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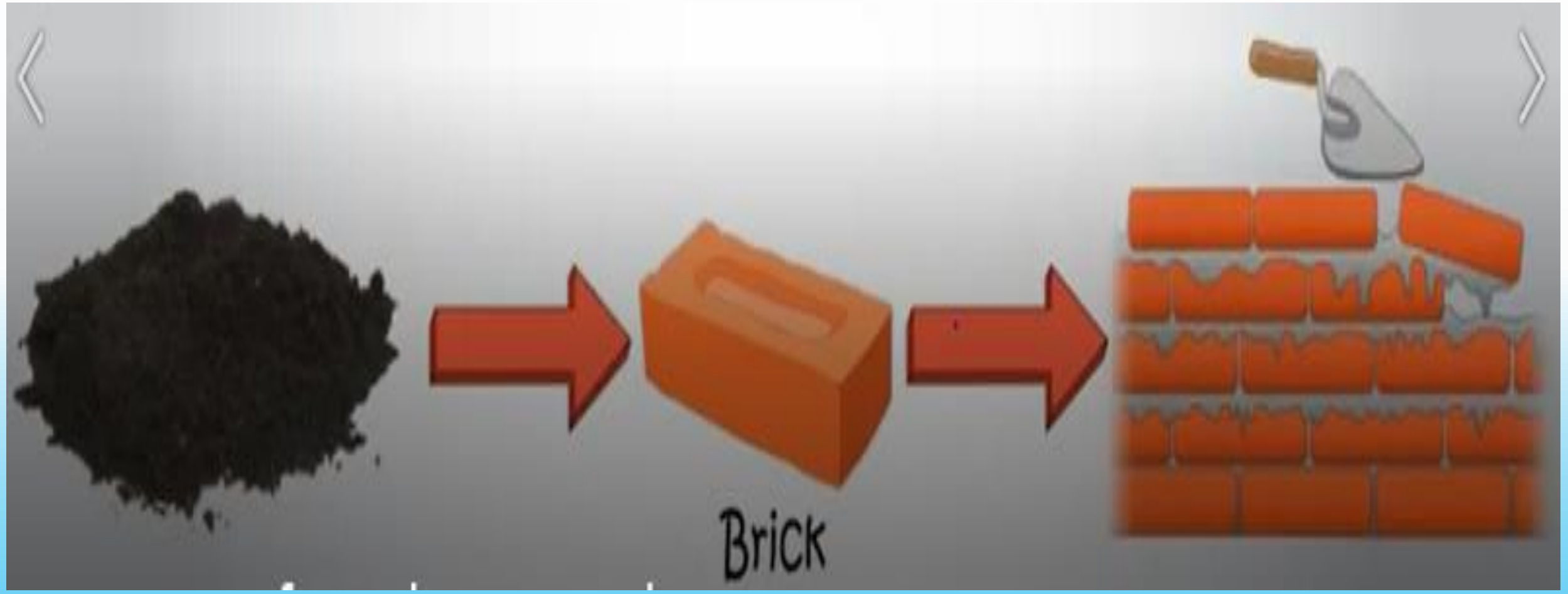
CCCC

SOIL

- Soil is the top most layer of the earth's crust.
- **OR** The finely divided material covering the earth's surface. It is normally treated as dirt
- Soil is the most essential natural resource on earth, and without it, there would be no home and food for all organisms on earth.


Brick


Wall
Floor
Counter top
ceramic tiles


The decaying plant and animal matter help give structure to the soil to hold the plant roots in place.

Importance of soil

- Soil provides nutrients e.g. water and minerals to plants which are the chief producers of food in the environment.
- Soil is a habitat (home) for many organisms such as earth worms, termites, bacteria fungi and arthropods.
- Soil provides a medium through which man and all other animals dispose of their wastes.
- Soil is an important natural resource which provides construction materials, supports agriculture, craft and art materials.

TYPES OF SOIL

- The appearance of soil varies from place to place.
- Question: are soils from the swamps similar to those from hills?, how do the two soils differ?

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- Soils differ in color, texture and size of the particles. The difference in this properties determines the type of the soil.
- The type of soil determines the use of the soil, which soil types are common in your area?, what are the main uses of the soil types in your community?

Different Types of Soil

TYPES OF SOIL

CLAY

LOAM

SAND

TYPES OF SOIL

CLAY particles are packed together tightly. It is sticky when wet and has the finest texture.

LOAM is a mixture of sand and clay. It contains large amount of decaying plants and animals. It has a fine texture.

SAND particles are coarse and loose


Loam
Silt
Sand
Clay

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- **LOAM SOIL**, this is a mixture of sand(about 40%), clay(15%) and organic matter. It is dark and has a stable crumb structure. Usually found almost everywhere especially in gardens, near compost pits and dumping areas.
- **SANDY SOIL**, it is light and has a gritty feel when wet. Found on lake shores and hilly areas.
- **CLAY SOIL**, it is heavy and has fine particles with a sticky feel when wet. found in swamps and anthills.

CHARACTERISTICS OF SOIL

- **A) COLOUR**
- Have you noticed that different soils have different colors?
- Do you know the color of loam soil? Why do you think it is that color?

