is a good time to sample to provide the producer with information hat can be used for the next growing season.• Don't sample when fields are wet. Mold can grow in the samples and they take longer to process at the lab because of drying time. If it's too wet to plow, it's too wet to sample.

A good sample is

• taken at the same time of the year

• taken when fields are dry enough to plow

- taken throughout the field for accurate representation, not just from one area
- taken from the right depth
- mixed in a clean, plastic pail, not metal
- soil only, with leaves, rocks and other things removed
- properly labeled in a sample box or bag
- submitted with a Field Soil Submission Form that's filled in as completely as possible Page

1.3 locating your soil sample using site plans

Using a trowel, shovel, or auger, and a clean pail, obtain thin slices or borings of soil from at least 13 places in a given area. Follow the diagram below to properly locate the samples. For contour strips, take 6 samples 20 feet in from the edge of the entire strip and 6 samples from the opposite side of the strip. Sample to plow depth in cultivated land or to a depth of 6 inches. Sample to a depth of 3 or 4 inches in permanent pastures. If the field varies in soil type, previous fertilizer or lime application, or cropping history, sample each area separately.

Grid Sampling

The common approach to achieve systematic soil sampling is to overlay a square or rectangular grid on a map or photograph of the field, identify and drive to the middle of each grid cell, and collect a soil sample at that point (Figure 1.2). The soil sample consists of several soil cores collected within a small radius of the cell center. The soil cores are composited and bagged as one soil sample for analysis at a soil testing laboratory. The purpose of compositing several cores is to average or "bulk" out variability in soil test properties that occurs over small distances. Grid cell sampling can be efficiently conducted by counting crop rows and using distance measuring devices to locate sampling points. While easy to implement in the field, this practice can lead to bias. Tillage, fertilizer application,

Density A well-done nutrient map derived from a grid sample can be a valuable resource for many years. Consequently, the density should be adequate to provide confidence in the accuracy of the maps developed from the data. We suggest analyzing one sample per acre, which is composited from five cores collected in a tight radius about the sample point (Figure 3). This density will result in a map that will be good for many years —10 to 20 years for soil organic matter and cation exchange capacity; five to ten years for pH; and four to five years for phosphorus, potassium and zinc. On fields in which variability is expected to be low, a sampling density of two to two-and-one-half acres per sample may be acceptable. Grid sampling at densities coarser than one sample for every 2.5 acres is not recommended, if the goal is to develop a resource of nutrient maps that can be used with confidence over several years.

Sampling Pattern and Depth. An offset grid pattern is recommended as shown in the figure below. This will provide more information at a lower cost than a regular grid pattern. Individual cores should be collected in a radius of 8-10 feet of the grid point, to a depth of 8 inches. The grid point should represent the central position of a composited sample. Collect samples within the 8-10 foot radius randomly, in order to avoid systematic patterns such as starter or pre-plant bands. Conduct a general fertility analysis on the samples, including soil organic matter, pH, phosphorus, potassium and other nutrients of interest.

- ✓ A grid of equally spaced lines is established.
- ✓ 8 soil cores randomly collected within a 10 ft. radius of the grid center.
- ✓ Cores composited as one soil sample. Systematic Grid Square Sampling Pattern

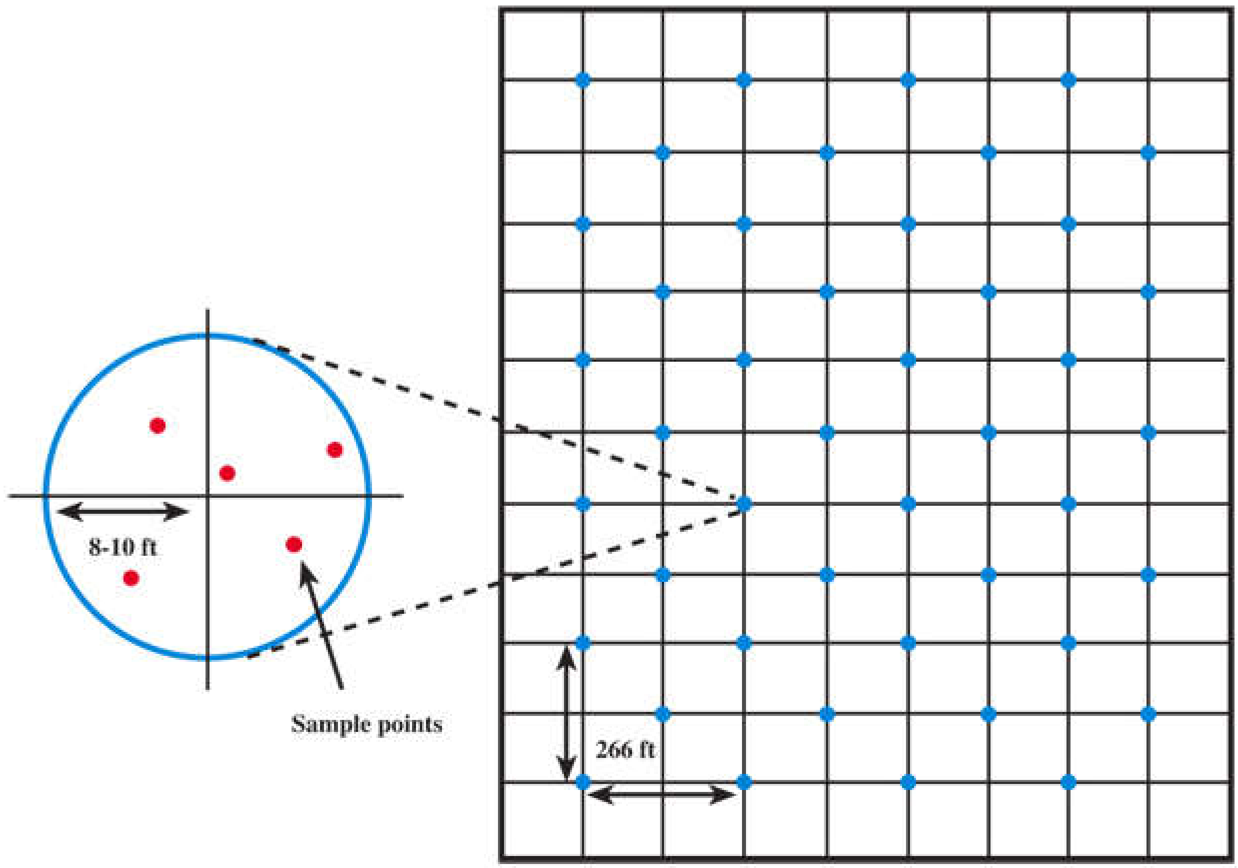

Figure 1.2 Schematic showing the layout of a square grid and locations where soil cores would be collected.

Frequency. As already mentioned, a nutrient map derived from a grid-sampled field can last a long time. If variable rate application of fertilizer or lime occurs, this will have the potential to change nutrient levels or soil pH over time. Soil phosphorus levels will not change drastically with single variable rate applications. We suggest that grid samples be collected every five years for phosphorus. Lime application according to recommendations should amend soil pH for 8-10 years. Even if variable rate lime application has occurred according to a grid-sampled map of pH, it should not be necessary to grid sample for soil pH for 8-10years after application.

Residual Nitrate Sampling. Grid sampling for nitrate-N is not recommended because annual fluctuations in nitrate levels would require annual grid sampling, which is not cost effective for most crops with current fertilizer prices. Instead, residual nitrate sampling (to a depth of 3 feet) should be done on a directed sampling basis.

1.4 Identifying OHS hazards report to the supervisor.

- **Why is occupational health and safety important?**

- ✓ Work plays a central role in people's lives, since most workers spend at least **eight hours** a day in the workplace, whether it is on afield, in an office, factory, etc. Therefore, work environments should be safe and healthy. Yet this is not the case for many workers. Every day workers all over the world are faced with a multitude of health hazards, such as: gases; noise; vibration; Extreme temperatures

- **Occupational health hazard(OHS)Hazards may include:**
- protection from disturbance or interruption of services, solar radiation, dust, noise, soil- and water-borne micro-organisms, chemicals and hazardous substances, sharp hand tools and equipment, manual handling, moving machinery and machinery parts, falling objects, and uneven surfaces..
- **What are the most common workplace hazards?**

Simply put, workplace hazards are any aspect of work that cause health and safety risks and have the potential to harm. Some hazards are more likely to be present in some workplaces than others, and depending on the work that you do; there will be hazards that are more or less relevant to your business.

