

SMACO AGRICULTURE DEPARTMENT

(S.1 term 1&2 notes in line with the new curriculum)

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QUOTE₁: Behind Every Success there is Effort.

AGRICULTURE / FARMING.

- ❖ This is the science and art of growing crops and rearing of animals.
- ❖ This is the growing of crops and rearing of animals

WHY IS AGRICULTURE A SCIENCE?

It is a science because it involves the following:

- ❖ **Biology:** for crops to grow and produce yields, biology is involved e.g. germination, pollination, photosynthesis, transpiration etc.
- ❖ **Mathematics:** e.g. spacing of crops when planting, measuring materials to use when constructing buildings, keeping farm records requires mathematics.
- ❖ **Physics:** construction of buildings, repair of machines etc requires physics
- ❖ **Chemistry:** preparation of chemicals, drugs, fertilizers requires knowledge of chemistry.

WHY IS AGRICULTURE AN ART?

- ❖ It is an art because it requires skills to operate machines, tools, construct buildings etc

BRANCHES OF AGRICULTURE

There are five branches of agriculture

- ❖ Soil science
- ❖ Animal science
- ❖ Crop husbandry
- ❖ Agriculture economics
- ❖ Agricultural mechanization

SOIL SCIENCE:

- ❖ This is a branch that deals with soil formation, soil and water conservation, soil physical and chemical properties, soil fertility etc

ANIMAL HUSBANDRY:

- ❖ This is a branch that deals with livestock keeping, management, breeding, feeding, livestock products, diseases and parasite control.

CROP HUSBANDRY:

- ❖ This is the branch that deals with crop growing i.e. Land preparation, planting, weeding, harvesting pest, disease control and pasture agronomy.

AGRICULTURE ECONOMICS:

- ❖ This branch covers farm accounting, budgeting, processing, marketing etc

AGRICULTURE MECHANIZATION:

- ❖ This branch is concerned with construction of farm structures, farm buildings, farm machines and their repair etc

QUOTE₂: Bad Attitude is like a flat tyre you cannot reach anywhere unless you change it.

IMPORTANCE OF AGRICULTURE TO MAN AND THE COUNTRY.

- ❖ It is a source of income
- ❖ It is a source of employment
- ❖ It is a source of food and beverages
- ❖ It is a source of revenue to the country
- ❖ It is a source of fuel in form of fire wood, bio-gas etc
- ❖ It is a source of manure
- ❖ It is a source of herbal medicine
- ❖ It is a source of foreign exchange
- ❖ It is a source of labour
- ❖ Etc

PROBLEMS FACING AGRICULTURE

- ❖ Lack of capital to buy good animals and better crop varieties
- ❖ Lack of good transport to transport goods to the market
- ❖ Poor storage facilities like granaries
- ❖ Shortage of land as many farmers have small pieces of land
- ❖ Diseases that attack crops and animals leading to losses
- ❖ Pests/parasites which attack crops and animals leading to losses
- ❖ Price fluctuation leading to exploitation by the middlemen
- ❖ Poor rainfall distribution leading to drought, landslides and floods
- ❖ Labour shortage due to migration to urban centers
- ❖ Bad attitude towards agriculture as many people regard agriculture as dirty job

❖ etc

SOLUTIONS TO THE PROBLEMS

- ❖ Getting loans from banks
- ❖ Construction of good roads to ease transportation of goods
- ❖ Construction of valley dams to harvest rain water
- ❖ Construction of better storage facilities to reduce wastage of produce
- ❖ The government should ensure good security in all parts in the country
- ❖ Extending good social services in rural areas
- ❖ The government should set up fixed prices
- ❖ By treating animals against diseases
- ❖ Formation of cooperatives to overcome the problem
- ❖ etc

QUOTE3: If you want to fly, give up everything that weighs you down

LOCAL FARMING SYSTEM

In Uganda, the following farming systems are recognized e.g.

- ❖ Banana – Robusta coffee system
- ❖ Banana- millet cotton system
- ❖ Montane system
- ❖ Pastoral system
- ❖ West Nile system
- ❖ Teso system

- ❖ Northern system

CHARACTERISTICS OF EACH LOCAL FARMING SYSTEM

TESO SYSTEM

- ❖ It is common in the districts of Kumi and Bukenda.
- ❖ It is characterized by use of ox – drawn equipment like ox – ploughs.
- ❖ The area has light soils sparse vegetation which has encouraged the use of ox – culture.
- ❖ The main cash crop grown is cotton while other crops are finger millet, peas, sweet potatoes and sorghum.
- ❖ Intercropping is a common practice in this area.

BANANA AND ROBUSTA COFFEE SYSTEM

- ❖ This is practiced in the most fertile places in Uganda around Lake Victoria.
- ❖ It covers the districts of Mubende, Masindi, Wakiso, Jinja and some parts of Iganga, Luwero and Kamuli.
- ❖ The area receives two seasons of rainfall.
- ❖ The main cash crop grown is coffee (Robusta). The common food crops are bananas, sweet potatoes, maize and vegetables, sugarcane and tea are grown at estates found in Lugazi and Kakira.
- ❖ A few animals are kept and ox – ploughing is not common.

BANANA MILLET AND COTTON SYSTEM

- ❖ It is common in the district of Tororo, Namutumba, Budaka, Kamuli, Kaliro Nakasongola, Kayunga and parts of Masindi and Kilyandongo.
- ❖ Most of these areas have long period of rainfall which begins from April to November

- ❖ The main cash crop grown here has been cotton through Robusta coffee is also grown and some areas that have two seasons of rainfall.
- ❖ The food crops grown are sweet potatoes, cassava, Maize beans ground nuts and Banana.
- ❖ Ox – ploughing is done in some areas since they have light soils.

NORTHERN SYSTEM

- ❖ This system is practiced in districts of Pakwachi, Gulu, Kitgum, Pader.
- ❖ The major cash crops are cotton, tobacco, sorghum figure millet pigeon peas, simsim, Cassava, sun flower and Ground nuts.
- ❖ Intercropping is common while the use of ox-ploughing becomes less common as you move further in North.
- ❖ The area receives one long seasons of rainfall from April to October.

THE WEST NILE SYSTEM

- ❖ This system covers the district of Arua, Koboko, Moyo, Adjumani.
- ❖ The major cash crop in this area is cotton and tobacco though Arabica coffee is grown at a high altitude.
- ❖ The food crops are finger millet, sorghum, millet, cassava and peas.

MONTANE SYSTEM

- ❖ It is practiced around the mountain ranges of Kigezi, Rwenzori and Elgon.
- ❖ The system is similar to the banana, Robusta coffee system but it is modified by relief and population density.
- ❖ The main cash crop from the area is Arabica coffee and tea.
- ❖ The food crops are Bananas, Irish potatoes, Ground nuts, yams, beans, Sweet potatoes, maize etc.
- ❖ Vegetables and fruit like passion fruit are grown for commercial purposes.

PASTORAL SYSTEM

- ❖ It is practiced by the pastoral tribes of Uganda, i.e. Bahima and Karamajong, Ankole and Bahima.
- ❖ They often live a nomadic way of life, moving from place to place with their animals.
- ❖ They grow drought resistant crops like sorghum, bulrush millet, Ground nut and maize.

Sketch map of Uganda showing the areas occupied by the different local farming system.

AGRICULTURE / FARMING SYSTEMS

QUOTE: success comes to those who are prepared to receive it.

SUBSISTENCE FARMING:

- ❖ This is a system of farming where crops are grown and animals are kept to produce food for home consumption. The surplus if any is either stored for future use or sold to earn income.

Characteristics of subsistence farming

- ❖ Small plots of land are used for production process
- ❖ Use of simple tools like hoes, pangas, knives etc.

- ❖ Labour is provided by family members
- ❖ It produces food for home consumption
- ❖ Surplus is sold to meet family demand
- ❖ Intercropping is common
- ❖ Standard of living is low
- ❖ Production is low
- ❖ Land fragmentation is common

Advantages of subsistence farming

- ❖ Requires little capital to start
- ❖ Requires less labour
- ❖ A farmer gets a balanced diet
- ❖ Intercropping maintains soil fertility
- ❖ The farmer is assured of what to use
- ❖ etc

Disadvantages of subsistence farming

- ❖ Low yields are obtained
- ❖ Low income is realized / obtained
- ❖ Standard of living is low
- ❖ Land fragmentation makes work difficult

- ❖ Some time poor quality products are obtained
- ❖ Famine is usually common in case of crop failure
- ❖ etc

MIXED FARMING / DIVERSIFICATION:

- ❖ Mixed farming is a system of farming where crops are grown and animals are kept on the same piece of land at the same time and benefit from each other.

ADVANTAGES OF DIVERSIFICATION

- ❖ Animal wastes are used as manure which improve soil fertility
- ❖ High income is obtained
- ❖ In case one enterprise fail, the farmer gets money from the other
- ❖ Crop remains are used as animal feeds
- ❖ There is balanced diet
- ❖ There is full utilization of labour
- ❖ There is full utilization of land
- ❖ Oxen is used in the ploughing of land
- ❖ etc

Disadvantages

- ❖ Requires a lot of labour
- ❖ Requires a lot of capital
- ❖ Requires a high level of management
- ❖ Etc

INTERCROPPING:

- ❖ This is the system of farming where more than one crop is planted on the same piece of land at the same time. The crop intercropped can be annual e.g. maize and beans or perennial e.g. coffee and bananas, coffee and vanilla or perennial and annuals e.g. banana and beans.