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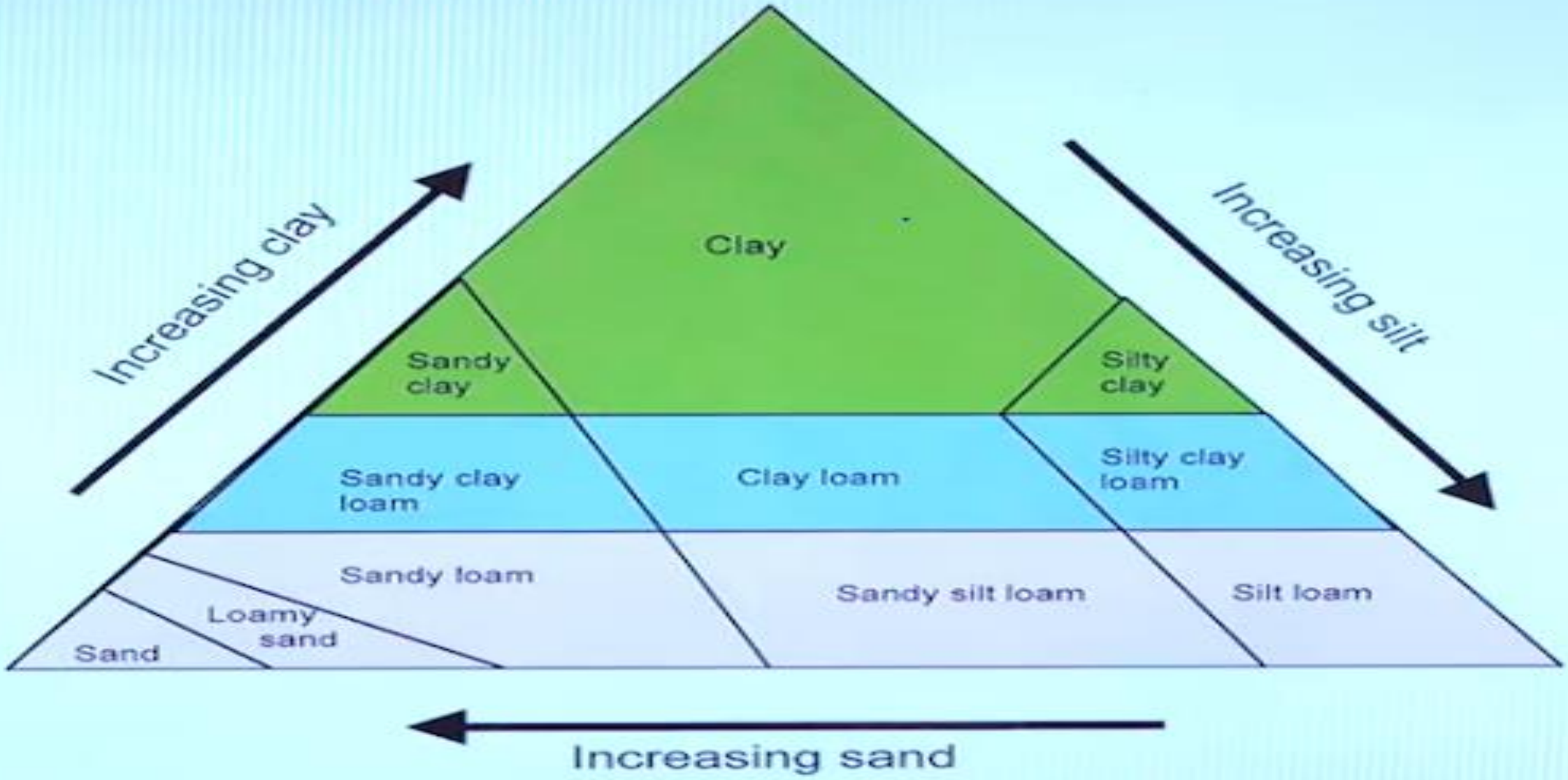
- The color of soil is usually determined by the mineral present and by the organic matter that covers the surface of the soil particles.
- Black soils are generally more fertile than lighter soils because they tend to have higher organic matter content.

- **B) TEXTURE**
- this is how rough or how smooth a particular soil sample is.
- The texture of a soil sample is determined by the relative proportions of sand, silt, clay and particle sizes present in the soil, e.g. using soil texture analysis chart, we see that sandy soils are coarse-textured and clay soils are fine-textured.