There are many types of workplace hazards, which tend to come under four main categories:

- ✓ physical hazards – the most common workplace hazards, including vibration, noise and slips, trips and falls;
- ✓ ergonomic hazards – physical factors that harm the musculoskeletal system, such as repetitive movement, manual handling and poor body positioning;

- ✓ chemical hazards – any hazardous substance that can cause harm to your employees;
- ✓ Biological hazards – bacteria and viruses that can cause health effects, such as hepatitis, HIV/AIDS and Legionnaire's disease.
- ➢ **Identifying workplace hazards** and controlling risks

Every workplace has hazards. As an employer, you have a legal responsibility to look after your employees' safety and protect them against health and safety hazards at work.

In order to manage workplace health and safety and help prevent accidents and sickness absence, it's important to identify, monitor and reduce the risk associated with workplace hazards.

Some of the most common health risks associated with workplace hazards include:

- ✓ breathing problems;
- ✓ skin irritation;
- ✓ damage to muscles, bones and joints;
- ✓ hearing damage;
- ✓ Reduced wellbeing..

Being able to identify hazards is crucial in ensuring tasks are carried out safely. Your past experience in the workplace may help you to identify some hazards, but remember to also use the skills and knowledge of those around you to help. Identifying hazards and controlling risk must be done continuously as new work processes, tasks, equipment and workers come into the workplace. Part of this process may be to ask your employer to employ or engage a suitably qualified occupational health and safety professional to come into the workplace to provide advice on health and safety.

- ➢ **Some ways to identify hazards and control risks:**
  - ✓ Talk with workers (including contractors) who are or will be performing any tasks to identify all potential hazards and the best ways to eliminate or reduce risk.
  - ✓ Make sure you are aware of any high risk activities, work with new machinery or new work processes before they happen.

- ✓ Understand the hazards associated with tasks you supervise and have risk controls in place before work starts. This could mean preventing work from being done while a safety issue is being resolved.

- ➢ Take action to resolve health and safety issues as soon as possible. This includes escalating the issue to more senior management if necessary. Once agreement is reached on how to fix a problem, implement it as soon as possible.
- ➢ **To identify and assess hazards, employers and workers**:

- ✓ Collect and review information about the hazards present or likely to be present in the workplace.
- ✓ Conduct initial and periodic workplace inspections of the workplace to identify new or recurring hazards.
- ✓ Investigate injuries, illnesses, incidents, and close calls/near misses to determine the underlying hazards, their causes, and safety and health program shortcomings.
- ✓ Group similar incidents and identify trends in injuries, illnesses, and hazards reported.
- ✓ Consider hazards associated with emergency or no routine situations.
- ✓ Determine the severity and likelihood of incidents that could result for each hazard identified, and use this information to prioritize corrective actions.

- ➢ **How to prevent workplace hazards**

The best way to protect yourself and your employees from workplace hazards is to identify and manage them and take reasonable steps to prevent their potential to harm.

In order to control workplace hazards and eliminate or reduce the risk, you should take the following steps:

- ✓ identify the hazard by carrying out a workplace risk assessment;
- ✓ determine how employees might be at risk;
- ✓ evaluate the risks;
- ✓ Record and review hazards at least annually, or earlier if something changes.

- ➢ **"Hazard Prevention and Control."**

- ✓ Collect existing information about workplace hazards
- ✓ Inspect the workplace for safety hazards
- ✓ Identify health hazards
- ✓ Conduct incident investigations
- ✓ Identify hazards associated with emergency and no routine situations
- ✓ Characterize the nature of identified hazards, identify interim control measures, and prioritize the hazards for control.

1.5 Using suitable safety equipment and personal protective equipment (PPE)

- ✓ This article offers a refresher on what personal protective equipment (PPE) is, how to choose the right PPE and how to wear and remove it safely. PPE aims to improve staff and patient safety, but self-contamination commonly occurs during its removal; failure to remove PPE carefully can lead to contamination of the user's skin, own clothes, uniform or scrubs, hair, face and hands.

- **Personal protective clothing and equipment may include:**
  - ✓ hat/hard hat
  - ✓ boots
  - ✓ overalls
  - ✓ gloves
  - ✓ goggles
  - ✓ 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.

Figure .1.1 boots

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

Figure .1.2 Eye protection

- **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.

Figure .1.3 hand protection

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

Figure .1.4 body protection

- **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.

Figure .1.5 Hard hat

- Respiratory protection

Figure .1.6 respiratory protection

- **Using and maintaining suitable safety equipment and personal protective equipment (PPE)**

- ✓ The development and validation of protective clothing test methods are very important to industrial hygiene practitioners. These methods will eventually help to ensure that protective clothing performance data are comparable, meaningful, and available to field personnel. However, field problems are typically very complex, with multiple challenges placed on protective clothing, as well as the users. The “perfect” protective clothing item is rarely, if ever, found in practice.
- ✓ Protective clothing challenges can often include combinations of heat, tear, and cut hazards, rough surfaces, puncture hazards, and complex chemical mixtures. Fitting problems, differences in performance of similarly-described clothing from different manufacturers, and occasional poor quality control can cause additional complications for users.
- ✓ Training in the proper wearing of clothing, whether or not the equipment is considered disposable, worker acceptance, comfort, flexibility, compatibility with the work being done, and other more subtle issues also influence whether or not clothing is actually used.
- ✓ Dermatitis aggravated by personal protective equipment use, skin cleaners, and hand creams can also present problems to clothing users. In addition, practical guidelines for assessing toxic risks from dermal exposures to chemical agents are critical if we are to meaningfully apply protective clothing performance data.
- ✓ This paper presents some of the factors that must be considered during personal protective equipment selection, and gives specific examples of typical selection problems.
- ✓ Engineering, job layout, and skills' training solutions are needed to minimize the need for personal protective equipment and to ensure effective use when it must be specified for protection.

1.6 Taking Soil Samples from the designated area

- ✓ A soil sample is the representative of the whole lot from which it is taken. It completely represents all the characteristics of the lot from which it is recovered. Following are some of the types of samples which are generally retrieved in geotechnical engineering:
- ✓ Soil Sampling should reflect tillage, past fertilizer/soil amendment placement, cropping patterns (and corresponding irrigation requirements), soil type (including drainage and slope characteristics) and perhaps old field boundaries (such as old feedlots, windrows, altered stream beds, etc.).
- ✓ The most commonly used method for soil sampling would be based on soil types. Fields are split into sampling areas that contain similar soils. Hillsides are kept separate from bottoms since the soil types will vary.
- ✓ Soil survey maps, if applicable, can help organize the soil types throughout the sampling area. Samples will not necessarily need to be collected for every soil type; however, similar soils should be kept together. Sampling maps can be kept to note the locations of the cores for subsequent sampling.
- ✓ The sampling area will be dependent on the soils and topography. Generally, an area of forty acres is considered the maximum size. Smaller sampling areas may be needed if the soils are quite variable or a production problem is apparent.
- ✓ Once the sampling area is determined, a sufficient number of cores should be taken to acquire a representative sample.
- ✓ This is generally 10 to 20 cores. The depth of sample for surface soils would be 0 to 6 inches or as deep as the primary tillage. Deeper samples to 24 or 36 inches can be taken for residual nitrate-nitrogen.
  - ❖ **These deep samples would be**

1. Disturbed soil samples (DS):
2. Undisturbed soil samples (UDS):

A) Disturbed soil samples (DS):

When the natural conditions of a sample such as its structure, texture, density, natural water contents or the stress conditions are disturbed then the sample is called as disturbed soil sample. By using shovel from auger cutting these samples can be recovered.

b) Undisturbed soil samples (UDS)

Without disturbing the natural conditions of a soil sample such as its structure, texture, density, natural water contents or the stress condition the sample obtained is called undisturbed soil sample. This type of soil sample cannot be recovered and it retains the original properties of the soil mass as much as possible.

➢ **Proper soil sampling techniques**

Proper soil sampling technique for soil sample collection and sub mission (Results are only as good as the soil sample submitted.)
Anyone can submit a sample(s) for testing, pH, phosphate, calcium, magnesium, potassium, iron and copper, etc. and other soil test can only analyze soil pH and soluble salts.