Advantages

- ❖ A farmer gets a balanced diet
- ❖ Interplanting maintains soil fertility
- ❖ Controls soil erosion as the soil surface is covered by crops
- ❖ Since crops mature at different times, famine is not common
- ❖ Total yield per unit area is higher since the farmer gets more than one product
- ❖ Total failure of product is not common as the farmer can get money from other product
- ❖ Etc

Disadvantages:

- ❖ Operations like weeding and spraying becomes difficult
- ❖ There is competition for nutrients/ growth requirement leading to low yields
- ❖ Pest and disease control is difficult
- ❖ etc

SHIFTING CULTIVATION:

- ❖ This is where a farmer clears land uses it until it loses fertility then she/he moves to fresh place

Characteristics of shifting cultivation

- ❖ Land is cleared by cutting and burning vegetation.
- ❖ It is practiced in areas with low human population
- ❖ Simple tools are used
- ❖ Small areas are cleared
- ❖ Intercropping is common
- ❖ Little attention is given to the crops
- ❖ Crops are mainly grown for home consumption.

Merits of shifting cultivation

- ❖ It uses simple tools therefore it is cheap to maintain.
- ❖ The use of fire makes clearance of land easy
- ❖ Bush burning adds more minerals to the soil.
- ❖ Intercropping guards against crop failure.
- ❖ It is easy to control pests and diseases since the farmers can move to a fresh place.
- ❖ Crop yields are usually high due to use of fresh land.
- ❖ There is less weeding as the fire used can burn weed seeds.
- ❖ etc

Demerits of shifting cultivation

- ❖ Bush burning leads to the destruction of soil living organisms.
- ❖ It can only be practiced in areas with low population.
- ❖ It cannot provide enough food for a big population.
- ❖ It may leave the land bare and exhausted which exposes it to erosion.
- ❖ It leads to massive destruction of forests.
- ❖ etc

NOMADISM AND NOMADIC PASTORALIST:

Nomadism: Means moving from one place to another.

While,

Nomadic Pastoralist

- ❖ Is the practice of rearing of cattle while moving from one place to another in search for water and pastures for the animals.

Characteristics of nomadic Pastoralist

- ❖ They keep very large number of animals.
- ❖ There is movement from place to place.
- ❖ There's growing of few annual crops on a small scale.
- ❖ Animals kept are of poor breeds.
- ❖ Poor animal husbandry practices are carried out.
- ❖ Over grazing is common which leads to soil erosion.
- ❖ Animals depend on natural pastures.
- ❖ Animals are grazed on land owned by the community.
- ❖ The practice is mainly carried out in the arid and semi-arid areas.
- ❖ etc

Problems faced by pastoral nomadism in Uganda

- ❖ Poor weather leading to drought.
- ❖ Walking long distances
- ❖ Lack of pasture for the animals
- ❖ Poor breeds of animals kept
- ❖ Cattle rustling which leads to death
- ❖ Parasites which attack animal leading to poor breeds.
- ❖ Pastoralists may be attacked by tropical diseases which lead to death.
- ❖ Conservatism.
- ❖ Poor veterinary services

- ❖ Poor housing of animal
- ❖ Shortage of land
- ❖ Lack of water for the animals
- ❖ etc

CROP ROTATION.

- ❖ Is the growing of different crops on the same piece of land in a particular sequence season after season for proper utilization of nutrients.

Benefits of crop rotation in crop production.

- ❖ Improves soil fertility / improves nitrogen content of soil
- ❖ Labour is utilized throughout the year
- ❖ Checks soil erosion by providing vegetative cover
- ❖ Controls pests by breaking their life cycle
- ❖ Controls diseases by breaking their life cycles
- ❖ Improves on soil structure
- ❖ Reduces farming costs since there is no use of fertilizers /manures
- ❖ Helps in recycling of nutrients /nutrient pumping
- ❖ Ensures efficient use of nutrients from different levels of soil
- ❖ etc

Factors to consider when planning a good rotation program.

- ❖ Deep rooted crops should be alternated with shallow rooted crops in order to draw nutrients from different levels of soil
- ❖ Crops of the same family shouldn't follow one another because they require similar nutrients
- ❖ Legumes should be included in the rotation to increase fertility of the soil
- ❖ Crops with similar pests should not follow one another to break their lifecycle
- ❖ Land should be left to fallow in order to regulate its fertility

- ❖ Crops with similar diseases should not follow one another to break their lifecycle
- ❖ Crops with leaves that expose the soil should be alternated with cover crops to control soil erosion
- ❖ Crops that is easy to weed should alternate those which are easy to weed
- ❖ Heavy feeders should be planted first in the rotation because they have a high demand for nutrients
- ❖ etc

SOIL SCIENCE (PEDOLOGY).

QUOTE: *positive thinking will make you do everything better than negative thinking will.*

Qtn. What is soil?

- ❖ Soil is the top most layer of the earth's surface that support plants and animal life
- ❖ Soil is a mixture of weathered rocks, water, air, organic matter and living organisms.
- ❖ Soil is a product of the breakdown of rocks and decomposition of organic matter (plants and animal remains)

FUNCTION OF SOIL.

- ❖ It provide anchorage /support to the plants
- ❖ Soil provide home of soil living organisms
- ❖ Soil provides nutrients to plants
- ❖ Soil provide water which dissolves plant nutrients
- ❖ etc

COMPONENTS OF SOIL :

- ❖ The four major ingredients of soil are **minerals, organic matter, air and water.**
- ❖ Mineral and organic matter is the solid particles in the soil. While water and air fill up the spaces between the particles. In the soil you also find living organisms; some are very tinny to be seen with our naked eyes. While other organisms are big like moles, millipedes and centipedes

COMPOSITION OF AVERAGE SOIL:

- ❖ Air = 25%
- ❖ Water = 25%
- ❖ Mineral matter = 45%
- ❖ Organic matter = 5%

Draw a circle showing those percentage compositions of soil

AIR (25%)

- ❖ Air is found between the spaces left between organic particles. The spaces are known as **PORE / AIR SPACES**.
- ❖ During dry season more air is found in the pore spaces and during rainy season, the pore spaces are filled with water.

IMPORTANCE OF SOIL AIR

- ❖ Air is needed for seed germination
- ❖ Air is needed for root respiration
- ❖ Air is responsible for living organisms
- ❖ Air is needed during the process of decaying
- ❖ Etc

Factors that influence the amount of air present in the soil.

- ❖ Amount of water in the soil; water logged soil contains less air
- ❖ Soil structure; granular structured soil contains more air than platy structured soil
- ❖ Soil texture; coarse textured soil contains more air

- ❖ Depth of the soil; as one goes deep into the soil the amount of air present reduces
- ❖ Organic matter content of the soil; organic matter holds particles together creating pores that are occupied by air
- ❖ Activities of burrowing animals; they make tunnels that are occupied by air
- ❖ Addition of lime to the soil. Lime binds soil particles together creating pores which are occupied by air

SOIL WATER: (25%)

- ❖ Water is found as a thin film which is strongly held by the force of capillarity on to the soil particles.
- ❖ The water molecules are held onto the inorganic particles by the force of capillarity.

IMPORTANCE OF SOIL WATER

- ❖ It is used in the process of germination
- ❖ It is important in the process of transpiration
- ❖ It is used as a raw material for photosynthesis
- ❖ It is a solvent and dissolve plant nutrients
- ❖ Prevents wilting by keeping the cells turgid
- ❖ Etc.

TYPES OF SOIL WATER.

There are three types of soil water e.g.

- ❖ Capillary water
- ❖ Hygroscopic water

- ❖ Gravitational water

Capillary water:

- ❖ This is the type of water which is held on to the soil particles by capillary.
- ❖ This water is readily available for plant use

Hygroscopic water:

- ❖ This is the type of water which is strongly held by the force of capillarity on to the soil particles. It is not available for plant use.

Gravitational water:

- ❖ This is water which drains out of the soil and is not available for plant roots. It drains out of the soil to deeper layers by the force of gravity.

FARMING PRACTICES FARMERS CAN USE TO RETAIN WATER IN THEIR GARDENS

How farmers can conserve moisture in the soil

- ❖ Mulching; Mulches allow water infiltration but reduce solar heat that reaches the soil thereby reducing evaporation
- ❖ Adding organic matter to the soil; Organic matter increases the soil water holding capacity
- ❖ Minimum tillage; It reduces evaporation since the soil is not frequently opened
- ❖ Deep cultivation; it breaks the hard pan and increases water infiltration
- ❖ Planting of cover crops; they adequately cover the soil and prevent evaporation
- ❖ Irrigation as it adds more water in the soil

AN EXPERIMENT TO DETERMINE RETENTION

- ❖ Assemble materials to use
- ❖ Weigh a known amount of dry soil sample
- ❖ Put filter paper/cotton wool in the funnel
- ❖ Put the filter paper in the funnel and place it on the beaker
- ❖ Put the soil sample in the funnel
- ❖ Measure the required volume of water and pour it in the funnel
- ❖ Allow the set up to stand until the water has stopped dripping
- ❖ Get the filtrate and record the volume
- ❖ Subtract the filtrate from the original volume of water used
- ❖ Calculate the percentage.