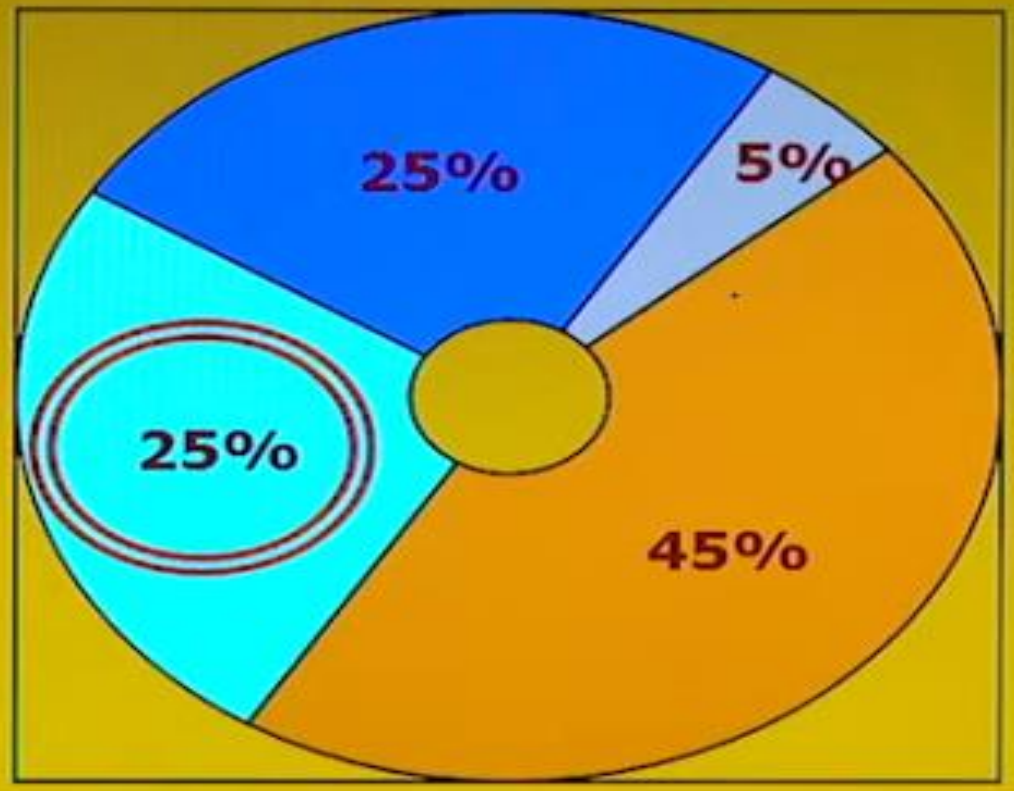

Increasing clay
Clay
Increasing silt
Sandy clay
Silty clay
Sandy clay loam
Clay loam
Silty clay loam
Sandy loam
Sandy silt loam
Silt loam
Loamy sand
Sand
Increasing sand
Heavy soils
Sandy and light silty soils
Medium soils

ctd

- **C) PARTICLE SIZE**
- soil particles can be categorized into 4 types based on their size in terms of average diameter of a particle, different types of soil are made up of different soil particles; most soils have a combination of 3 or more particles

Particle size	Average diameter
Gravel	Greater than 2.0mm
Sand	0.02-2.0mm
Silt	0.002-0.02mm
Clay	Less than 0.002mm

Constituents of the ideal soil



Mineral = Sand / Silt / Clay

- Mineral
- Air
- Water
- Organic Matter

Water & Air in direct proportion to each other

CONSTITUENTS OF SOIL

- Soil constituents are materials that combine to form soil. They include living and non-living things e.g……..,
  ……..., ……..,
  …….. And
  ……..

soln

Humus or organic matter
Water,
Air,
Minerals
Soil living organisms.

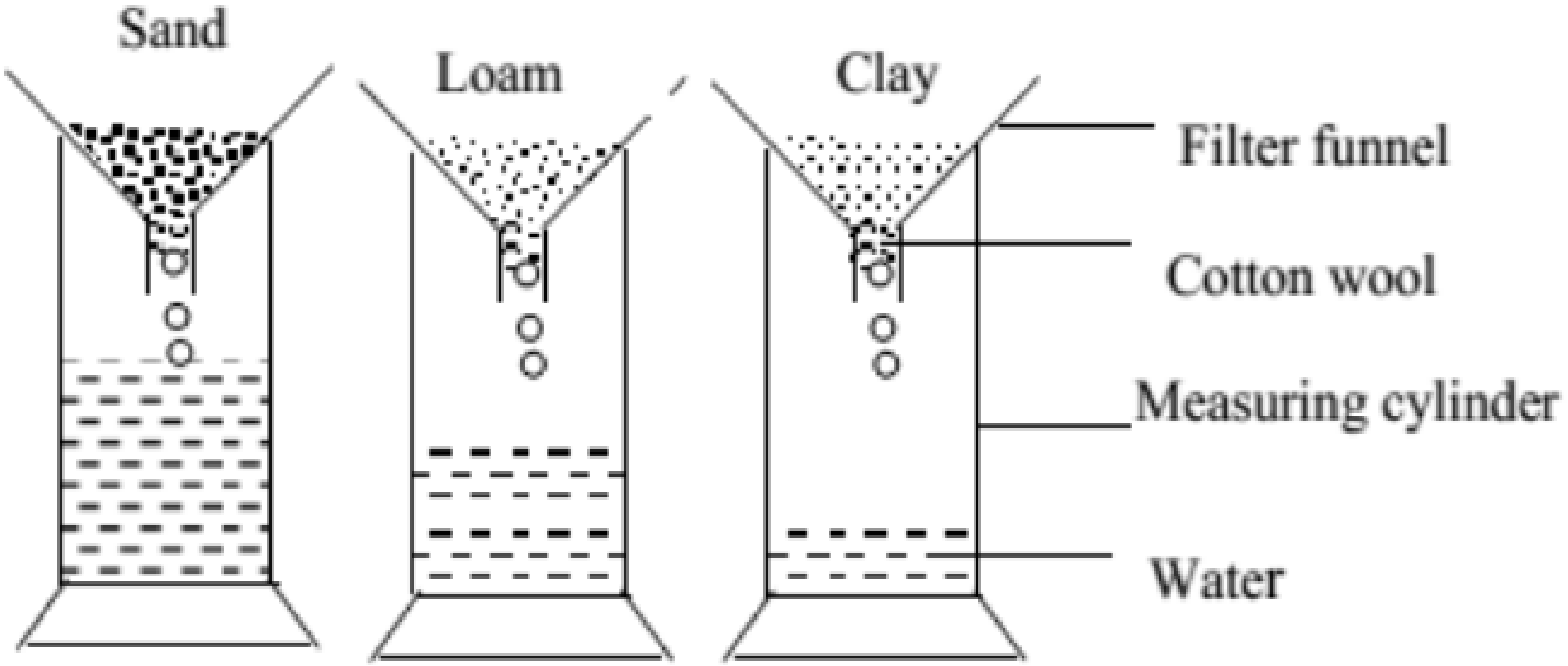
PROPERTIES OF SOIL

- Different soils have different properties. The properties can be categorized into physical and chemical properties.
- **PHYSICAL PROPERTIES**, are qualities that can be perceived by body senses like seeing, feeling and tasting E.g. water retention, drainage, color, texture and particle size.
- **A) WATER RETENTION**
- If plants are to obtain water from the soil, then the soil must have the ability to retain water in its particles.
- Qn. Do all the soils have the same capacity to retain water?

ctd

- Soils that retain more water are said to have a High water retention capacity while soils that retain less water are said to have ……
- **Experiment Comparing water retention capacity of clay, loam and sandy soil**
- **Procedure**
- a) Measure an equal volume of each soil sample.
  b) Fold filter papers properly and put one in each funnel.
  c) Then place clay soil in the filter paper in one funnel and the sand in the other funnel.
  d) Place the funnels with their contents over measuring cylinders and at the same time pour an equal volume of water on each of the soil samples as shown in the diagrams.