➢ **Before sampling**

- ✓ Develop a soil sampling plan of your field. Samples should represent the area being tested, so collect samples from areas that are of the same soil type, appearance, or cropping history. Sample problem areas
- ✓ Separately, if needed. From this plan, count the number of samples you will collect.
- ✓ Soil sample bags, addressed shipping boxes are available from your county Extension office if you are using the Soil Testing Laboratory. Obtain the materials you need to complete your sampling plan.

➢ **Guide lines to take soil samples from the field.**

A. Division of Field to Collect the Representative Samples:

Demarcate the filed into uniform patches, each of which may be sample separately.

i) Do not Sample Unusual Area:

- ✓ Avoid areas recently fertilized, old bunds, marshy spots near trees, compost heaps and other non-representative locations.
- ✓ **ii) Use Proper Sampling Tools**:
- ✓ Satisfactory samples can be taken with a soil tube augar spade, trowl, khurpi or pickaxe. Tools should be clean and free from fertilizer contamination.
- ✓ **iii) Use Other Accessories:**
- ✓ Bucket, information sheet, plastic or tarpaulin piece, cloth bag labels.

B) Collection of Soil Samples:

- ✓ Remove organic debris, rocks and trash from the surface of the soil sampling areas before the sample is collected the soil sample to plough layer. Select the sampling spot in a zigzag manner from about 10-20 places. Collect all the samples in a bucket
- ✓ . Depth of sampling is desired according to the purpose.
    - Soil fertility (15-25 cm)
    - Salinity and alkalinity (1m)
    - Establishment of gardens (2m)
    - Soil survey profile of (1-1.5m) depth
  - ❖ Keep record of the areas sampled and simple sketch map for reference.

C) Handling and Dispatch of Sample to Laboratories:

- ➢ After complete collection of soil samples from field the organic residues like tree leaves, twings, dung etc. and gravels , stones and other unwanted material should be kept out and sample should be prepared for laboratory analysis by adopting following steps.

- Drying
- Grinding
- Sieving
- Mixing
- Partitioning
- Weighing
- Storing
- Labeling

➢ **Collecting preparation samples**

- ✓ Collect soil from 20 or more spots within each area; mix these samples in a clean plastic bucket.
- ✓ Sample from soil surface to depth of tillage, usually 0 to 6 inches. For pastures, sample from 0 to 4 inch depth.
- ✓ Spread the collected material on clean paper or other suitable material to air dry. Do not send wet samples.
- ✓ Mix the dry soil, and placed about one pint of soil in a labeled sample bag.

1.6 preparing on site or off site analysis Soil samples

Preparation of soil samples

- ✓ This is an absolutely critical step, and tends to be overlooked in a review of methods, but if the preparation is not carefully done, then no amount of sophisticated instrumentation will improve the result.
- ✓ Many tests cannot be performed on a dried and crushed sample, as some of the parameter of interest will be lost, so soils must be initially mixed (and tested) in a wet, as

received state, and these include: Volatiles, leach ate testing, phenols, ammonia cal nitrogen, sulphides, cyanides, most organics, hexavalent chromium.

- ✓ Moisture contents will be needed for all testing performed on as received soils, as these must be adjusted back to a dry weight basis for reporting purposes. For contaminated soils, it is not regarded as advisable to remove anything from the sample, as potential hazardous material may coat the lumps (e.g. paint, electroplating fluids), or constitute the whole lump (e.g. tar), but if any component is removed, this must be noted on the final report to comply with requirements.
- ✓ Once a subsample of soil is weighed out, then for most methods, some form of liquid is added to the soil to extract the required parameter of interest. For example, anions and pH require a 2:1 water extraction, metals use an acidic digest, cyanides need an alkaline extraction, phenols use a methanol/water mix, and most organics need a solvent extraction.
- ✓ Samples must be shaken, refluxed, or digested for specific periods of time, then filtered or centrifuged, and the liquid extract then analyzed by an instrument specific for the analyte in question.

- **There are two methods of laboratory soil analysis**.

1. Physical analysis

- ✓ Determination of rubbed and unrubbed fiber (volume basis)
- ✓ Particle size analysis (pipet method) - Mechanical Procedure
- ✓ Determination of Waterberg limits (liquid and plastic)
- ✓ Shrinkage factors of soils.
- ✓ Laboratory measurement of hydraulic conductivity of saturated soil (constant-head method)
- ✓ Determination of soil water content at 15 bars X-ray diffraction for mineral identification and mineralogical composition

2. Chemical analysis

- ✓ Measurement of soil pH - pH Procedure
- ✓ Determination of electrical conductivity and % saturation -Electrical Conductivity Procedure
- ✓ Determination of water soluble cations and anions Determination of CaCO3 equivalent and estimates for calciteand dlomite – Carbonate Procedure
- ✓ Determination of organic carbon Determination of pyrophosphate-soluble organic matter index (organic soils Loss-on-ignition)

- **Sending samples to the Extension Soil Testing Laboratory**

- Enter each sample's identification on its sample bag and in the "Soil Sample identification" column. List each sample separately.
- Lime and fertilizer recommendations are provided only if the crop code(s) is listed.

- Include the analysis code for each desired test.
- Enter costs form the Analysis Cost list and Sum the costs of all samples and analyses. Make check or money order payable to Extension Soil Testing Laboratory.

➢ Include the completed Producer Soil Test Information Sheet and the check or money order in the shipping box with the samples(s)test result

- A soil test report will be mailed to you within 5 to 10 days after your sample arrives at the Extension Soil Testing Laboratory.

1.8Labeling, recording and storage of sample

• Label the sample box or bag with your name, sample identification, and address. Fill in the Field Soil Submission Form as completely as possible. You must indicate the crop you intend to grow on the submission form. Laboratory Services needs this information to provide interpretation ratings, and lime and nutrient recommendations on the soil test report.

• Mail or take samples to the Laboratory Services ask Laboratory Services for the S1,Standard Soil Package, unless you want additional tests run.

• The standard soil package required is called S1. You can request additional tests such as nitrogen and soil conductivity. Review the fee schedule for additional tests and pricing.

➢ **Processing and storage**

1. Assign the sample number and enter it in the laboratory soil sample register.
2. Dry the sample collected from the field in shade by spreading on a clean sheet of paper after breaking the large lumps, if present.
3. Spread the soil on a paper or polythene sheet on a hard surface and powder the sample by breaking the clods to its ultimate soil particle using a wooden mallet.
4. Sieve the soil material through 2 mm sieve.

5. Repeat powdering and sieving until only materials of >2 mm (no soil or clod) are left on the sieve.
6. Collect the material passing through the sieve and store in a clean glass or plastic container or polythene bag with proper labeling for laboratory analysis.
7. For the determination of organic matter it is desirable to grind a representative sub sample and sieve it through 0.2 mm sieve.
8. If the samples are meant for the analysis of micronutrients at-most care is needed in handling the sample to avoid contamination of iron, zinc and copper. Brass sieves should be avoided and it is better to use stainless steel or polythene materials for collection, processing and storage of samples.
9. Air-drying of soils must be avoided if the samples are to be analyzed for NO3-N and NH4-N as well as for bacterial count.
10. Field moisture content must be estimated in un-dried sample or to be preserved in a sealed polythene bag immediately after collection.
11. Estimate the moisture content of sample before every analysis to express the results on dry weight basis.

Self-Check 1	**Written Test**

Name: ___________________________ **Date:** ________________

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

1. Discuses about grid sampling techniques (10 points)
2. What are the most common workplace hazards**?**(5pt)
3. List Personal protective clothing and equipment may include?(5)
4. What are the common laboratory soil analysis methods ?(5pt)
5. List the depth of soil sample according the purpose?(5pt)

Note: **Satisfactory rating –15 points and above Unsatisfactory - below 15 points**

You can ask your teacher for the copy of the correct answer.

Operation sheet-1	Investigate surveying tools, material and equipment

Objectives: To know the method of locating soil sample.

Procedure:

1. Identify tools and equipment and soil sampling techniques
2. Name the tools and equipment and its application
3. Locate the sample area

LAP Test1	Practical Demonstration

Name: _____________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions:

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

1.1 Request your teacher to arrange for you to visit the nearby soil sampling area. You should identify important soil sampling tools and equipment

1.2 Request a set of micro irrigation equipment, then perform the following tasks in front of your teacher

- Name of the tool and
- Its application
- Using grid method locate the sampling area

1.3 Request your teacher for evaluation and feedback

Information sheet -2	Perform basic soil tests

2.1 Determining soil profile.

The soil profile is defined as a vertical section of the soil that is exposed by a soil pit. A soil pit is a hole that is dug from the surface of the soil to the underline.