FACTORS THAT DETERMINE THE AMOUNT OF WATER IN THE SOIL

- ❖ Soil structure, soil with good particle arrangement holds and retains more water.
- ❖ Type of soil, clay soils hold more water than the sand soil because of the small sizes of the soil particles.
- ❖ Amount of organic matter; a high level of organic matter improves on the rate of water retention.
- ❖ Soil depth, Drainage and irrigation
- ❖ Farming practices like mulching, minimum tillage helps to improve the water retention.
- ❖ Amount of rainfall received.

ORGANIC MATTER: (5%)

- ❖ This is the decayed plant and animal remains found in the soil.
- ❖ Organic matter is one of the major source of plant nutrients

IMPORTANCE OF ORGANIC MATTER.

- ❖ It gives the soil its dark colour
- ❖ Organic matter controls the temperature of the soil
- ❖ Organic matter improves the water holding capacity since it is spongy
- ❖ Provides the soil with nutrient / improves soil fertility
- ❖ Provides food to the soil living organisms
- ❖ Improves on the soil ph
- ❖ Improves on the soil structure by binding the particles together
- ❖ Etc.

INORGANIC MATTER / MINERAL MATTER (45%)

- ❖ Mineral matter is the largest component of soil particle. Rocks provide soil with mineral matter. There are three different types of rocks. The first type is called **igneous**. Igneous rocks are composed of melted rock that hardens and cools. A few examples include **obsidian** and **pumice**.
- ❖ The second type is called **sedimentary**, and they are formed from materials that settle into layers. The layers are squeezed until they harden into rock. A few examples include **limestone** and **sandstone**.
- ❖ The third type of rock is called **metamorphic**. These are changed by heat and pressure. A few examples include **slate** and **marble**.
- ❖ These particles come together to form a skeleton which gives support to the plant (anchorage)
- ❖ The inorganic particles are the major sources of plant nutrients

- ❖ The nutrients are absorbed from the soil in a solution form through the root hairs
- ❖ The plant nutrients are divided into two major groups i.e.
- ❖ **Macro nutrients:** these are plant nutrients needed in large amount for proper plant growth. Lack of them results into deficiency symptoms. E.g.
 - ✓ Oxygen
 - ✓ Hydrogen
 - ✓ Carbon
 - ✓ Nitrogen
 - ✓ Phosphorus
 - ✓ Potassium
 - ✓ Magnesium
 - ✓ Calcium
 - ✓ Sulphur
- ❖ **Micro nutrients:** these are nutrients needed by plants in small amount and plants can do or grow without them e.g.
 - ✓ Iron
 - ✓ Zinc
 - ✓ Copper
 - ✓ Chlorine
 - ✓ Manganese
 - ✓ Cobalt
 - ✓ Boron

Importance of soil inorganic matter

- ❖ It supplies nutrients to plants
- ❖ It offers anchorage to plants

- ❖ Makes the frame work of the soil
- ❖ Offers a surface on to which water is held

SOIL LIVING ORGANISMS:

- ❖ Living organisms in the soil are grouped into two i.e.
 - i). plant kingdom (flora)
 - ii). those that belong to the animal kingdom (fauna)
- ❖ Some can be seen with a naked eye i.e. macro e.g. termites, earthworms, snails, cricket centipedes and moles and millipedes. And others cannot be seen with a naked eye e.g. bacteria, virus, protozoa and fungi

IMPORTANCE OF LIVING ORGANISMS IN THE SOIL.

- ❖ Living organism's break down plants and animal remains to form organic matter
- ❖ Living organisms like nitrogen fixing bacteria (Rhizobium) they fix nitrogen in the soil
- ❖ When they die, decay to form organic matter
- ❖ They make tunnels in the soil e.g. termites hence improving aeration
- ❖ Etc.

HARMFUL EFFECT OF LIVING ORGANISMS

- ❖ They are responsible for a number of plant diseases
- ❖ They eat plant roots leading to wilting and death
- ❖ They eat crop produce lowering their quality
- ❖ Denitrifying bacteria change nitrates into gaseous form which escape to the atmosphere
- ❖ Etc.

FACTORS THAT INFLUENCE THE ABUNDANCE AND ACTIVITY OF SOIL LIVING ORGANISMS

- ❖ Soil pH: pH between 6 and 8 is the most suitable for living organisms
- ❖ Level of soil organic matter: High level of organic matter increases the number and activity of living organisms
- ❖ Soil temperature: temperature range of 20 to 40 degrees Celsius is favorable for most organisms
- ❖ Moisture content of the soil: Adequate moisture content favors a large number and high activity of soil living organisms
- ❖ Soil aeration: A high supply of oxygen favors a large number and high activity of soil living organisms
- ❖ Frequency of tillage. Maximum tillage reduces the number and activity of living organisms
- ❖ Competition between organisms: Some organisms produce chemicals that kill others e.g. fungi produce antibiotics that kill bacteria
- ❖ Level of soil pollution. Over use of agrochemicals reduces the number and activity of soil living organisms
- ❖ Depth of the soil. Deeper soils hold more living organisms as compared to shallow soil
- ❖ Type of crops grown. Legumes increase the population of nitrogen fixing bacteria while algae are common in rice fields
- ❖ Type of vegetation in the area: Forested areas support a large number and activity of soil living organisms
- ❖ Introduction by man: Man increases the population of soil living organisms through practices such as seed inoculation and application of organic matter

WAYS OF MAINTAINING OPTIMUM LEVEL OF SOIL ORGANISMS

- ❖ Application of organic manure in the soil; organic matter acts as food to the soil living organisms
- ❖ Proper draining of the soil to improve soil temperature and aeration
- ❖ Liming of the soil to improve the levels of cations in the soil
- ❖ Mulching to prevent rapid temperature fluctuations in the soil
- ❖ Growing cover crops that cover the soil and prevent it from being over heated
- ❖ Proper use of agriculture chemical and proper waste disposal
- ❖ Minimum tillage to prevent disturbance of the biosphere
- ❖ Irrigation during the dry periods to keep the soil moist'
- ❖ Seed/ soil inoculation to increase the level of rhizobia in the soil
- ❖ Crop rotation to increase biodiversity and the level of organic matter in the soil
- ❖ Fallowing to minimize disturbance of the soil and to increase the level of organic matter

EXPERIMENT TO DETERMINE THE PERCENTAGE OF INORGANIC PARTICLES IN THE SOIL.

- ❖ You must have the following apparatus / material; water, measuring cylinder, and dry lamp of soil.

Procedure:

- ❖ Get a measuring cylinder
- ❖ Put water in a measuring cylinder in a certain level
- ❖ Get a sample of dry garden soil
- ❖ Draw the sample in the cylinder containing water

- ❖ Shake vigorously / stir the components and leave it to settle over night.

Observation:

- ❖ On dropping the soil sample into the cylinder, air bubbles are seen on dropping the sample in the cylinder. The level of water decreased after shaking vigorously to stand, humus is seen floating on the surface.

Diagram of setup:

Conclusion:

- ❖ After staying overnight, sedimentation takes place
- ❖ After overnight, coarse sand settles down, followed by fine sand, silt and clay particles on suspension
- ❖ Humus remain floating on the surface

SOIL FORMATION:

Quote: Success is a public celebration and failure is a personal funeral.

- ❖ Soil formation or pedogenesis, is the combined effect of human impact on environment, physical, chemical and biological process working on soil parent material.

The first process in soil formation is called **weathering**.

WEATHERING

- ❖ Weathering is the breaking or splitting down of rocks into smaller particles to form soil.
- ❖ The weathered rocks or rock particles combine with organic matter and animal remains to form soil.

TYPES OF WEATHERING:

Weathering is of three types i.e.

- ❖ Chemical weathering
- ❖ Physical weathering
- ❖ Biological weathering

PHYSICAL WEATHERING

- ❖ This is the splitting of rocks into small particles without any change in chemical composition. The agents of physical weathering are:
- ❖ **Force of running water:** when water is fast flowing in a river or stream, it carries along with it any small rocks, stones, boulder and other particles. As these materials move they knock each other and keep breaking. The small particles that break off form part of soil.
- ❖ **Glaciations:** rocks are split by the movement of huge blocks of ice ending up knocking each other and breakdown into small particles known as soil.
- ❖ **Wind:** when strong wind blows small particles they knock each other and split further into small particles.
- ❖ **Freezing of water:** when rain water collects in cracks in rocks. When it becomes very cold, this water freezes and expands. This forces the cracks to widen, making the rock to break.
- ❖ **Temperature:** when rocks expand during day, at night they contract due to drop in temperature. As a result, cracks are formed and rock particles break off forming soil.

CHEMICAL WEATHERING

- ❖ This involves a change in the chemical composition of the original rock. The processes involved are;
- ❖ **Solution:** when water dissolves any soluble minerals found in rocks, this weakens the structure and changes the form of the resulting rock. Thus the rock will easily crumble.
- ❖ **Hydrolysis:** when weak acids react with minerals found in rocks they form new substances that dissolve out and this weakens the structure of rocks. Examples of weak acids are sulphur dioxide and nitric acid.
- ❖ **Oxidation:** when oxygen from air reacts with minerals like iron and aluminium – containing rocks new compounds are formed. These weaken the structure of rocks.
- ❖ **Carbonation:** when carbon dioxide reacts with metals found in rocks to form carbonates, it weakens the structure of rock

BIOLOGICAL WEATHERING

- ❖ This involves living things (plants and animals) and include the following;
- ❖ When heavy animals move over rocks will set up vibrations that weaken the structure of rocks
- ❖ The activities of human beings like stone quarrying, mineral extraction lead to rocks being broken down into small particles
- ❖ Expansion of plant roots: when roots expand as they grow, they exert force on to the rocks which break down.
- ❖ When plants and animals die they decompose / decay into organic matter and humus, these are components of soil and contains plant nutrients.
- ❖ The activities of burrowing animals like moles and squirrel mix rock particles with organic matter

- ❖ The activities of animals with sharp hooves on rock surface will cause crumbling of rocks.