Setup


Sand
Loam
Clay
Filter funnel
Cotton wool
Measuring cylinder
Water

Observation

- Water passes through sandy soil faster than it does in loam and clay soils.
- Sandy soil gives the first drop of water and clay soil gives the last.
- So much water is collected in the cylinder with sandy soil and the least water is collected in the cylinder with clay soil.

- **CONCLUSION**, Clay soil holds more water than loam and sandy soil

explanation

- Sandy soil has large air spaces which enable water to pass through more rapidly and on the other hand , clay soil retains more water than sandy and loam soils. This is because clay soil has many small particles with small air spaces thereby retaining more water
- Loam soil has medium retention
- **B) DRAINAGE**
- After rain, some places dry immediately while others remain water logged. What is the reason for this?
- The ability of the soil to let water move through it is called soil …….

ctd

- Soil drainage depends on the size of the particles and air spaces between the soil particles. The soil type that easily allows water to pass through it is said to have ……drainage while the soil type that does not allow water to go through it easily is said to have ……drainage .
- Poor soil drainage leads to water logging that destroys property and crops.

- **Experiment to compare drainage of sandy, loam and clay soils.**
- **NB: For procedure and setup, refer to experiment on water retention**

observation

- Water passes faster through sandy soil than through loam and clay soils.
- Sandy soil gives the first drop of water and clay soil gives the last drop So much water is collected in the cylinder with sandy soil and the least water is collected in the cylinder with clay soil.

- **CONCLUSION**, sandy soil drains faster than loam and clay soil

explanation

- Sandy soil has larger air spaces which enable water to drain through more rapidly and on the other hand, clay soil has low drainage and retains more water than sandy and loam soil. This is because clay soil has few air spaces and small particles.
- Loam soil has a medium drainage

- **C) CAPILLARITY**
- Qn. At a construction site, you have seen builders use a black polythene sheet to cover the slab after laying the foundation. Why do you think this is necessary before continuing the construction of the wall?

ctd

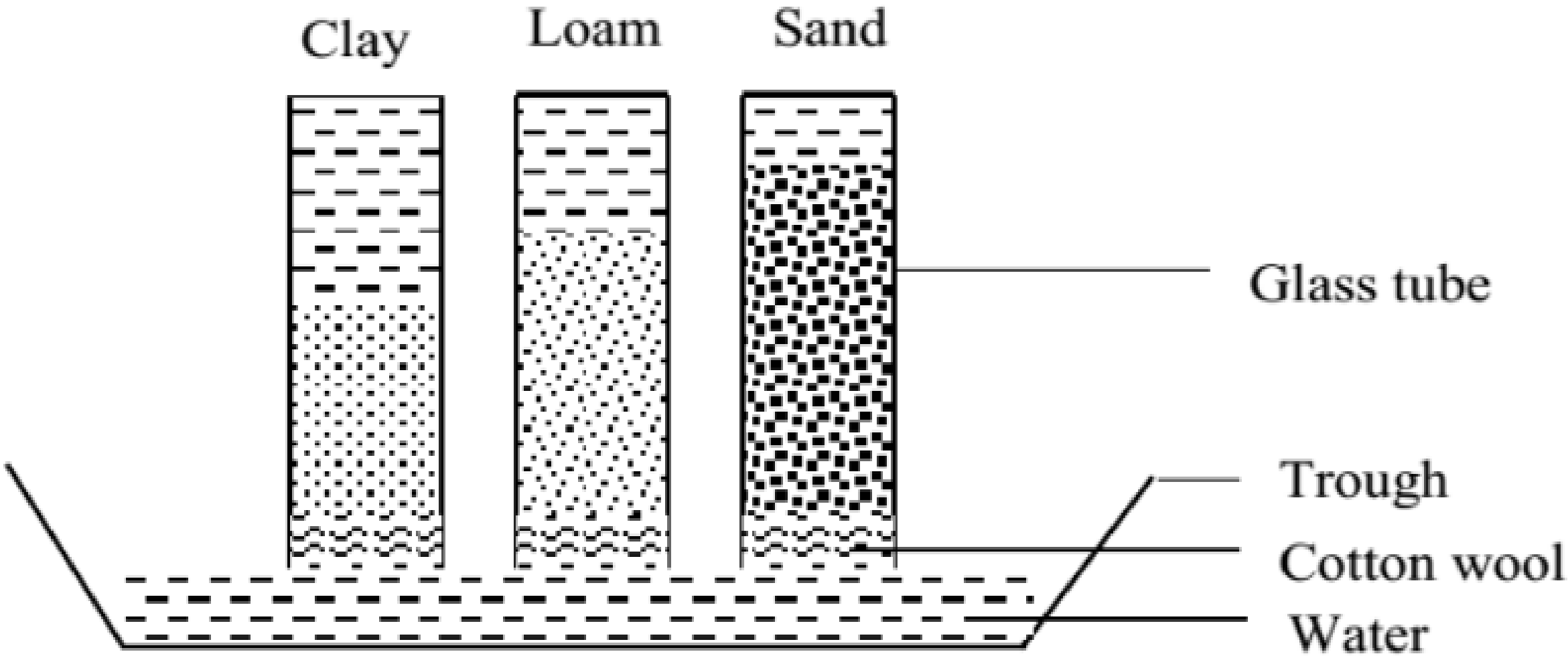
- The rise of water from the bottom layers to the top layers through the soil particles is called…….. It also depends on the size of the soil particles.