The soil profile is one of the most important concepts in soil science. It is a key to understanding the processes that have taken in soil development

And is the means of determining the types of soil that occur and is the basis for their classification.

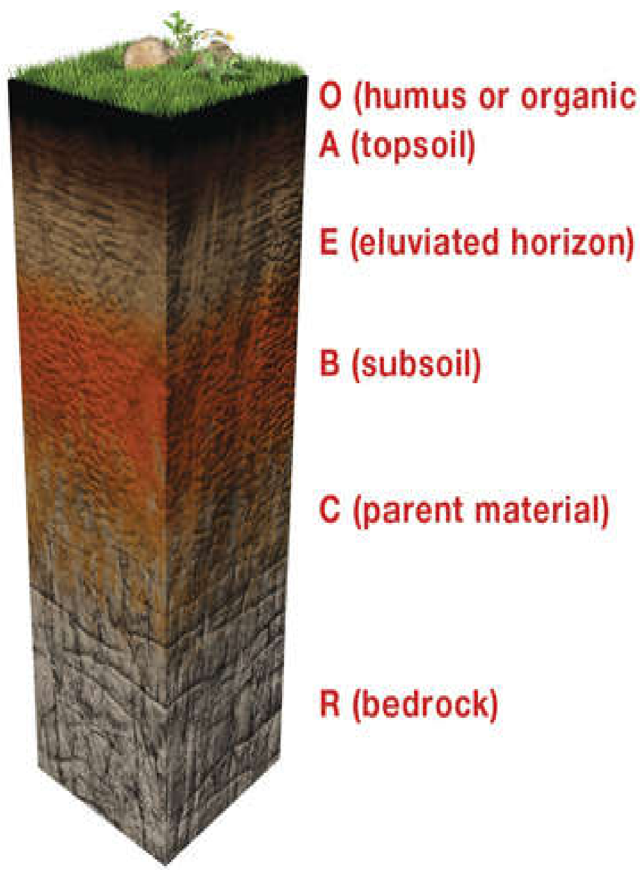

Fig 2.1 soil profile

On the surface, soils look pretty much the same… dirt. The soil profile is where the secrets of the soil and landscape around it are hidden. The soil profile is defined as a vertical section of the soil that is exposed by a soil pit. A soil pit is a hole that is dug from the surface of the soil to the underlying bedrock.

Because of the way soils develop, most soil profiles are composed of a series of horizons, or layers of soil stacked on top of one another like layers of a cake. These horizons can tell us a lot about how the soil formed and what was going on around the soil in the past, much like a diary of the landscape.

- **How Does the Soil Profile Develop?**

Let's pretend we're looking at a brand-new landscape surface. It could be a bed of lava that just cooled, some rocks and minerals exposed by a receding glacier, debris laid down by a flooding river, or many other things. We call that brand-new landscape surface parent material, and at that point, it is new and not technically soil!

Will it remain that way forever? No… it won't take long before it can be called 'soil,' which just means that the parent material has been altered, or weathered, in some way by the five soil forming factors.

While we discuss the soil forming factors, think about how they might influence a parent material differently in different locations or situations.

An easy way to remember the five soil forming factors is to remember the word ClORPT,

Where:

- Cl stands for climate,
- For organisms,
- R for relief (another way of saying topography),
- P for parent material, and T for time.

The climate in which a soil is developed determines many things, most importantly, the amount of water that will flow, or leach, through the profile. It might seem odd that water dissolves rocks or minerals, but the more water a parent material is exposed to, the quicker it will be weathered. Freeze/thaw cycles and other climatic factors also weather parent material.

Organisms, especially plants and soil microorganisms, do a lot to weather parent material by producing acids and other organic matter. Different groups of organisms have different effects on parent materials. For example, trees in a forest have different root systems and produce different organic matter than grasses in grassland.

Relief, or topography, influences where water and other materials accumulate on or leave the landscape. For example, the bottom of a hill will receive more water than the top because water runs down the hill. So, the parent material at the bottom will have more water leaching through it than the parent material on the top, so the soils will eventually look different.

Parent material, which we've been discussing all along, is what is being altered into soil. While it will change over time because of weathering, a soil with a parent material like basalt lava will be different than a soil with a parent material like beach sand, because the parent materials are so different chemically and physically.

Time is the last soil forming factor. Soils take a very long time to develop; new soils do not have distinguishing profiles or horizons. But given enough time and the other four soil-forming factors, soils develop interesting and storytelling horizons.

- **The Horizons**

Now that we know the different factors that drive soil development, we can move on to the features the development creates, giving each soil its unique profile. Again, most developed soils have horizons that can tell us about the type of environment in which the soil was produced. The most commonly referred-to horizons are easy to remember: they are the O, A, E, B, and C horizons.

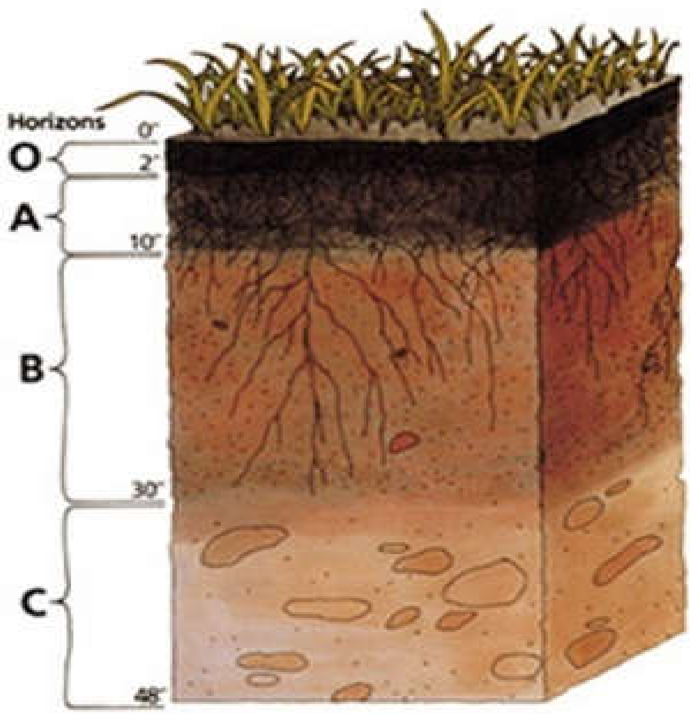

Fig 2.2 soil horizon

The O horizon, when it is present, is the uppermost horizon. The O stands for 'organ.' You can think of dead plants and animal parts falling on the surface of the soil. Sometimes it's very recognizable and sometimes, the organic material is decomposed enough that it just looks like muck.

The A horizon is usually the first mineral horizon. Often referred to as the topsoil, the A horizon is rich in organic matter, which gives it its characteristic brown color. In fact, many soils don't have a true A horizon because there isn't enough organic matter to make the surface horizon brown enough. Typically, tilled crop agriculture takes advantage of the nutrient richness of the A horizon.

The E horizon follows the A horizon if it is present. The E stands for 'elluvial,' or very leached, and has been very weathered by water and organic acids and, depending on the parent material, may be white. In soils with very low productivity, such as desert soils, the E can be the uppermost horizon because there isn't enough organic matter production to develop an A horizon.

2.2. Performing basic soil tests

Soil test may refer to one or more of a wide variety of soil analyses conducted for one of several possible reasons. Possibly the most widely conducted soil tests are those done to estimate the plant-available concentrations of plant nutrients, in order to determine fertilizer recommendations in agriculture. Other soil tests may be done for engineering

Soil testing

Soil testing is often performed by commercial labs that offer a variety of tests, targeting groups of compounds and minerals. The advantages associated with local lab are that they are familiar with the chemistry of the soil in the area where the sample was taken. This enables technicians to recommend the tests that are most likely to reveal useful information.

Soil testing in progress

Laboratory tests often check for plant nutrients in three categories:

- Major nutrients: nitrogen (N), phosphorus (P), and potassium (K)
- Secondary nutrients: sulfur, calcium, magnesium
- Minor nutrients: iron, manganese, copper, zinc, boron, molybdenum, chlorine

Do-it-yourself kits usually only test for the three "major nutrients", and for soil acidity or pH level. Do-it-yourself kits are often sold at farming cooperatives, university labs, private labs, and some hardware and gardening stores. Electrical meters that measure pH, water content, and sometimes nutrient content of the soil are also available at many hardware stores. Laboratory tests are more accurate than tests with do-it-yourself kits and electrical meters .Soil testing is used to facilitate fertilizer composition and dosage selection for land employed in both agricultural and horticultural industries.