FACTORS INFLUENCING SOIL FORMATION

Quote: Do not be afraid of being different, but be afraid of being the same as everyone else.

They include the following;

- ❖ Climate
- ❖ Parent rock material
- ❖ Living organisms
- ❖ Topography/ relief
- ❖ Time

Parent materials:

- ❖ This is the material from which soil develops. These materials include rocks, stones, in some places peat, and specific materials. Peat is the decaying plant matter found in a very wet place.

Climate:

- ❖ The action of wind, temperature and rainfall of an area affects the weathering process and the movement of rock particles.
- ❖ Strong winds can move large quantities of particles from one area to another
- ❖ Heavy rain fall a round streams and rivers fill up or swells up then carry particles too far away distance.

Living organisms:

- ❖ These include vegetative cover and living organisms. These break down the rocks by physical and chemical means.
- ❖ Plants shed of leaves which decay to form organic matter. Plant roots grow and increase in size which put pressure on the rocks leading to breakdown
- ❖ Micro organisms decompose plant and animal remains in to organic matter which is added to the soil
- ❖ Earth worms and termites feed on animal and plant remains and mix the remains into the soil.

Topography / relief.

- ❖ Hilly areas / mountainous areas, there is severe erosion as a result soil formed is washed away and usually the soil is shallow and not very fertile.
- ❖ In low lying areas / flat areas soils which are formed are deep and fertile.
- ❖ In swampy areas the type of soil found there is a clay and sand soil. Usually swamps are water logged.

Time:

- ❖ The longer the rocks are exposed to the type of weathering process the deeper the soil is formed.

Soil profile:

- ❖ This is the vertical section of the soil through all its horizons/layers and down to the parent material

WELL LABELED DRAWING OF A MATURE SOIL PROFILE

Top soil /A horizon

- ❖ It's darker in colour because of high organic matter accumulation
- ❖ It's an area of eluviations as plant nutrients are removed by leaching
- ❖ Its more subject to weathering and cultivation operations
- ❖ Its well aerated and has active micro organisms
- ❖ It contains a lot of plant nutrients and support plant growth

Subsoil / horizon B

- ❖ It's a zone of illuviation as materials from top soil are deposited here
- ❖ It's more compact than top soil
- ❖ It's less aerated
- ❖ Hard pans are mainly found in this region
- ❖ In young soil, the B horizon is absent
- ❖ The brown colour is due to the iron oxides in this horizon

Parent material /Horizon C

- ❖ Contains broken down rocks
- ❖ It has clay material

Horizon D

- ❖ This is the soil rock at the bottom of the soil profile
- ❖ It is also called a bed rock. It may collect underground water forming ponds on top of this rock.

- ❖ Zonal soils is one where climate and vegetation have played part in formation
- ❖ A zonal is produced by deposition of material and without a soil profile
- ❖ Intrazonal soils are formed basing on parent material

N.B. Soil catena is the sequence of soil developed from a similar parent rock material under similar climatic conditions but whose x-tics differs due to difference in relief and drainage

IMPORTANCE OF SOIL PROFILE

SOIL SAMPLING

- ❖ Soil sampling is the practice of collecting samples of soil from a given area for detailed study in the soil laboratory.

REASONS FOR SAMPLING SOIL

- ❖ To determine the soil drainage
- ❖ To know the water holding capacity
- ❖ To determine the soil structure
- ❖ To determine aeration of the soil
- ❖ To determine the organic matter
- ❖ To determine the ph of the soil
- ❖ To determine the texture of soil
- ❖ To determine the capillarity of the soil
- ❖ To determine the type of fertilizer to use
- ❖ To determine the nutrient content of the soil

TOOLS USED IN SAMPLING

Sampling can be carried out using the following tools

- ❖ Soil auger
- ❖ Hand hoe
- ❖ Spade
- ❖ Shovel
- ❖ Garden trowel

METHODS USED IN SAMPLING

- ❖ There are two methods of sampling i.e. definite / regular / traverse and irregular / zigzag / random method.

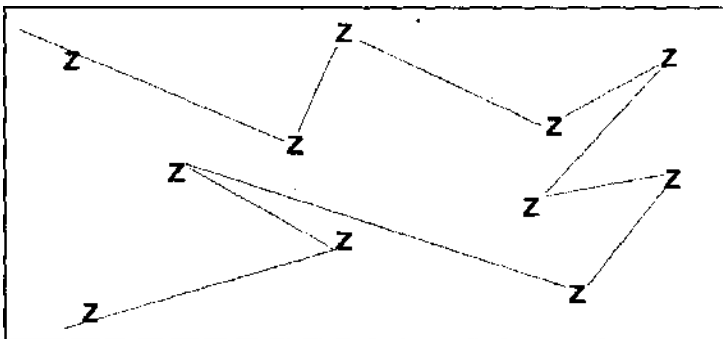
Traverse method:

- ❖ In this method, soil samples are collected in a uniform pattern following the diagonals. The samples are then put together to form a composite.

Diagram.

Zigzag / random method

- ❖ In this method soil samples are collected without following a uniform pattern to form a composite circle.



PROCEDURE OF SAMPLING

- ❖ Obtain clean and complete equipment to use
- ❖ Choose the best method of sampling to use
- ❖ The area from which samples are to be collected is divided into plots of convenient size
- ❖ Clear the vegetation from each spot where the samples are to be collected
- ❖ Using the auger, scoop out soil from the first spot and put it in a clean container

- ❖ Following the same procedure, collect samples from the rest of the spots in the plot of land
- ❖ Add the different samples to obtain a composite sample
- ❖ Mix the soil thoroughly and then divide it into four equal portions
- ❖ Keep on mixing, dividing and discarding three portions until you remain with a sub sample
- ❖ Label the final sample and take it to the laboratory for analysis

Precautions to take when collecting soil samples.

- ❖ Avoid collecting samples from unusual places, such as anthills, ditches, kraals, foot paths, areas near manure heaps, water logged areas and recently fertilized sites. Samples from such sites give results that do not represent the soil in the sampled area.
- ❖ Always use clean equipment to avoid contamination.
- ❖ Care should be taken when handling the samples to avoid mixing them up.
- ❖ Collect as many samples as possible so as to make a good representative sample. Collect 10-20 samples in every 2- 5 hectare plot of land.

Note: The following areas should be avoided during sampling.

- ❖ Water logged / poorly drained areas.
- ❖ Under vegetation cover.
- ❖ manure heaps
- ❖ Old house sites.
- ❖ Vegetation burning sites.
- ❖ pathways
- ❖ Fence lines
- ❖ Ant hill areas
- ❖ Heavy vegetation heaps

PHYSICAL PROPERTIES OF SOIL.

Farmers need to know the physical properties of soil and these include;

- ❖ Soil structure
- ❖ Soil texture
- ❖ Water holding capacity
- ❖ Soil colour
- ❖ Soil drainage
- ❖ Soil temperature
- ❖ Soil capillarity
- ❖ Etc

SOIL STRUCTURE

- ❖ Soil structure is the way soil particles are arranged together to form an aggregate or lump.
- ❖ It is the way the soil particles stick together and hold our plants.

EXAMPLES OF SOIL STRUCTURES:

In summary there are five types of soil structure namely:

- ❖ **Crumb or granular:** is the porous granule with high amounts of organic matter, subjected to wide and rapid changes.
- ❖ **Platy / plate like:** arranged as horizontal plates and found in virgin lands
- ❖ **Blocky:** are irregularly six faced cubes or rectangles found in the sub soil
- ❖ **Prismatic:** are pillar like aggregates with a prism shape found in the sub soil
- ❖ **Columnar:** are round pillar like aggregates found in the sub soil

IMPORTANCE OF SOIL STRUCTURE

- ❖ It influences soil aeration
- ❖ It influences water infiltration
- ❖ It influences plant root penetration and growth
- ❖ It influences water retention capacity
- ❖ It influences water movement within the soil
- ❖ It influences soil workability
- ❖ It influences germination ability indirectly by influencing the final tilth of the soil
- ❖ It influences the resistance of the soil to soil erosion
- ❖ It indirectly influences the availability of the organisms by influencing aeration
- ❖ It indirectly influences pH by influencing soil aeration

HOW SOIL STRUCTURE CAN BE LOST

- ❖ Use of heavy tillage machines for a long time causes compaction, making aeration difficult.
- ❖ Soil erosion by either water or wind removes soil particles.
- ❖ Poor farming methods such as over cultivation, overstocking and ploughing up and down a slope.
- ❖ Bush burning destroys the organic matter and exposes soil to agents of erosion
- ❖ Pollution decreases the population of micro organisms which break down organic matter, hence the binding property of organic matter is lowered

HOW SOIL STRUCTURE/TEXTURE BE MAINTAINED

- ❖ Cover cropping; this reduces evaporation and controls soil erosion.