Experiment to compare capillarity of sandy, loam and clay soils

- **Procedure**

  a) Tie a muslin sheath tightly at the end of the glass tubes.
  b) Fill one glass tube with dry sample of sand soil and pack it well ensuring that there are no spaces in the soil.
  c) Repeat this with clay and loam soils.
  d) The glass tubes are stood vertically with the ends tied with muslin sheath immersed in a glass trough containing enough water.
  e) The glass tubes are supported upright with retort stands and clamps as shown in the diagram below.

Setup



Observation

- Water rises faster but to a lower level in sandy soil while in clay soil, water rises slowly but to higher levels.
- In loam soil water rises moderately to a moderate level.
- **CONCLUSION**; Clay soil has the highest capillarity while sandy soil has the lowest capillarity and loam soil has medium water capillarity.
- **EXPLANATION**: Water rises fastest during early stages of the experiment in sandy soil because sand has large spaces that enable water to rise rapidly
- Clay soil has the highest water capillarity because it is composed of tiny soil particles which present a large surface are over which water molecules cling.
- Water rises at a slow rate in clay soil because clay has small spaces between its particles.

Application

- Clay mixed with water, oil and honey can be used to make clay masks that ladies apply on their faces to maintain beauty.
- Basing on clay's property of being sticky when wet, it binds with germs on the surface of the skin and deep in the pores and brings the dried up germs to the surface of the skin to be washed away
- Pottery, brick making …….

Chemical properties of soil

- **SOIL PH,** IS the degree of acidity or alkalinity of the soil. Most soils in the tropics are acidic. The pH of soil can be determined using a universal indicator or litmus solution.
- Qn. Why do you think it is important to know the pH of soil?
- SOLN. Helps one to know the crops can grow well in a given soil or land type.
- Qn. What would happen if you grew crops in soils with unsuitable pH?
- PH scale range from 0 to 14.

ctd

- Soils with pH above 7 are basic or alkaline while soils with pH below 7 are acidic. A soil type with a pH 7 is neither acidic nor basic, it is neutral.
- The pH of soil depends on its parent rock (rock from which the soil was formed). pH controls which nutrients are available for plant use
- **NB**: PH is Potential of Hydrogen
- Examples of crops that grow well in acidic soils include; beans, onions, tomatoes, sweet potatoes…….
- Crops that grow well in alkaline soils include; pumpkin, cabbages …..

QUICK TIP

- .

Acidic soils are found in places where the rainfall is very high and drainage is poor. Why is this so?

PERCENTAGE COMPOSITION OF SOIL CONSTITUENTS

- **Experiment to determine the percentage of air in the soil**
  Apparatus: Measuring cylinders (2), dry soil sample, water, and glass rod.
  Method
  1. Measure about 50 cm3 of dry soil in a measuring cylinder and tap the container to level out the soil.
  2. Measure 50 cm3 of water in another measuring cylinder.
  3. Add the two together (observe carefully as you pour the water onto the soil)
  4. Allow the mixture to stand until no more bubbles appear. Read and record the final level of water plus soil in the measuring cylinder. Calculate the air content in terms of percentage.

Example

- Volume of soil = 50cm3
  Volume of water = 50cm3
  Final volume of water + soil after mixing = 85cm3
  Volume of air in soil (100 - 85) = 15cm3
  Percentage of air = $\frac{\textit{volume of air}}{\textit{volume of soil used}}$ x **100**
  Percentage of air = $\frac{15}{50}$ x 100

  Percentage of air = 30%

NB

- The final volume of the mixture after stirring is lower than the initial volume of the mixture before stirring due to displacement of air around soil particles by water
- Expected volume = volume of water + volume of soil
- Volume of air = Expected volume - Actual volume observed

exercise

- Bosco, a senior two student carried out an investigation to determine the percentage of air in a given soil sample and obtained the following values:
- Volume of soil used = 40cm3
- Volume of water added to the soil = 50cm3
- Final volume of water + soil after mixing = 80cm3
- a) determine the volume of air in the soil sample.
- b) calculate the percentage of air in the soil sample

Experiment to determine the percentage of water in a soil sample

- **Apparatus:**
  Evaporating dish, fresh soil, weighing scale and oven or Bunsen burner.
  Procedure:
  a) Weigh a clean evaporating dish and record its weigh. *(Let the weight be X g).*
  b) Fill the evaporating dish with soil and record the weight of the soil plus the evaporating dish. *(Let the weight be Y g).*
  c) Dry the soil by heating it gently over a Bunsen burner flame for about 30 minutes.
  d) Heating and weighing is repeated until a constant mass is achieved. *(Take care not to burn the soil to produce smoke).*
  e) Re-weigh the soil and the evaporating dish. *(Let it be Z g).*
  f) Then calculate the water content in the soil sample as shown below;
  Note:
  You should cool in a desiccator before weighing. This ensures that no fresh vapor enters the soil.

Results

- Weight of the evaporating dish= X
  Weight of soil + evaporating dish = Y
  Weight of soil + evaporating dish after heating = Z
  Weight of soil sample = Y-X
  Weight of water in the soil sample = Y-Z
- Percentage of water = $\frac{\textbf{\textit{amount of water}}}{\textbf{\textit{amount of fresh soil}}}$ **X 100**
- Percentage of air = $\frac{Y-Z}{Y-X}$ X 100

EXERCISE

- 1. In an investigation, 80g of fresh soil was heated in a crucible. After repeated heating and cooling, the constant mass of the soil was found to be 65g. Calculate the percentage of water in the soil sample.
- 2. which factors affect the water content of any given soil?