Prepaid mail-in kits for soil and ground water testing are available to facilitate the packaging and delivery of samples to a laboratory. Similarly, in 2004, laboratories began providing fertilizer recommendations along with the soil composition report.

Lab tests are more accurate, though both types are useful. In addition, lab tests frequently include professional interpretation of results and recommendations. Always refer to all provisostatements included in a lab report as they may outline any anomalies, exceptions, and shortcomings in the sampling and/or analytical process/results.

Some laboratories analyze for all 13 mineral nutrients and a dozen non-essential, potentially toxic minerals utilizing the "universal soil extract ant" (ammonium bicarbonateDTPA).

- **Soil Texture analysis Procedure:**

This test requires few tools, and is relatively fast. It will help you know if you have an extremely sandy soil, clayey soil, or something in between. I have just moved, and after the winter ground thaws, I will be doing this test on my own soil. You need a container with fairly precise measurements. I am going to use my 2 cup Pyrex kitchen measuring cup for measuring. But you also need a container, where you can shake your soil sample, mixed with water. I am going to use a quart canning jar to do my shaking, and immediately pour the solution into the Pyrex measuring cup.

- Obtain your soil sample by digging down 6 inches.
- Combine 3 such soil samples, as your soil may be different in different spots.
- Fill a quart canning jar with 1/2 cup of your soil sample.
- Dilute the sample by adding 1 & 1/2 cups of water.
- Add either 1/2 teaspoon of salt, or 1/2 teaspoon of dishwashing detergent.
- Cap the canning jar and shake for 2 minutes.
- Immediately after 2 minutes of shaking, pour the contents of the quart canning jar into your 2 cup Pyrex measuring cup.
- Allow the 2 cup Pyrex measuring cup to stand for *exactly* 30 seconds. Measure the height in ounces (or ml) of the soil particles that have settled at this time. This is the sand portion. Record this value.
- Allow the 2 cup Pyrex measuring cup to stand undisturbed for 30 minutes. Measure the height in ounces (or ml) of the soil particles that have settled at this time and record that

value. Subtract the first (30 second) reading. This difference is the portion of soil that is silt.

- Now let the 2 cup Pyrex measuring cup of soil stand for at least 24 hours. At the 24-hour point, take another reading. Subtract the height at the 30 minute reading. This difference is the clay portion of the soil. If the water is still very cloudy, take another reading after it has completely cleared. Compare it to the 24-hour reading. If the level has risen, subtract the 30-minute reading from this value, and use this for the clay reading.

Now, put the three height readings in the form of percentages. For example;

Height in ounces after:	Corresponds to fraction of:	Example - total height in ounces:	Difference in height, or portion:	Portions expressed as percentage:
30 seconds	sand	4 oz	4 oz	4/8 = 50 %
30 minutes	silt	5 oz	1 oz	1/8 = 12.5 %
24+ hours	clay	8 oz	3 oz	3/8 = 37.5 %
			total = 8 oz	

TABLE 2.1 Showing soil

Using the soil texture triangle, find the spot on the diagram that corresponds to the fractions of sand, silt and clay in your soil test. Write down the name of your soil texture. In the example, the soil texture as determined by the triangle for a soil with 50% sand, 12.5% silt and 37.5% clay is a Sandy Clay Soil. You can now use this soil texture classification when estimating water, and fertility requirements of your soil, as well as choosing the best amendment for your soil.

- A sandy soil is one with large particles that drains quickly but holds nutrients poorly.
- A clay soil is composed of extremely small particles, with a large capacity for holding water and dissolved plant nutrients.
- Un-amended clay soil is sticky, heavy, and hard to breathe. It tends to expand when wet and crack apart when dry.

- A silt soil is one with medium-size mineral particles, larger than clay and smaller than sand. Silt adds little to the characteristics of a soil.

The term loam refers to a soil with a combination of sand, silt, and clay sized particles.

- **The Most Common Basic Lab Tests**

Here are the basic soil tests:

- Testing for soil pH and buffer pH and required amendments if needed. The correct pH is based on grass species or plant requirements.
- The macro nutrients- Nitrogen, Phosphorus, Potassium.
- Your soil's composition with percentages. What is included varies with labs.
- Soil calcium.
- Micronutrients are sometimes included, while other labs will offer them with an additional charge.

Remember that accurate results begin with the way you collect the soil for your tests. This, and more, is explained in the links at the bottom.

Don't forget that many home and professional soil pH test kits are available with fairly accurate results. How to use the information obtained from home kits is sometimes included.

Big pro kits like the Gemplers Test Kit shown in the photo offers 12 different types of tests.

This kit tests for soil pH , soil nitrates, soil salinity, soil compaction, soil texture, soil respiration, and more. Manufacturers offer kits with a wide variety of tests. Turf managers, nursery and greenhouse workers, and lawn enthusiasts can purchase these pro meters and kits, ranging from soil compaction test equipment to full soil testing kits.

Smaller kits are more affordable and can be purchased at home and garden stores and online. The big soil testing kits are not really practical for the occasional user and are quite expensive. The large kit above is several hundred dollars. They are used by golf course superintendents and commercial turf and nursery operations, farmers, and others.

It still remains that for some specialized test procedures or where accuracy is absolute, a testing lab should be contracted.

- **Why is a Knowledge of Soil Testing Methods Important**

It is impossible to tell what nutrients are in your soil just by looking at it. Some soil conditions may be more obvious, such as the presence of heavy clay, but the percentage is determined at a lab. The soil pH, along with specific nutrients that may be lacking, cannot be determined unless a test is performed. The test results determine what amendments and nutrients should be added or withheld.

Whether you use a commercial lab or your own testing equipment, an understanding of soil testing methods is always helpful.

Check out the pages below for help in performing basic tests, for understanding the test analysis, soil testing methods, and more.

How To Collect A Soil Sample

The first step in understanding what is in your soil is to take a soil sample.

Understanding the Soil Analysis Report

Understanding the soil analysis report can be difficult. Click here for an explanation of results commonly found of most reports.

Spreader Calibration Made Easy

Spreader calibration made easy! Knowing if your spreader is actually putting down the right amount is important for professionals and homeowners alike. This page offers all you need to know about calibrating your broadcast or drop spreader.

Nitrogen Sources for a Green Lawn

Nitrogen is the most important element in lawn fertility. However, different types of fertilizers can deliver nitrogen differently. See what sources of nitrogen are available from organic to inorganic, as well as, when and how they are best used.

Developing a Lawn Fertilization Program

Behind every beautiful lawn is a good lawn fertilization program. Whether it's a championship golf course or your home lawn, certain fundamentals always apply. Click here to begin planning your fertilization program.

2.2 Testing or inspecting soils for physical properties.

Physical properties of the soil

Texture:

Texture refers to the relative proportions of particles of various sizes such as sand, silt and clay in the soil. The proportions of the separates in classes commonly used in describing soils are given in the textural triangle shown in Fig.2.3

In using the diagram, the points corresponding to the percentages of silt and clay present in the soil under consideration are located on the silt and clay lines respectively.

Lines are then projected inward, parallel in the first case to the clay side of the triangle and in the second case parallel to the sand side. The name of the compartment in which the two lines intersect is the class name of the soil in question. For examples soil containing 15% clay, 20% silt and 65% sand is sandy loam and a soil containing equal amounts of sand, silt and clay is clay loam.

The percentages of sand, silt and clay in a soil could be determined in a soil laboratory by two standard methods –

- hydrometer method and
- pipette method

Both methods depend on the fact that at any given depth in a settling suspension the concentration of the particles varies with time, as the coarser fractions settle at a faster rate than the finer.

In the field, soil texture could be estimated by the following methods

(I) Feel method. In this method, the soil is moistened with water and rubbed between the thumb and fingers. The way the wet soil "slicks out" gives a good idea of the clay content. The sand particles are gritty, the silt has a floury or talcum - powder fell when dry and is only moderately plastic and sticky when wet. Accuracy of this method depends largely on experience.