- ❖ Addition of organic manure; manure has colloidal properties to bind particles together.
- ❖ Minimum tillage; reduces on compaction and allows the soil to restore its structure.
- ❖ Bush fallowing; the thick vegetation under fallow system controls erosion and adds organic matter to the soil.
- ❖ Mulching; decaying organic mulches provide organic matter which binds the particles together.
- ❖ Agro-forestry and afforestation; tree canopies control erosion, shad leaves which provide organic matter on decomposition.
- ❖ Crop rotation and intercropping.
- ❖ Drainage.
- ❖ Erosion control methods.

SOIL TEXTURE

- ❖ Soil texture is the degree of fineness or coarseness of the soil particles when rubbed between the thumb and fingers
- ❖ Soil texture is the size distribution of different particle that make up soil.
- ❖ It is the proportion of clay, silt and sand in a given sample

ROLES/ IMPORTANCE OF SOIL TEXTURE

- ❖ It influences soil aeration
- ❖ It influences water infiltration
- ❖ It influences plant root penetration and growth
- ❖ It influences water retention capacity
- ❖ It influences water movement within the soil
- ❖ It influences soil workability

- ❖ It influences germination ability indirectly by influencing the final tilth of the soil
- ❖ It influences the resistance of the soil to soil erosion
- ❖ It indirectly influences the availability of the organisms by influencing aeration
- ❖ It indirectly influences pH by influencing soil aeration
- ❖ It influences cation exchange capacity of the soil
- ❖ It influences soil capillarity
- ❖ It influences heat transfer within the soil

SOIL TEMPERATURE.

- ❖ This is the degree of coldness or hotness of the soil

IMPORTANCE OF SOIL TEMPERATURE

- ❖ Warm temperature encourages decomposition of organic matter and crops benefit the nitrogen flush.
- ❖ Very low temperatures slow down germination, flowering and seeding of planted crops.
- ❖ High soil temperatures encourage evaporation of water from the soil making the soil dry and unfavorable for crop growth.
- ❖ Low temperatures slow down microbial activities in the soil.
- ❖ Temperature influence physiological process e.g. photosynthesis, respiration etc.

TYPES OF SOIL

Quote: it pays in the end to do the best in the beginning

Soils are of three types and these are:

- ❖ Clay soil
- ❖ Sand soil
- ❖ Loam soil

CLAY SOIL

- ❖ It has a high water holding capacity
- ❖ It has a high capillarity
- ❖ It has a high nutrient holding capacity.
- ❖ It has small air spaces
- ❖ It is not gritty / it is smooth
- ❖ It forms extremely cohesive balls and long threads which bend into rings easily when wetted.
- ❖ Becomes hard during dry season

Challenges:

- ❖ Can be water logged
- ❖ Difficult to cultivate
- ❖ Require lime to flocculate

How clay soil can be improved

- ❖ Addition of lime to improve texture
- ❖ Addition of organic matter / manure to improve texture
- ❖ Through draining
- ❖ Mulching to conserve moisture

SANDY SOIL

- ❖ It is extremely gritty / it is not smooth
- ❖ It is not plastic
- ❖ It has low water holding capacity
- ❖ It has a low water nutrient holding capacity
- ❖ It has big air spaces
- ❖ It has big soil particles.
- ❖ It has a low capillarity
- ❖ Has a high erodability

How to improve sand soil

- ❖ By carrying out irrigation during dry season
- ❖ By adding clay to improve texture / marling
- ❖ Addition of organic manure
- ❖ Mulching to conserve moisture

LOAM SOIL

- ❖ It is moderately gritty
- ❖ It is slightly smooth
- ❖ It is slightly sticky
- ❖ It is slightly plastic
- ❖ It forms moderately cohesive balls
- ❖ It forms long threads which bend into rings with difficulty.
- ❖ It has a moderate water holding capacity
- ❖ It contains 5 – 10% organic matter
- ❖ Loam soil is an optimum mixture of sand, silt and clay.

Experiment to determine the different sizes of particles present in the soil:-

- ❖ Place 40g of soil in 100cm³ measuring cylinder
- ❖ Fill the cylinder with water up to $\frac{3}{4}$ of it
- ❖ Cover the open end firmly with land and shake the content of the cylinder vigorously
- ❖ Stand the cylinder on a land flat surface and observe how the suspension settles down.

Results

- ❖ Some bubble escape from the container indicating the presence of air.

- ❖ After shaking, the largest particles fall to the bottom (sand) followed by fine sand, silt, clay and finally organic matter.

PLANT NUTRIENTS

- ❖ These are the chemical elements that are necessary for plant growth.
- ❖ These chemical elements are divided into two major categories. These are the: macro and micro elements

Macro nutrients: these are chemical elements or plant nutrients needed in large amount for proper plant growth. Lack of them results into deficiency symptoms.

E.g.

- ❖ Oxygen
- ❖ Hydrogen
- ❖ Carbon
- ❖ Nitrogen
- ❖ Phosphorus
- ❖ Potassium
- ❖ Magnesium
- ❖ Calcium
- ❖ Sulphur

Micro nutrients: these are chemical elements or plant nutrients needed by plants in small amount and plants can do or grow without them e.g.

- ❖ Iron
- ❖ Zinc
- ❖ Copper
- ❖ Chlorine
- ❖ Manganese

- ❖ Cobalt
- ❖ Boron

NITROGEN

FORMS IN WHICH NITROGEN IS ABSORBED BY PLANTS

- ❖ Ammonium compounds
- ❖ Nitrite
- ❖ Nitrate

USES OF NITROGEN TO PLANTS

- ❖ It is used in chlorophyll formation
- ❖ Helps in the formation of protein
- ❖ It promotes vegetative growth
- ❖ It regulates the utilization of phosphorous and potassium
- ❖ It improves the size and quality of leafy vegetables e.g. cabbages
- ❖ It improves the size and protein quantity of grains
- ❖ It is important in cell division and growth
- ❖ It improves succulence in fruits e.g. pineapples

DEFICIENCY SYMPTOMS OF NITROGEN

- ❖ Stunted growth
- ❖ Yellowing of leaves
- ❖ Premature fall of leaves
- ❖ Reduced flowering
- ❖ Premature ripening and dropping of fruits and seeds
- ❖ Seeds, grains and fruits become small and less succulent
- ❖ Poor development of roots
- ❖ Low yields

HOW NITROGEN CAN BE LOST IN THE SOIL / FATE OF NITROGEN

- ❖ Crop removal during harvesting
- ❖ Soil erosion
- ❖ Through leaching
- ❖ Burning of crop residues
- ❖ Volatilization
- ❖ Monocropping
- ❖ Immobilization
- ❖ Denitrification

SIGNS OF EXCESS NITROGEN IN THE SOIL

- ❖ Excessive leaf production
- ❖ Delayed maturity of crops
- ❖ Leaf and stem lodging
- ❖ Scorching of leaves
- ❖ Poor crop yields
- ❖ Reduced disease resistance

GIVE THREE SOURCES OF NITROGEN

- ❖ Commercial fertilizers e.g NPK, Urea, CAN etc
- ❖ Organic fertilizers like farm yard manure
- ❖ Lightning
- ❖ Nitrogen fixation from the atmosphere

Phosphates

Give functions of phosphorous to plants

- ❖ It is a component of nucleic acids

- ❖ It is a component of the genetic material of the plant
- ❖ It is a constituent of amino acids
- ❖ It stimulates growth and development
- ❖ It stimulates flowering
- ❖ It improves the quality of forages and vegetables
- ❖ It strengthens the straw tissues in cereals thereby preventing logging
- ❖ It promotes normal root growth and development
- ❖ It imparts disease resistance to crops

Outline the deficiency symptoms of phosphorous

- ❖ Stunted growth
- ❖ Leaves are grey or purple
- ❖ Poor root growth and development
- ❖ Exceptional purpling of leaves and stems
- ❖ Delayed maturity
- ❖ Poor flowering and fruit formation
- ❖ Reduction in yields

SOURCES OF PHOSPHATES

- ❖ Through organic matter
- ❖ Through artificial fertilizer
- ❖ Through weathering of rocks containing phosphates

LOSSES OF PHOSPHATES

- ❖ Plant removal
- ❖ Soil erosion
- ❖ Leaching
- ❖ Fixation / immobilization

- ❖ Etc

POTASSIUM

IMPORTANCE

- ❖ It increases resistance to certain diseases
- ❖ It encourages root development and growth
- ❖ It is necessary for formation of starch and transport of sugar within the plant.
- ❖ It is essential for chlorophyll formation.
- ❖ It is needed in nitrogen metabolism and protein synthesis.
- ❖ It reduces lodging in plants by strengthening cellulose cell wall.
- ❖ It controls stomata movement hence loss of water.
- ❖ It has been linked with carbohydrates metabolism.
- ❖ It regulates water in plant cells.

DEFICIENCY SYMPTOM

- ❖ Retarded root development
- ❖ Plants are easily attacked by diseases
- ❖ Leaves dry out at the edges
- ❖ Browning of leaf edges
- ❖ Premature loss of leaves
- ❖ Chlorosis can also be experienced
- ❖ In cereals cell at the leaf tip and margin die first.

FACTORS AFFECTING THE AVAILABILITY OF POTASSIUM IN THE SOIL

- ❖ **Soil moisture:** Too much moisture interferes with exchangeable moisture.

- ❖ **Soil pH:** High soil pH favours potassium fixation
- ❖ **Temperature:** High temperature favours the level of exchangeable potassium
- ❖ **Types of colloids:** Potassium fixation is usually done in soil containing montmorillonite.