Experiment to determine the percentage of humus (organic matter) in the soil

- **Apparatus:** Crucible, soil sample, weighing scale, heat source, wire, tripod stand, pipe clay triangle
- **Procedure:**
- a) Weigh a clean empty crucible and record its weight (W g).
- b) Fill the crucible with soil halfway and record the weight of soil plus crucible on weighing scale (X g).
- c) Dry the soil by heating it in an oven at 105 degrees C to constant weight (Y g) - the loss in weight of soil at this temperature is due to the water driven out by evaporation.
- d) Reweigh the soil and crucible and record the weight.
- e) Heat the dried soil on a crucible to redness in an oven, then weigh the soil after cooling and record its weight. Repeat this till a constant weight is achieved (Z g).

RESULTS

- Weight of crucible = W g
- Weight of crucible + fresh soil = X g
- Constant weight of soil + crucible after heating at 1050C =Y g
- Constant weight of soil + crucible after heating to redness = Z g
- Weight of fresh soil = X - W
- Weight of dry soil = Y - W
- Weight of dry soil after burning off humus = Z - W
- Weight of humus = Y - Z g
- Percentage of humus = $\frac{\textit{amount of humus}}{\textit{amount of fresh soil}} \times 100$
- Percentage of humus = $\frac{Y-Z}{X-W} \times 100$

Exercise

- The following data was obtained by a student while determining the percentage of humus in a given soil sample ;
- Weight of the crucible = 100g
- Weight of the crucible containing fresh soil = 156g
- Constant weight of the crucible containing soil after heating at 105 degrees Celsius = 143g
- Constant weight of the crucible containing soil after heating to redness = 128g, calculate;
- a) weight of the fresh soil
- b) weight of the dry soil
- c) weight of the humus
- d) percentage of the humus in the soil sample

NB:

- Humus burns off into carbon di oxide and water vapor causing change in color, smell and emergency of smoke

Experiment to investigate presence of living organisms in the soil

- **Requirements:** muslin bag, soil from compost or top soil, 2 conical flasks, 2 corks, lime water/bicarbonate indicator solution
- **Procedure:**

✓Collect a handful of fresh top soil and divide it into 2 equal portions

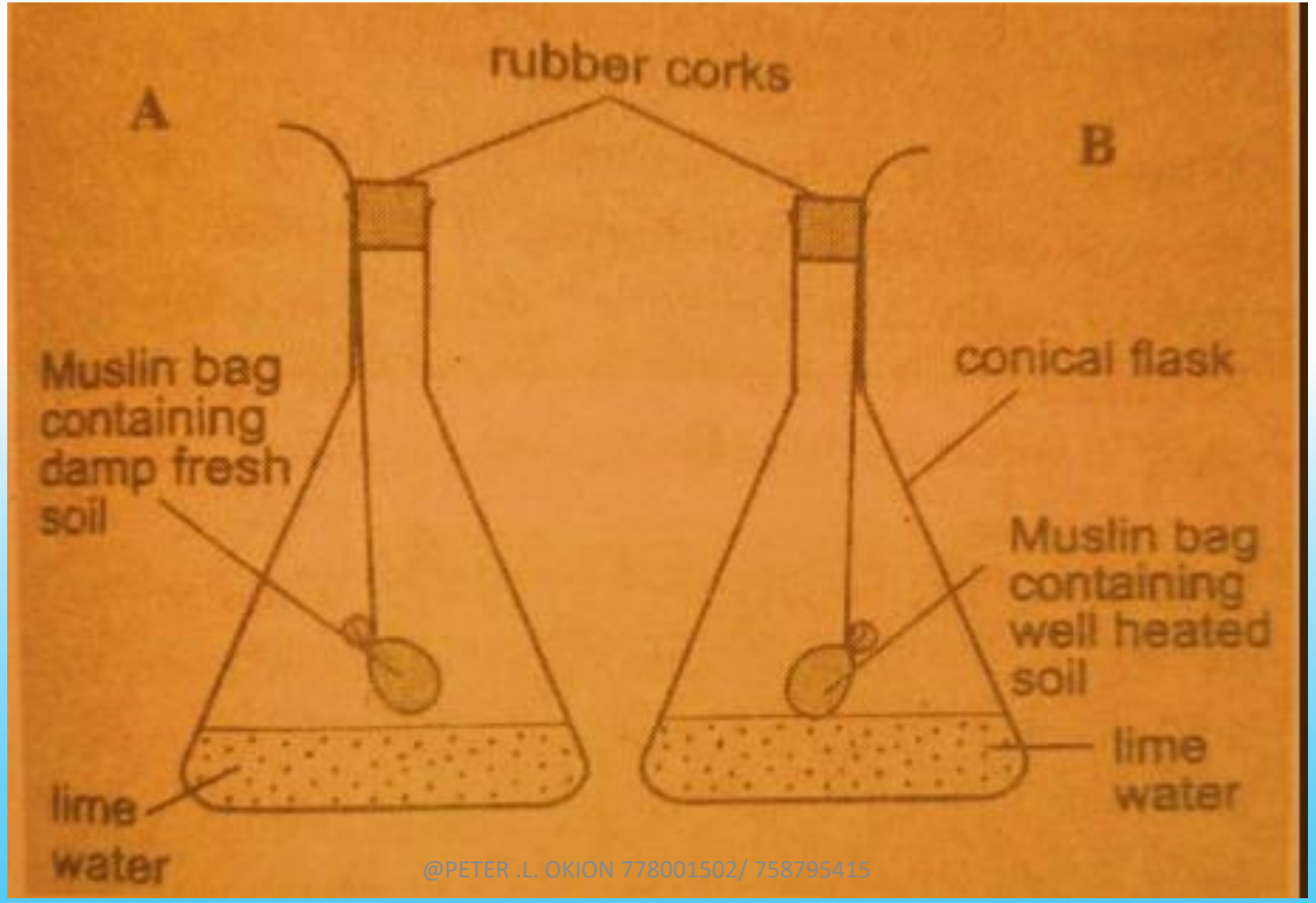
✓Sterilize one portion of the soil sample by heating strongly on a crucible for 30minutes. Leave it to cool and place it in a muslin bag