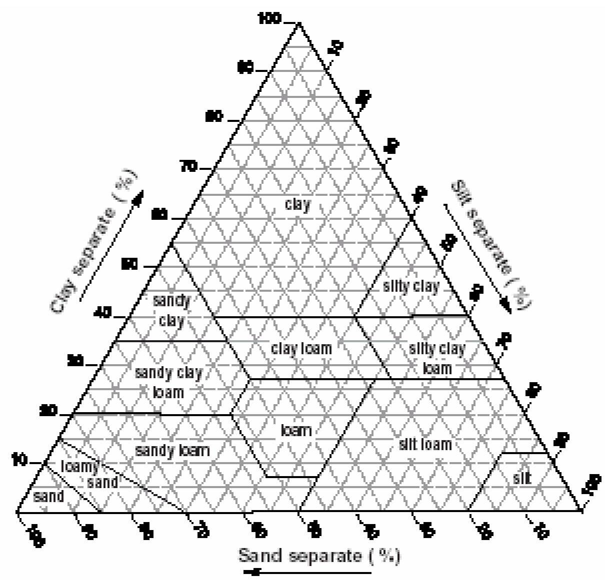

Fig. 2.3 Soil textural triangle

(**ii) Ball and ribbon method:** The procedure of this method as described by Coche and Laughlin (1985) is as follows: Take a handful of soil and wet it so that it begins to stick together without sticking to the hand. A ball of about 3 cm diameter is made and put down. If it falls apart it is sand. If it sticks together roll the ball into a sausage shape 6 – 7 cm long. If it does not remain in this form it is loamy sand. If it remains in this shape, continue to roll until it reaches 15 – 16 cm long. If it does not remain in this form, it is sandy loam. If it remains in this shape, try to bend the sausage into a half circle and if it doesn't, it is a loam. If it does, bend the sausage to form a full circle and if it doesn't it is heavy loam. If it does with slight cracks in the sausage, it is light clay. If it does without any cracks, it is a clay.

(iii) Ball throwing method: The texture of the soil can be inferred by the way a ball of soil acts when it is thrown at a hard surface such as a wall or a tree: Throw a ball of soil to a tree or wall 3 m away. If the soil is good only for splatter shots when either wet or dry, it has a coarse texture (loamy sand). If there is a “shot gun” pattern when dry and it holds its shape against medium range target when wet, it has a moderately coarse texture (sandy loam). If the ball shatters on impact when dry and clings together when moist but does not stick to the target it has a medium texture (loam, sandy clay loam, silty clay loam). If the ball holds its shape for long - range shots when wet and sticks to the target but is fairly easy to remove it has a moderately fine texture (clay loam). If the ball sticks well to the target when wet and becomes a very hard missile when dry, it has a fine texture (clay).

Soil texture is an important soil parameter determining the suitability of a site for aquaculture. A clayey soil stabilises pond bottom besides the fact that it adsorb large quantity of nutrients and release them slowly over a long period to the overlying water. The clayey soil normally holds higher amounts of organic matter than light textured soils and thereby increases the productivity of the pond. It should be noted that too clay a soil (very sticky clay) may not be very satisfactory as it may give rise to fixation of phosphorus and create other physico-chemical biological problems. Such soils may give rise to cracks on draining the ponds, thereby increase seepage losses.

- **Structure:**

The term texture is used in reference to the size of individual soil particles but when the arrangement of the particles is considered the term structure is used. Structure refers to the aggregation of primary soil particles (sand, silt and clay) into compound particles or cluster of primary particles which are separated by the adjoining aggregates by surfaces of weakness.

Structure is defined in terms of grade, class and type of aggregates.

Grade: Grade of structure is the degree of aggregation and expresses the differential between cohesion within aggregates and adhesion between aggregates. These properties vary with the moisture content of the soil and it should be determined when the moisture content is normal - not when unusually dry or unusually wet. The four major grades of structure rated from 0 to 3 are listed below.

0 – Structureless:	No observable aggregation or no definite orderly arrangement of natural lines of weakness. Massive if coherent; single grain if non coherent.
1 - Weak:	That degree of aggregation characterized by poorly formed indistinct aggregates that are barely observable in place. When disturbed, soil material that has this grade of structure breaks into a mixture of few entire aggregates many broken aggregates and much un aggregated material.
2 - Moderate:	Well formed distinct aggregates that are moderately durable and evident but not distinct in undisturbed soil. When disturbed, they break down into a mixture of many distinct entire aggregates, some broken aggregates and little un aggregated material.
3 - Strong:	Durable aggregates that is quite evident in undisturbed soil that adheres weakly to one another. When removed from the profile the soil material consists very largely of entire aggregates and includes few broken ones and little or no non aggregated material.

Diameter of particle (mm)

1. Gravel and sand(old alluvium)	A	Soil suitable for pond bottom if coefficient of permeability is less than 5×10^{-6} m/s
2. Sand		
3. Silt	B	Soil suitable for building dikes without

		impermeable clay core
4. Calcareous clayey soil (marl)	C	Soil suitable for pond bottom or dike only after modification of soil using amendments.
5. Heavy clay		

- **Consistence:**

Is the resistance of a soil to deformation or rupture and is determined by the cohesive and adhesive properties of the soil mass. This is a term used to designate the manifestation of the cohesive and adhesive properties of soil at various moisture contents. A knowledge of the consistence of the soil is important in tillage operations, traffic and pond constructions. Consistence gives also an indication of the soil texture.

Consistence is described for three moisture levels:

- Wet soil - non sticky, slightly sticky, sticky, very sticky; non plastic, slightly plastic, plastic and very plastic.
- Moist soil - loose, very friable, friable, firm, very firm, extremely firm.
- Dry soil - loose, soft, slightly hard, hard, very hard and extremely hard.

- **Particle density**

Of soil is the mass per unit volume of soil particles (soil solid phase) - expressed in g/c.c. Most soils have particle density of about 2.6 g/cc. Presence of organic matter decrease the density and iron compounds increase the density.

- **Bulk density**

Of soil is the mass of soil per unit volume of soil (volume includes both soil and pores) - expressed in g/c.c.

Pore space:

$$\% \text{ Pore space} = 100 - \frac{\text{bulk density}}{\text{particle density}} \times 100$$

Particle density can be determined using specific gravity bottle technique and bulk density by taking soil core samples of known volume in the field and determining the even dry weight (Black et al., 1965a). Water and air movements through soil depend on the pore space and the size distribution of the pores (micro Pores and macro pores). Lower the pore space or higher the bulk density of the soil, the higher the suitability of the soil for aquaculture.

- **Atterberg limits:**

From the previous section it could be noted that consistence of soils changes with the amount of moisture in the soil. Atterberg limits correspond to the moisture content at which a soil sample changes it's consistence from one state to the other. Liquid limit (LL) and plastic limit (PL) are two important states of consistence. Liquid limit is the percentage moisture content at which a soil changes with decreasing wetness from the liquid to the plastic consistence or with increasing wetness from the plastic to the liquid consistence, whereas the plastic limit is the percentage moisture content at which a soil changes with decreasing wetness from the plastic to the semi-solid consistence or from the semi-solid to the plastic consistence. Plastic index (PI) = LL - PL, is the moisture content range at which the soil remains plastic.

- **Soil color:**

Soil color gives an indication of the various processes going-on in the soil as well as the type of minerals in the soil. For example the red color in the soil is due to the abundance of iron oxide under oxidized conditions (well-drainage) in the soil; dark color is generally due to the accumulation of highly decayed organic matter; yellow color is due to hydrated iron oxides and hydroxide; black nodules are due to manganese oxides; mottling and gleying are associated with poor drainage and/or high water table. Abundant pale yellow mottles coupled with very low pH are indicative of possible acid sulphate soils. Colors of soil matrix and mottles are indicative of the water and drainage conditions in the soil and hence suitability of the soil for aquaculture.

Soil color is described by the parameters called hue, value and Chrome. It represents the dominant wave length or color of the light; value, refers to the lightness of the color; Chrome, relative purity or strength of the color. The color of the soil in terms of the above parameters could be quickly determined by comparison of the sample with a standard set of color chips mounted in a note-book called MUNSELL SOIL COLOUR CHARTS (Munsell Soil Color Charts, 1973). In these charts, the right hand top corner represents the Hue; the vertical axis, the value; and the horizontal axis, the Chroma.

- **Soil permeability:**

Is the ability of the soil to transmit water and air. An impermeable soil is good for aquaculture as the water loss through seepage or infiltration is low. As the soil layers or horizons vary in their characteristics, the permeability also differs from one layer to another. Pore size, texture, structure and the presence of impervious layers such as clay pan determines the permeability of a soil. Clayey soils with platy structures have very low permeability.