SOIL FERTILITY AND PRODUCTIVITY

- ❖ Soil fertility is the ability of the soil to supply all the required plant nutrients at the right proportion to support crop growth and give high yields.
- ❖ while soil productivity is the ability of the soil to give high crop yields throughout the year.

CHARACTERISTICS OF A PRODUCTIVE SOIL FERTILE SOIL

- ❖ It's well drained or has a good drainage
- ❖ It's well aerated or has a good aeration
- ❖ It has a good structure
- ❖ It has a good depth
- ❖ It has a high organic matter content or high nutrient content
- ❖ It has a good texture
- ❖ It has a good or favorable pH
- ❖ Its free from pests and diseases
- ❖ It has good water retention/water holding capacity
- ❖ It has moderate capillarity
- ❖ It has adequate soil living organisms
- ❖ Has favorable soil temperature
- ❖ It's free from soil pollutants

FACTORS WHICH CONTRIBUTES TO SOIL FERTILITY

- ❖ Good soil depth; deep soils give plant roots greater volume to exploit nutrients
 - ❖ Good soil drainage; reduces water logging which cause poor soil aeration
 - ❖ Good aeration; promotes healthy root development and functioning
 - ❖ High nutrient content; supplies enough plant nutrients for plant growth
 - ❖ Suitable soil PH; to meet the requirements of different crops
 - ❖ Freedom from pests and diseases; to promote healthy crop growth
 - ❖ Freedom from weeds; to minimize competition for nutrients
 - ❖ Good organic matter content; to supply plant nutrients for plant growth
-
- ❖ Availability of living organisms; to break down organic matter to release plant nutrients
 - ❖ Freedom from soil pollutants like polythene which can prevent aeration

CAUSES OF LOW SOIL FERTILITY

- ❖ Leaching- soluble nutrients dissolves in water and are washed away into deep layers of soil
- ❖ Volatilization- solid nutrients turn into gas and escape from the soil
- ❖ Immobilization- some soil living organisms use some nutrients like nitrogen to build up their bodies
- ❖ Soil erosion-plant nutrients are washed away together with soil during erosion
- ❖ Bush burning- organic matter is burnt and destroyed during bush burning
- ❖ Over cultivation- this leads to reduction of organic matter
- ❖ Weed over growth- these plants extracts a lot of nutrients from the plants

- ❖ Monoculture- crops extracts a lot of nutrients from the soil leading to soil infertility
- ❖ Change of soil ph- some nutrients becomes unavailable in soil when ph changes
- ❖ Crop removal at harvesting- removal of crop products that have accumulated soil nutrients leads to low soil fertility.
- ❖ Hard pans which prevents water drainage /root penetration
- ❖ Soil caps which prevent water drainage and aeration
- ❖ Dumping of polythene / pollution which affects soil physical/ chemical properties

HOW SOIL FERTILITY CAN BE MAINTAINED.

- ❖ Apply manures or fertilizers to increase the level of plant nutrients in the soil
- ❖ Plant legumes that fix nitrogen in the soil to improve fertility
- ❖ Mulch gardens with organic mulches that decompose to add humus in the soil or mulches control erosion and weeds
- ❖ Carry out proper weeding to reduce loss of nutrients from the soil
- ❖ Carry out bush fallowing to allow land or soil rest so as to regain lost nutrients
- ❖ Planting cover crops that controls soil erosion and maintain soil fertility
- ❖ Carry out minimum cultivation to conserve soil organic matter content or soil moisture
- ❖ Controlling soil erosion to reduce loss of plant nutrients
- ❖ Carry out crop rotation for legumes to fix nitrogen in the soil
- ❖ Lime the soil to improve on soil texture/ structure

- ❖ Control soil pollution to increase on soil living organisms
- ❖ Carry out proper drainage to control leaching of soluble soil nutrients

SOIL PH

- ❖ Soil ph is the acidity or alkalinity of the soil solution

CAUSES OF SOIL ACIDITY IN AGRICULTURAL PRODUCTION

- ❖ Decomposition of organic matter releasing organic acids that make the soil acidic
- ❖ Application of acidic fertilizers such as sulphur and ammonium sulphate
- ❖ Leaching that leads to loss of exchangeable base forming cations leaving acid forming cations
- ❖ Water logging which encourages anaerobic respiration
- ❖ The effect of acid rain as a result of high concentration of carbon dioxide in the atmosphere
- ❖ Selective absorption of base forming cations by crops
- ❖ Inheritance of acidic conditions from the parent rock

HOW TO TEST FOR SOIL PH IN THE LABORATORY USING THE UNIVERSAL INDICATOR

- ❖ Assemble all the materials/apparatus to use
- ❖ Get a small amount of soil and place it in a test tube
- ❖ Add barium sulphate to help in breaking soil clods
- ❖ Add distilled water and shake the contents
- ❖ Wait for the contents to settle and then add universal indicator solution
- ❖ Hold the test tube against the color chart on which ph values corresponding to different indicator colors are recorded
- ❖ The exact ph of the soil under investigation is read off the color chart

AGRICULTURAL LIME

- ❖ Lime is a carbonate, oxide or hydroxide of calcium or magnesium that is added to the soil to decrease acidity.

FORMS OF AGRICULTURAL LIME

- ❖ Quick lime (burnt lime)
- ❖ Limestone
- ❖ Slaked lime
- ❖ liming materials used when liming soil
- ❖ Calcium carbonate (lime)
- ❖ Calcium Sulphate
- ❖ Calcium carbonate
- ❖ Magnesium carbonate.
- ❖ Wood ash
- ❖ Sugar factory lime
- ❖ Calcium hydroxide
- ❖ Calcium magnesium carbonate

IMPORTANCE OF ADDING LIME TO THE SOIL

- ❖ It decreases the hydrogen ion concentration in the soil solution
- ❖ Decreases the solubility of iron, manganese and other trace elements thereby reducing their solubility
- ❖ It increases the availability of phosphorous in the soil
- ❖ It increases the availability of calcium as a nutrient for microbes and crops
- ❖ It improves the soil structure by binding soil particles together
- ❖ It promotes existence and multiplication of microorganisms which increases breakdown of organic matter

- ❖ It prevents the prevalence of some pathogens which flourish in acidic conditions e.g. fungi
- ❖ It improves on drainage and aeration
- ❖ It makes clay soil less sticky and therefore easy to cultivate

EFFECTS OF SOIL PH IN SOIL PRODUCTIVITY

- ❖ It influences the availability of certain plant nutrients in the soil e.g. at a low ph (acidic) phosphorous is not available but potassium is available.
- ❖ It affects the existences of both micro and macro organisms in the soil
- ❖ It influences the availability and toxicity of trace elements e.g. Fe, Mn and Co
- ❖ It influences the rate of activity of micro organisms in the soil
- ❖ It affects the type of crops to be grown
- ❖ It influences the presence of certain pathogens in the soil
- ❖ It affects the amount and the type of soil inputs to add
- ❖ It influences the rate of organic matter decomposition

FACTORS THAT SHOULD BE CONSIDERED BEFORE ADDING LIME TO THE SOIL

- ❖ Ph of the soil; lime should be added when the ph is low
- ❖ The buffer capacity of the soil; lime should be added when the buffer capacity of the soil is low
- ❖ The percentage base saturation on the exchange complex; lime should be added when the percentage base saturation is low
- ❖ Size of lime particles; the particles should be small so that they can easily dissolve
- ❖ Type of crops to be grown; Lime should be added when the crops to be grown require high ph

- ❖ Residual period of calcium element in the soil; Less lime should be added if the residual effect is high
- ❖ Soil texture; if the soil is fine textured, less lime should be added

FERTILIZERS / MANURES

- ❖ Fertilizers / manures are any material or substance which when applied to the soil increases the level of soil nutrients. This because crops use nutrients to grow and bear fruits. Good crop yield will require adequate supply of nutrients.
- ❖ Fertilizers may occur as dry or liquid form. The dry fertilizers are packed in bags or containers as pellets or granules. While liquid fertilizers are normally materials that have been dissolved in water at a certain concentration. However there are two major forms of fertilizers namely **organic (manure)** and **inorganic fertilizers**.