✓Place the remaining portion of the fresh soil sample in another muslin bag

✓Add equal amounts of lime water/ bicarbonate indicator in the conical flasks and then suspend the muslin bags with soil in the conical flasks as shown in the set up

✓Allow the conical flasks to stand for about 2days and observe the appearance of lime water/ bicarbonate indicator

Set up

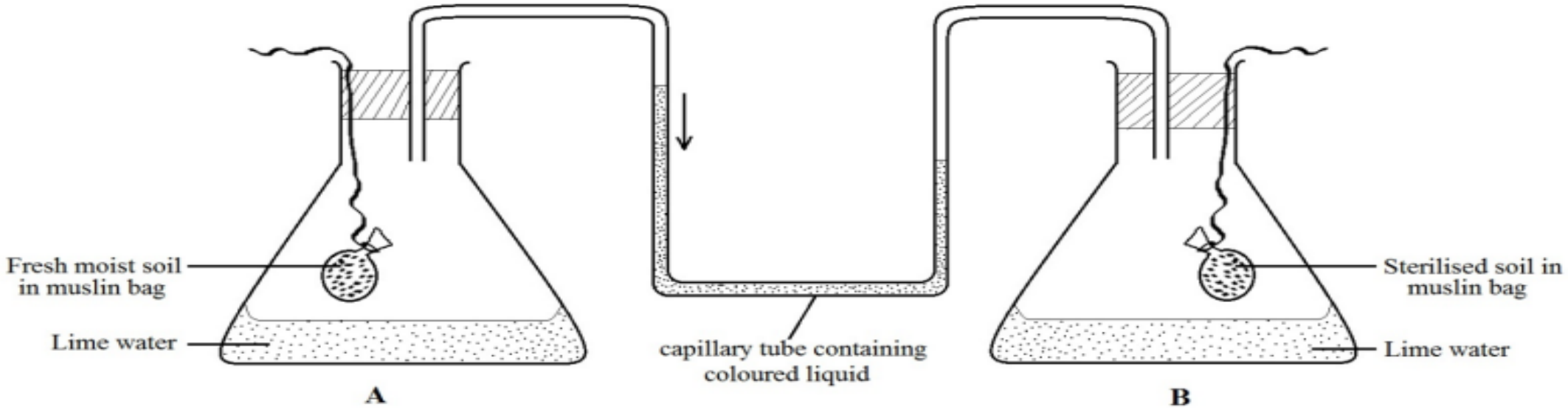

rubber corks
A
B
Muslin bag containing damp fresh soil
conical flask
Muslin bag containing well heated soil
lime water
lime water

Observation

- Lime water turns milky or bicarbonate indicator solution turns yellow in the conical flask **A** but remains clear in test conical flask **B**
- **CONCLUTION**
- Carbon dioxide was produced in conical flask **A** during respiration indicating the presence of living organisms
- Lime water remained clear in conical flask **B** because the living organisms in soil in conical flask **B** were killed by heating

Sample question

1 The apparatus below was set up by a student. Study it carefully and answer the questions that follow.



(a). What was the:

(i) aim of the experiment. *(01 mark)*

(ii) use of the lime water in the setup *(01 mark)*

(b). State what would be observed in each flask if the experiment was left to continue for 24 hours. Explain your observations. *(04 marks)*

(c). Explain why was:

(i) the soil in the flask B was sterilised *(01 mark)*

(ii) coloured liquid level in the capillary tube dropped . *(02 marks)*

(d). State one role played by the soil component being investigated in this experiment? *(01 marks)*

IMPORTANCE OF AIR AND WATER IN SOIL TO LIVING ORGANISMS

- **a) AIR**

✓Provides oxygen for respiration of soil organisms and plant roots

✓Oxygen is also needed for the decay that produces humus

✓Provide nitrogen for fixation by nitrogen- fixing bacteria in the soil, the nitrogen absorbed is needed in the formation of nitrates and proteins

✓Carbon dioxide present in the air helps in increasing the soil acidity which favors proper growth of some plants

✓Carbon dioxide present in the air dissolves in water to form carbonic acid for weathering

b) WATER

- It moistens soil and keeps it humid/ moist, making it favorable for survival of micro organisms
- It dissolves mineral salts making them available for plants to take in
- It dissolves carbon dioxide produced by living organisms to form carbonic acid which causes chemical weathering of rocks
- It is a raw material for photosynthesis
- Water absorbed from the soil allows plant cells to be rigid (turgid), and this is very important for support of the plant, particularly herbaceous plant

c) Organic matter

✓It is food for soil organisms

✓it moderates temperature of the soil

EXERCISE

- At home you have; a garden which normally gets dry shortly after it has rained. The crops have even started to dry up due to such high drainage
- a) which soil type makes up the highest composition of the soil in your garden?
- b) which challenge are the crops likely to face apart from lack of enough water?
- c) how can you improve the water drainage of your garden?