Permeability is measured in terms of permeability rate or coefficient of permeability (cm per hour, cm per day, cm per sec.).

Permeability rate or coefficient of permeability is determined in the laboratory by measuring the rate of flow of water from a constant head of water through a colomn of soil at specific moisture content and other conditions. It is determined in the field by digging a hole of approximately 30 cm diameter, smearing the sides of the hole with heavy wet clay or lining with plastic sheet and measuring the rate of infiltration of water by filling the hole repeatedly with water and noting the time it takes for the water level to go down by a specific depth.

Four easy tests that will help us to determine soil properties

- **Soil Test 1: The Squeeze Test**

One of the most basic characteristics of soil is its composition. In general, soils are classified as clay soils, sandy soils, or loamy soils. Clay is nutrient-rich, but slow draining. Sand is quick draining but has trouble retaining nutrients and moisture. Loam is generally considered to be ideal soil because it retains moisture and nutrients but doesn’t stay soggy.

To determine your soil type, take a handful of moist (but not wet) soil from your garden, and give it a firm squeeze. Then, open your hand. One of three things will happen:

It will hold its shape, and when you give it a light poke, it crumbles. Lucky you—this means you have luxurious loam!

It will hold its shape, and, when poked, sits stubbornly in your hand. This means you have clay soil.

It will fall apart as soon as you open your hand. This means you have sandy soil.

Now that you know what type of soil you have, you can work on improving it.

- **Soil Test 2: The Percolation Test**

It is also important to determine whether you have drainage problems or not. Some plants, such as certain culinary herbs, will eventually die if their roots stay too wet. To test your soil's drainage:

- Dig a hole about six inches wide and one foot deep.
- Fill the hole with water and let it drain completely.
- Fill it with water again.
- Keep track of how long it takes for the water to drain.
- If the water takes more than four hours to drain, you have poor drainage.

- **Soil Test 3: The Worm Test**

Worms are great indicators of the overall health of your soil, especially in terms of biological activity. If you have earthworms, chances are that you also have all of the beneficial microbes and bacteria that make for healthy soil and strong plants. To do the worm test:

Be sure the soil has warmed to at least 55 degrees, and that it is at least somewhat moist, but not soaking wet.

Dig a hole one foot across and one foot deep. Place the soil on a tarp or piece of cardboard.

Sift through the soil with your hands as you place it back into the hole, counting the earthworms as you go.

If you find at least ten worms, your soil is in pretty good shape. Less than that indicates that there may not be enough organic matter in your soil to support a healthy worm population, or that your soil is too acidic or alkaline.

- **Soil Test 4: Ph Test**

The Ph (acidity level) of your soil has a lot to do with how well your plants grow. Ph is tested on a scale of zero to 14, with zero being very acidic and 14 being very alkaline. Most plants grow best in soil with a fairly neutral Ph, between six and seven. When the Ph level is lower than five or higher than eight, plants just won't grow as well as they should.

Every home and garden center carries Ph test kits. These kits are fairly accurate, but you must make sure you follow the testing instructions precisely. Once you know whether your soil Ph is a problem or not, you can begin working to correct the problem.

If you find that you've done all of these tests, and amended the soil as needed to correct the issues, and your plants are still struggling along, the next step is to contact your local cooperative extension service. They will tell you how to go about collecting a soil sample and sending it into their lab for analysis. They will return a report that will alert you to any mineral deficiencies in your soil, as well as steps to correct the issues.

These tests are simple, inexpensive ways to ensure that your garden has the best foundation possible.

2.3. Testing soils for chemical properties.

- **What are the Soil Chemical Properties?**

I. Cation Exchange Capacity (CEC)

Some plant nutrients and metals exist as positively charged ions, or "cations", in the soil environment. Among the more common cations found in soils are hydrogen (H^+), aluminum (Al^{+3}), calcium (Ca^{+2}), magnesium (Mg^{+2}), and potassium (K^+). Most heavy metals also exist as cations in the soil environment. Clay and organic matter particles are predominantly negatively charged (anions), and have the ability to hold cations from being "leached" or washed away. The adsorbed cations are subject to replacement by other cations in a rapid, reversible process called "cation exchange".

Cations leaving the exchange sites enter the soil solution, where they can be taken up by plants, react with other soil constituents, or be carried away with drainage water.

The "cation exchange capacity", or "CEC", of a soil is a measurement of the magnitude of the negative charge per unit weight of soil, or the amount of cations a particular sample of soil can hold in an exchangeable form. The greater the clay and organic matter content, the greater the CEC should be, although different types of clay minerals and organic matter can vary in CEC.

Cation exchange is an important mechanism in soils for retaining and supplying plant nutrients, and for adsorbing contaminants. It plays an important role in wastewater treatment in soils. Sandy soils with a low CEC are generally unsuited for septic systems since they have little adsorptive ability and there is potential for groundwater

II. Soil Reaction (pH)

By definition, "pH" is a measure of the active hydrogen ion (H+) concentration. It is an indication of the acidity or alkalinity of a soil, and also known as "soil reaction".

The pH scale ranges from 0 to 14, with values below 7.0 acidic, and values above 7.0 alkaline. A pH value of 7 is considered neutral, where H+ and OH- are equal, both at a concentration of 10-7 moles/liter. A pH of 4.0 is ten times more acidic than a pH of 5.0.

The most important effect of pH in the soil is on ion solubility, which in turn affects microbial and plant growth. A pH range of 6.0 to 6.8 is ideal for most crops because it coincides with optimum solubility of the most important plant nutrients. Some minor elements (e.g., iron) and most heavy metals are more soluble at lower ph. This makes pH management important in controlling movement of heavy metals (and potential groundwater contamination) in soil.

In acid soils, hydrogen and aluminum are the dominant exchangeable cations. The latter is soluble under acid conditions, and its reactivity with water (hydrolysis) produces hydrogen ions. Calcium and magnesium are basic cations; as their amounts increase, the relative amount of acidic cations will decrease.

III. Salinity. Some soils, particularly in arid regions, hold high levels of salt. We discussed earlier how clay soils are more prone to salt buildup, and the same principle applies to arid-region soils. Low rainfall prevents leaching of salts, so they build up in soils. Pan layers, common in arid regions, further inhibit drainage and leaching. Some fertilizers and amendments also can increase salinity.

- **Factors that affect soil pH include**

Parent material, vegetation, and climate some rocks and sediments produce soils that are more acidic than others: quartz-rich sandstone is acidic; limestone is alkaline. Some types of vegetation, particularly conifers, produce organic acids, which can contribute to lower soil pH values. In humid areas such as the eastern US, soils tend to become more acidic over time because rainfall washes away basic cat ions and replaces them with hydrogen. Addition of certain fertilizers to soil can also produce hydrogen ions. Liming the soil adds calcium, which replaces exchangeable and solution H+ and raises soil pH.

Lime requirement, or the amount of liming material needed to raise the soil pH to a certain level, increases with CEC. To decrease the soil pH, sulfur can be added, which produces sulfuric acid.

2.4 Record and reporting results

- **Soil Test Results**

At the far left of the results section is a box labeled "Sample/Field Number" which contains the identifying name or number you attached to the sample on the Soil Sample Information Sheet when you sent it to the laboratory. If you send in more than one sample it is critically important that you give those names or numbers and maintain a list of the sample identifiers you attached to each field.

To the right of Sample/Field Number is "Estimated Soil Texture". Texture is determined by an experienced lab technician on the basis of how a moist soil sample feels when it is manipulated between the thumb and fingers.

The rest of the categories in the RESULTS section are the numerical measurements of laboratory analyses that were performed on your soil sample. The amount of soil organic matter is important, because it is one of the main factors determining nitrogen fertilizer recommendations. The higher the organic matter content, the lower the nitrogen fertilizer recommendation. This is because decomposition of organic matter and the associated release of plant-available nitrogen is a significant source of this nutrient for plants.

A soil test that is often confusing to people is the Buffer Index. The Buffer Index is used to determine how much lime is required when soil pH is too acid. The Buffer Index is only run if the pH of a mineral soil is less than 6.0. The box will be blank if the soil is organic or if the pH is 6.0 or higher. Soils differ in their buffering capacity, or ability to resist a change in pH, so soils with the same pH may need different amounts of lime to achieve a similar pH change. The pH measurement tells you whether you need to apply lime and the Buffer Index tells you how much lime will be required to accomplish the desired change in ph.