ORGANIC FERTILIZER /MANURE

- ❖ These are plant and animal residues which the farmer can use to maintain soil fertility
- ❖ These are fertilizers which are made from decomposed organic materials such as plants and their residues and dead animals and their wastes

TYPES OF ORGANIC FERTILIZERS

- ❖ Compost manure
- ❖ Farm yard manure
- ❖ Green manure
- ❖ Liquid manure (plant tea, animal tea and slurry)
- ❖ Night soil
- ❖ Organic mulches

GREEN MANURE

- ❖ This is made by ploughing green plants such as legumes into the soil

CHARACTERISTICS OF A GOOD GREEN MANURE CROP

- ❖ It should have high nitrogen content
- ❖ It should have a high growth rate
- ❖ It should be free from pests and diseases
- ❖ It should be easy to incorporate into the soil
- ❖ It should decompose faster when ploughed into the soil
- ❖ It should have a high leaf to stem ratio
- ❖ It should be able to grow on relatively infertile soil
- ❖ It should be drought resistant
- ❖ It should have highly viable seeds
- ❖ It should be resistant to pests and diseases

STEPS FOLLOWED WHEN MAKING GREEN MANURE

- ❖ Select and plant a good quality green manure plant preferably a legume
- ❖ Allow the plant to grow until when it is about to flower
- ❖ Plough the plant into the soil
- ❖ Allow the incorporated plant adequate time to decompose
- ❖ Replough the soil and prepare it for planting the main crop

ADVANTAGES OF GREEN MANURE

- ❖ The incorporated plant materials promote activities of soil living organisms
- ❖ It releases a variety of plant nutrient
- ❖ The green manure crop controls weeds and protects the soil against erosion
- ❖ The surplus nutrients in the soil are utilized by the green manure crop thus enhancing efficiency of nutrient utilization
- ❖ In case legumes are used, they fix nitrogen into the soil

OUTLINE THE DISADVANTAGES OF GREEN MANURE

- ❖ Plants with perenating organs may sprout after being incorporated into the soil
- ❖ It may lead to nitrogen depletion since the nitrogen present may be used as a source of energy to decompose materials by the microbes
- ❖ Heat produced during decomposition of materials may scotch the young seedlings
- ❖ It requires a lot of labor
- ❖ Decomposition of materials leads to depletion of soil water

COMPOST MANURE

- ❖ This is the crop residues, weeds, kitchen or household wastes and animal remains that have been rotten and decomposed as materials to supply plant nutrients.
- ❖ This type of manure is normally got from decaying household wastes like food peelings, slashed grass, leaves of trees, kitchen refuses, plants or animal remains, ash from cooking stove and rubbish from compound.

There are two methods of preparing compost manure i.e.

- ❖ Compost pit / indoor method
- ❖ Compost heap

Steps followed when making compost manure using the pit / indoor method

- ❖ Choose the site near your crop garden for making compost
- ❖ Get the materials, tools and equipments to use
- ❖ Clear away the vegetation

- ❖ Five pits of about 150cms by 150cms are dug
- ❖ Materials to make manure are arranged in the first pit in the following order
- ❖ Dry hedge, maize stalks or cuttings make the first layer
- ❖ Fresh leaves and kitchen refuse form the second layer
- ❖ Farm yard manure is added to increase the nutrient content and to provide micro organisms
- ❖ A Layer of wood ash is added to provide potassium
- ❖ Top soil is added to provide micro organisms
- ❖ If the pit is not full the above order is repeated until when the pit is full
- ❖ When the pit is full it is covered with dry leaves
- ❖ After 3-4 weeks, materials in the first pit are transferred to the second pit and covered with leaves. More fresh leaves are put in pit one
- ❖ After 3-4 weeks, materials in pit 2 are transferred to pit 3 and covered. Materials in pit 1 are transferred to pit 2 and pit 1 is filled again
- ❖ After another month, materials in pit 3 are transferred to pit 4 where they stay for another month
- ❖ From pit 4 materials are transferred to pit 5 where they stay for another month
- ❖ From pit 5 materials are allowed to cool and taken to the garden

Diagram.

COMPOST HEAP METHOD.

- ❖ Compost materials are gathered and piled into two heaps
- ❖ Soil should be added to provide micro organisms and also artificial fertilizer added to improve the nutrient content
- ❖ After 3 weeks materials in the 2 heaps are combined to form a third heap
- ❖ After another 3 weeks the materials in the third heap are combined to form the fourth heap

- ❖ After 3 weeks the materials in the fourth heap is fully rotten, it is cooled and applied in the field.

Diagram.

SIGNS OF FULLY DECOMPOSED MANURE

- ❖ It reduces in size
- ❖ The temperature of the materials lowers
- ❖ Materials break to pieces
- ❖ Fungi grow on the manure
- ❖ etc

Advantages of preparing compost manure using the indoor method

- ❖ It ensures continuous supply of manure
- ❖ Pits are used permanently
- ❖ Losses through erosion and leaching are minimized
- ❖ Improves soil nutrients
- ❖ It buffers soil ph
- ❖ Improves soil structure by binding soil particles together
- ❖ etc

Disadvantages of using compost manure

- ❖ The method is not good in areas that receive a lot of rain
- ❖ Land is wasted through constructing pits
- ❖ It requires a lot of space
- ❖ Requires a lot of labour
- ❖ Its heavy and bulky to transport and apply
- ❖ Takes a lot of period of time to make

Precautions taken when making compost manure

- ❖ The site of making the compost should be sheltered from sun's heat

- ❖ The heaps should be big enough to avoid incomplete decomposition
- ❖ Avoid putting plastics and metals on the heap
- ❖ Add compound fertilizers to improve on nutrient content
- ❖ Sprinkle water on the heap to regulate temperature
- ❖ Constant turning
- ❖ Add top soil
- ❖ Put hard materials at the bottom so as to trap the leaching nutrients

FARM YARD MANURE

- ❖ This is the straw, food remains and animal beddings mixed with urine and faeces allowed to rot and decompose to be used as fertilizers.
- ❖ It is a mixture of rotten beddings and animal wastes. It is normally made by people who keep animals and put dry grass on the floor or ground where animals are kept. The grass materials absorb the urine and faeces. After some time these animal beddings are collected with the food remains and are put in a heap to be allowed to rot and decompose.

STEPS FOLLOWED WHEN MAKING FARM YARD MANURE

- ❖ Select good quality litter of high moisture absorption capacity and place it in the animal shade or poultry house
- ❖ The litter is left in the house for 2-6 months. During this time animals defecate and urinate in the litter
- ❖ When the litter becomes fully saturated with dung and litter, it is removed from the animal house and heaped on concrete floor under shade
- ❖ Leave the manure to decompose for a period of 2-3 months

FACTORS INFLUENCING THE QUALITY OF FARM YARD MANURE

- ❖ Type of animal providing the manure; non ruminants produce better quality manure as compared to ruminants
- ❖ Age of the animal; Young animals produce low quality manure as compared to old ones
- ❖ Health of the animals; sick animals produce manure of better quality as compared to normal animals
- ❖ Type of feeds fed on by animals; Animals that are fed on high protein food produce better quality manure as compared to those that are fed on low protein food
- ❖ The type of litter used; Litter which is highly decomposable results into better quality manure
- ❖ Handling and storage of manure; well handled manure is of better quality as compared to one that is poorly handled
- ❖ Time allowed for decomposition; where adequate time is allowed, manure obtained will be of better quality

ORGANIC MULCHES / MULCHING

- ❖ Mulching is the covering of top soil with organic or inorganic materials
- ❖ Plant materials used in mulching are referred to as organic mulches e.g.
- ❖ Dry banana leaves and fiber
- ❖ Dry cereal stalk
- ❖ Coffee husks
- ❖ Rice husks
- ❖ Threshed bean rubbish
- ❖ Saw dust and wood shavings
- ❖ Dry elephant grass

Inorganic mulches on the other hand include materials like polythene bags / black polythene used to mulch pineapples, straws and sacks.

REASONS WHY FARMERS SHOULD MULCH THEIR GARDENS

- ❖ Mulches decompose and increase the organic matter content of the soil
- ❖ Organic matter obtained improves soil aeration, water infiltration and water holding capacity of the soil
- ❖ Mulches supply a lot of nutrients to plants especially N,P and K
- ❖ Mulching improves the soil structure
- ❖ It encourages and gives nourishment to living organisms in the soil, which in the end help in decomposing organic matter
- ❖ Mulches prevent soil erosion by improving infiltration of rain water into the soil
- ❖ On decomposition, mulches add organic matter and nutrients into the soil
- ❖ Mulches conserve moisture in the soil by preventing erosion
- ❖ Mulches moderate the soil temperature by preventing the sun's heat from reaching the soil surface
- ❖ Mulches control annual weeds
- ❖ Mulches decompose and increase the organic matter content of the soils

Disadvantages associated with mulching

- ❖ Dry mulches are a fire hazard
- ❖ Mulches act as a breeding ground for pests and disease causing organisms
- ❖ Mulches act as sources of weed seeds
- ❖ Mulching becomes expensive in case synthetic materials are used
- ❖ It may lead to loss of soil nutrients especially where microbes use the nutrients available as energy for decomposing the materials

N.B.1. Polythene is commonly used as an inorganic mulching material in pineapple growing.

This is because of the following reasons

- ❖ It last for a long time
- ❖ It reduces nutrient loss through volatilization
- ❖ It suppress weed growth
- ❖ Easy to apply
- ❖ It raise the temperature which favours root growth

N.B.2. It has the following problems

- ❖ It prevents water infiltration
- ❖ Polythene does not decompose
- ❖ It has to be removed after harvesting, this requires a lot of labour

Why farmers are are advised to use organic fertilizers / importance of using organic manure.