The numerical laboratory measurements are not very useful to many people, because unless you work with them a lot it is not clear what the numbers mean (except for pH). That is why the **interpretation** section comes first. Laboratory tests for the amounts of plant-available nutrients are indexes of relative availability, rather than absolute measurements of availability and different laboratory methods give results that have varying numerical scales. The INTERPRETATION section tells you whether the laboratory measurement is low or high in terms of the need for fertilizer application. If the soil test is low, it means that the crop is likely to respond positively to the addition of fertilizer. If the soil test is high, it means that additional fertilizer is much less likely to improve crop growth.

What do you do with the samples?

• Label the sample box or bag with your name, sample identification, and address. Fill in the

Field Soil

Submission Form as completely as possible. You must indicate the crop you intend to grow on the submission form. Laboratory Services needs this information to provide interpretation ratings, and lime and nutrient recommendations on the soil test report.

• Mail or take samples to the Laboratory Services in Truro or drop them off at regional

Agricultural Offices.

Ask Laboratory Services for the S1, Standard Soil Package, unless you want additional tests run.

• The standard soil package required is called S1. You can request additional tests such as nitrogen and soil conductivity. Review the fee schedule for additional tests and pricing.

Soil test reporting procedures

Collect and organize the materials the required materials. Review and confirm the accuracy of sampling information using the soil test report.

- Name
- Field identification name/number
- Date sampled
- Crop
- Soil depth sampled
- Soil textural classification
- Soil pH
- Organic matter
- Excess carbonates/lime
- CEC
- Buffer pH
- Soluble salts.

Transcribe tested nutrient levels and ratios from the lab report to the nutrient budgeting worksheets.

Soil investigation is required for the following purposes

- To know the allowable bearing capacity soil for the required purpose.
- To know the depth and type of foundation for the required purpose.
- To know the allowable passive resistance for the required purpose.
- To know the type, grading and nature of soil.
- To know the ground water level.

Methods of soil investigation

The common methods of soil investigation are –

- Inspection
- Test pits
- Probing, and
- Boring.

Inspection: In some places you don't have to investigate much. You'll get enough data to design the foundation of the proposed building by just inspecting the plot. This method of soil investigation includes know the geological condition of the plot, getting data about neighbor buildings, their foundation type and depth, etc.

Test pits: This is done to collect soil samples for detail analysis. In this method several pits are dug by hand or excavator. The depth of pit is below 5 feet so that one can have visual inspection. Several samples are collected from the pit of both disturbed and undisturbed soil.

Probing: In this method a 25 mm or 40 mm diameter steel bar is driven into the ground till solid soil strata is found. It is normally driven by hammer. The penetration and withdrawal of the steel rod is closely observed to know the nature of soil layer.

Boring: In this method several bore holes are made for the purpose of collecting soil sample from below the ground. Then the collected sample is analyzed for preparing the soil report.

Typical steps of soil investigation

- Soil investigation involves following steps .
- Details planning for the sequence of operations.
- Collecting the samples of soil from the plot.
- Determining the soil characteristics by conducting field tests.
- Study the condition of ground water level.
- Collecting ground water sample for chemical analysis.
- Soil exploration.
- Testing all collected samples in the laboratory.
- Analysis the test results.
- Preparing report.

Self-Check 2	Written Test

Name: ___________________________ Date: ________________

Directions: Answer all the questions listed below.

1. Briefly explain the way how we can determine the soil profile, development procedures and soil horizon. (10 pts)
2. What is the soil physical and chemical properties mean and explain the ways how we can test them. (5pts)
3. What are the main soil investigation procedures, briefly explain each of them. (5pts)

Note: Satisfactory rating - 10 points and above Unsatisfactory - below 10 points

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

Operation sheet 2	Perform basic soil tests

Perform basic soil tests

Purpose: - Most soil nutrients are readily found in the soil provided that its pH level is within the 6 to 6.5 range. However, when the pH level rises, many nutrients (like phosphorus, iron, etc.) may become less available. When it drops, they may even reach toxic levels, which can adversely affect the plants. Getting a soil test can help take the guesswork out of fixing any of these nutrient issues. There’s no need to spend money on fertilizers that aren’t necessary. There’s no worry of over fertilizing plants either. With a soil test, you’ll have the means for creating a healthy soil environment that will lead to maximum plant growth.

Equipment, Tools and Materials:

Spades, augers, core sampler soil sample storing and recording materials, field test kits, and interpreting charts

Conditions:

Soil samples can be taken at any time of the year, with fall being preferable. They are normally taken annually or simply as needed. While many companies or gardening centers offer soil testing kits, you can usually obtain a soil test for free or low cost through your local county extension office. Avoid having the soil tested whenever the soil is wet or when it's been recently fertilized. To take a sample for testing garden soil, use a small trowel to take thin slices of soil from various areas of the garden (about a cup's worth each). Allow it to air dry at room temperature and then place it into a clean plastic container or Ziploc baggie. Label the soil area and date for testing.

Procedure:

- Taking soil sample from the field.
  - When walking through the field takes subsamples that represent the entire field.
  - Divide the fields into a number of different plots.
  - Determine the number of sample per plot.
  - Determine sampling purpose and the depth.
  - Prepare all necessary materials and equipment as necessary
  - Remove upper pars of soil, grass and any unnecessary things.
  - Clean the area and make suitable for activity.
  - Take soil samples by using auger
  - Hold by clean, residue-free plastic pail
  - Put in to laboratory for testing activity of PH value of soil, alkalinity, acidity and neutrality of soil and Nutrient content of soil/primary, secondary and tertiary nutrients
- Take soil randomly from the field area
  - Crash with pistil or mortar
  - Mix it with water

- Take same part and make ball in your hand

➢ Procedure to estimate soil texture in field by Feel method.

- the soil is moistened with water
- Rubbed between the thumb and fingers.
- The way the wet soil "slicks out" gives a good idea of the clay content.
- The sand particles are gritty,
- the silt has a floury or talcum - powder fell when dry and
- Moderately plastic and sticky when wet. Accuracy of this method depends largely on experience.

➢ Procedure to estimate soil texture in field by Ball and ribbon method:

- Take a handful of soil and wet it
- That it begins to stick together without sticking to the hand.
- A ball of about 3 cm diameter is made and put down.
- If it falls apart it is sand.
- If it sticks together roll the ball into a sausage shape 6 – 7 cm long.
- If it does not remain in this form it is loamy sand.
- If it remains in this shape, continue to roll until it reaches 15 – 16 cm long.
- If it does not remain in this form, it is sandy loam. If it remains in this shape, try to bend the sausage into a half circle and if it doesn't, it is a loam.
- If it does, bend the sausage to form a full circle and if it doesn't it is heavy loam. If it does with slight cracks in the sausage, it is light clay.
- If it does without any cracks, it is clay.

➢ Procedure to estimate soil texture in field by Ball throwing method:

The texture of the soil can be inferred by the way a ball of soil acts when it is thrown at a hard surface such as a wall or a tree:

- Throw a ball of soil to a tree or wall 3 m away.

- If the soil is good only for splatter shots when either wet or dry, it has a coarse texture (loamy sand).
- If there is a "shot gun" pattern when dry and it holds its shape against medium range target when wet, it has a moderately coarse texture (sandy loam).
- If the ball shatters on impact when dry and clings together when moist but does not stick to the target it has a medium texture (loam, sandy clay loam, silty clay loam).
- If the ball holds its shape for long - range shots when wet and sticks to the target but is fairly easy to remove it has a moderately fine texture (clay loam). If the ball sticks well to the target when wet and becomes a very hard missile when dry, it has a fine texture (clay).

Quality Criteria:

At the completion of the soil test, should inspect for leaks in irrigation pipes and connections ensure that all emitters are operating at their proper flow rate, and ensure all trenches have been properly covered. The backflow preventer should be tested by a certified tester. Backflow preventer testing is mandatory for commercial installations.

LAP Test/ Job Sheet	**Practical Demonstration**

Name: ______________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions:

You are required to perform the following:

Request a set of different activities in performing basic soil test and then perform the following task in front of your trainer:

- Identify and prepare appropriate sampling tools
- Perform soil test analysis

REFERENCES

1. https://www.gardeningknowhow.com/garden-how-to/soil-fertilizers/testing-soil.htm
2. Munsell soil colour charts (munsell soil color charts, 1973).
3. https://us.search.yahoo.com/yhs/search?hspart=elm&hsimp