- ❖ They increase the organic matter content and the population of living organisms in the soil
- ❖ The organic matter obtained improves soil aeration, water infiltration and water holding capacity of the soil
- ❖ They supply a variety of plant nutrients especially N, P and K
- ❖ They improve the soil structure
- ❖ They encourage and give nourishment to living organisms in the soil, which in the end help in decomposing organic matter
- ❖ Organic fertilizers prevent soil erosion by improving infiltration of rainwater into the soil

- ❖ On decomposition, mulches add organic and nutrients into the soil
- ❖ Organic fertilizers conserve moisture in the soil by preventing erosion
- ❖ Organic fertilizers moderate the soil temperature by preventing the sun's heat from reaching the soil surface
- ❖ Organic fertilizers suppress annual weeds
- ❖ They supply nutrients in the soil for a long time
- ❖ They provide organic humus in the soil after decomposition that imparts a darker color to the soil. This conserves soil temperature
- ❖ They are cheap to make or buy
- ❖ They require less skill to apply to the soil
- ❖ They do not cause toxicity when applied in excess
- ❖ They increase nutrient adsorption and cation exchange capacity of the soil

Problems associated with the use of organic fertilizers

- ❖ It may lead to immobilization of nutrients especially if materials used have a high C: N ratio
- ❖ They contain a low nutrient content per unit volume
- ❖ They take long to release nutrients to the soil since mineralization takes a long period of time
- ❖ They are bulky and it's difficult to transport and apply to the soil
- ❖ They have a filthy unpleasant smell that makes their handling and use unfriendly
- ❖ They possess weeds, pests and disease causing organisms
- ❖ Their application cannot be mechanized
- ❖ Being bulky, they require a large space to store

INORGANIC FERTILIZERS/MANURE

- ❖ Inorganic fertilizers is a chemically combined substance which is added to the soil to improve its fertility
- ❖ Fertilizers are made from industries or factories and supply specific plant nutrients
- ❖ They quickly release nutrients to exhausted soils and they contain high concentration of plant nutrients
- ❖ Inorganic fertilizers are manmade fertilizers therefore they are artificial

TYPES OF FERTILIZERS

- ❖ Fertilizers are grouped according to the number of macro nutrients they contain
- ❖ Major macro nutrients include nitrogen, phosphorous, potassium and sulphate

There are two types of fertilizers

Single / simple / straight fertilizers

- ❖ This is the type of fertilizer which contains / supplies one of the major plant nutrients e.g. ssp, urea, ammonium nitrate, CAN, muriate of potash

Compound fertilizers

- ❖ This is the type of fertilizer which contains / supplies all the three major plant element e.g. NPK, DAP, ammonium phosphate, sulphate of potash etc

N.B. Fertilizers may also be characterized according to form in which they are made e.g.

- ❖ Liquid fertilizers e.g. rapid or supper grow
- ❖ Granular fertilizer e.g. DAP, CAN, NPK etc
- ❖ Crystalline form e.g. sulphate of ammonium and ammonium phosphate

FERTILIZERS FORMS AND NUTRIENTS SUPPLIED

COMMON	FORMULAR	NUTRIENT	STATE / FORM
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NAME			
Nitrogen phosphorus potassium	NPK	Nitrogen, phosphorus and potassium	Granular
Calcium ammonium nitrate	CAN	Calcium Nitrogen	Granular
Single super phosphate	SSP	Phosphorus	Granular
Diammonium phosphate	DAP	Nitrogen and Phosphorus	Granular
Potassium nitrate	KNO_3	Potassium and nitrogen	Crystalline
Urea	$\text{CO}(\text{NH}_2)_2$	Nitrogen	Crystalline
Ammonium phosphate	NH_4PO_4	Nitrogen	Crystalline
Sulphate of ammonium	$(\text{NH}_4)\text{SO}_4$	Nitrogen and sulphur	Crystalline
Calcium oxide	CaO	Calcium	Powdery white

QUALITIES OF A GOOD FERTILIZER

- ❖ It should be easy to apply
- ❖ It should be easy to handle.
- ❖ It should supply the required nutrients readily to the soil.
- ❖ It should be affordable to buy.

- ❖ It should have long lasting effect in the soil.
- ❖ It should be easy to store.
- ❖ It should have high nutrient content.
- ❖ It should be easy to dissolve in the soil
- ❖ Should be easy to supply nutrients to exhausted soils

ADVANTAGES OF USING INORGANIC FERTILIZERS

- ❖ They release and supply nutrients quickly in the soil
- ❖ Their application can easily be mechanized
- ❖ They contain a high concentration of nutrients as compared to organic fertilizers
- ❖ They are more convenient to handle
- ❖ They can be stored for a long period of time
- ❖ The nutrients added to the soil are known to the farmer
- ❖ They contain a known concentration of nutrients
- ❖ They can readily be obtained from the shops any time the farmer needs them
- ❖ They can be supplied using a variety of methods
- ❖ They are economical on a large scale

PROBLEMS ASSOCIATED WITH THE USE OF INORGANIC FERTILIZERS

- ❖ They can easily be exhausted from the soil
- ❖ They can easily be leached from the soil due to their high solubility
- ❖ Their application can alter the soil ph
- ❖ They may pollute the environment especially water bodies as a result of erosion
- ❖ Their application requires some specialized skills

- ❖ They are generally more expensive to buy
- ❖ They are uneconomical on a small scale

METHODS OF FERTILIZER APPLICATION

- ❖ -Broadcasting; fertilizers are randomly scattered using hands or machines
- ❖ Top dressing; fertilizers are applied to the soil after full crop establishment
- ❖ Side dressing; fertilizers are placed a few centimeters on the side of the crop
- ❖ Ring placement; a ring is made around the crop and fertilizers are applied in it.
- ❖ Spot application; particular sites are chosen and fertilizers are applied in them next to the crop
- ❖ Foliar application; fertilizers to be applied are dissolved in water and sprayed to the crop leaves
- ❖ Plough sole method; fertilizers are applied at ploughing and mixed with soil as ploughing takes place
- ❖ Fertigation; in areas where irrigation is done fertilizers are mixed with irrigation water and applied together
- ❖ Band placement; fertilizers are applied between rows of crops in bands
- ❖ Contact placement; fertilizers are put together with seeds in the planting hole at planting time

FACTORS THAT INFLUENCE THE METHOD OF FERTILIZER APPLICATION

- ❖ Level of soil fertility; broadcasting is used when the soil is fairly fertile
- ❖ Amount of fertilizers available; band placement is used when the quantity of fertilizers is low

- ❖ Type of root system of the crop; Broadcasting is used when the crop that is to be grown has spreading roots
- ❖ Crop arrangement within the field; band placement is used when the crops are planted in rows
- ❖ Solubility of the fertilizer; soluble fertilizers are applied using fertigation method
- ❖ Kind of fertilizers; fertilizers containing phosphorus and potassium are not broadcasted since they can be rendered useless
- ❖ Ease of fixation; phosphatic fertilizers are applied using contact placement since they can easily be fixed
- ❖ weather conditions; in hot weather volatile fertilizers are placed near the rooting zone
- ❖ stage of development of the crop; fertilizers that are to benefit young crops are applied using side dressing because at that stage the crops have a narrow root zone
- ❖ Cost of the fertilizers; cheap fertilizers are applied using broadcasting
- ❖ Availability of labor; where labor is scarce, fertilizers are applied using broadcasting
- ❖ Size of land; ring placement is used when the piece of land is small

FACTORS THAT INFLUENCE CROP RESPONSE TO FERTILIZERS

- ❖ Age of the crop/stage of crop growth; young crops respond better to fertilizers than very old crops
- ❖ Texture of the soil; coarse textured soil has poor adsorption nutrients and encourages leaching and therefore leads to poor response to fertilizers
- ❖ type of soil; clays soils encourages fixation of nutrients making them unavailable

- ❖ Ph of the soil; extreme soil ph reduces crop response to fertilizers
- ❖ Method of placement of fertilizers; fertilizers applied near the crop roots are well responded to by crops
- ❖ Amount of water of water in the soil; water helps to dissolve nutrients and therefore when it is present in sufficient quantities, crops respond better to fertilizers
- ❖ Amount of fertilizers applied; response is high when adequate quantity of fertilizers is applied to the soil
- ❖ Rooting habit of the crop; crops with spreading roots respond better to fertilizers since the wide roots can easily absorb the fertilizers
- ❖ Amount of biochemical activities in the soil; when activity is high, crops respond faster to fertilizers since some microbes carry out nutrient transformations making nutrients more available
- ❖ Health of the crop; normal crops respond better to fertilizers as compared to those which are diseased
- ❖ Level of weed infestation; weeds reduce crop response to fertilizers by causing competition for nutrients
- ❖ Solubility of the fertilizers; soluble fertilizers are highly responded to by crops as compared to those which are sparingly soluble

FACTORS WHICH INFLUENCE / DETERMINE THE CHOICE OF FERTILIZER/ MANURE TO APPLY BY THE FARMER

- ❖ Soil analysis: This is important because it expresses the need and type of fertilizers
- ❖ The types of fertilizers available; Different crops require specific nutrients and therefore the fertilizers available in shops should meet the above.

- ❖ Price of a fertilizer, increases use of fertilizers by farmers is determined by the prices and the expected profits after use.
- ❖ Management; The farmer's follow-up of the right application method and period of application affects the results achieved after use.
- ❖ Knowledge and skills of the farmer; Farmers more informed about fertilizers can use more of it
- ❖ Crop value; growing low value crops may not encourage the use of fertilizers since the cost may be higher than the yield expected

Exercise.

Given an NPK fertilizer with a ratio 5:20:20, calculate the amount of each element in 100kg bag of NPK.

Solution:

- ❖ Nutrient ratios are N=5 P=20 K=20
- ❖ Total nutrient ratio = $5+20+20=45$
- ❖ Thus the amount of NPK in 100kg will be,
- ❖ $N=5/45 \times 100\text{kg} = 11.1\text{kg}$
- ❖ $P= 20/45 \times 100\text{kg} = 44.4 \text{ kg}$
- ❖ $K = 20/45 \times 100\text{kg} = 44.4 \text{ kg}$

END