soln

- a) sandy soil
- b) shortage of nutrients
- c) adding humus, mulching and planting trees and cover crops

Activity of integration

- Soil types in Uganda vary from place to place. The people in Kirark, a village in your neighborhood are individuals engaging in different activities. Some are;
  - Commercial farmers who cultivate crops in pots
  - Builders who plaster houses in the village
  - Potters who make stoves

These individuals have been using soil from a certain mining site in the neighboring village. However the plaster which the builders use gets too loose in a very short period of time and falls off, the potters' products crack while drying while the farmers' crops produce poor yields. This has made them to worry as their businesses are nearly collapsing. You have been contacted by the village leaders who are seeking for advice on what the individuals can do to sustain their businesses

Task

- Using your knowledge of physical and chemical properties of soil, write a speech you will deliver to the individuals for them to understand the soil type each one needs to save his businesses

Support Material

Pottery

Builder

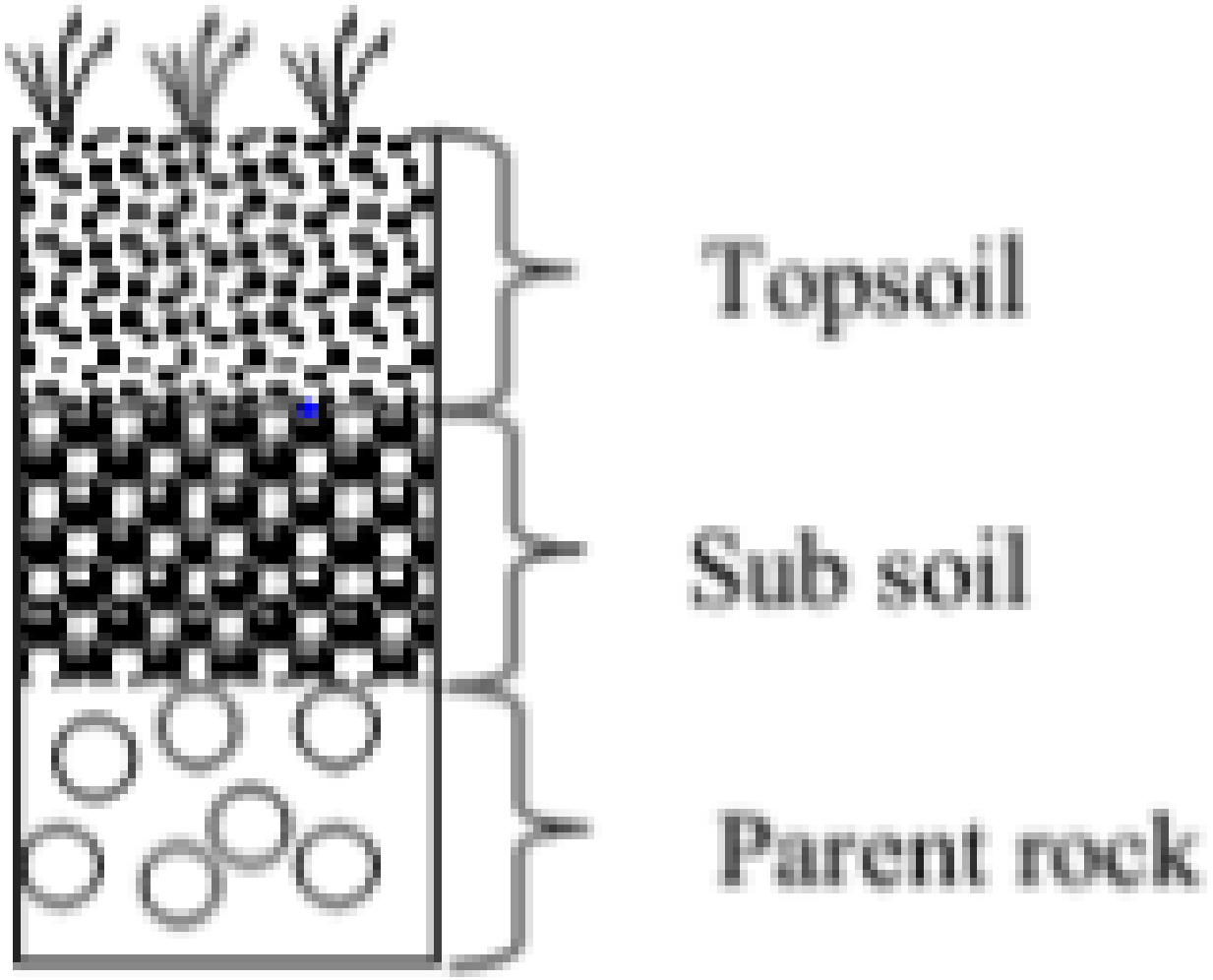
Farmers

Figure 1.9: Users of soil types

SOIL PROFILE

- This is the vertical arrangement of the various soil layers called horizons.
- It represents the different layers at various stages of soil development. A soil with distinguished soil layers is known as **mature** and that without clear profile is **immature** or **young**.
- The profile consists of the following:
- i) Top soil
- ii) Sub soil
- iii) Parent or underlying rock

Drawing to show the soil profile



Features of fertile soil

- Fertile soil is one which can provide adequate amounts of nutrients for plant growth, resulting into better crop yields and quality
- Soil fertility is the ability of the soil to sustain plant growth and optimize crop yield
- The healthy plants are grown in soil which has adequate water, humus, mineral salts and is well aerated for proper plant growth while the soil with unhealthy plants might be lacking some of these constituents.

SOIL EROSION AND CONSERVATION

- What is soil erosion?
- **Process of soil erosion**
- This involves loosening of soil particles (detachment), moving of soil particles (movement) and placement of soil particles (deposition)

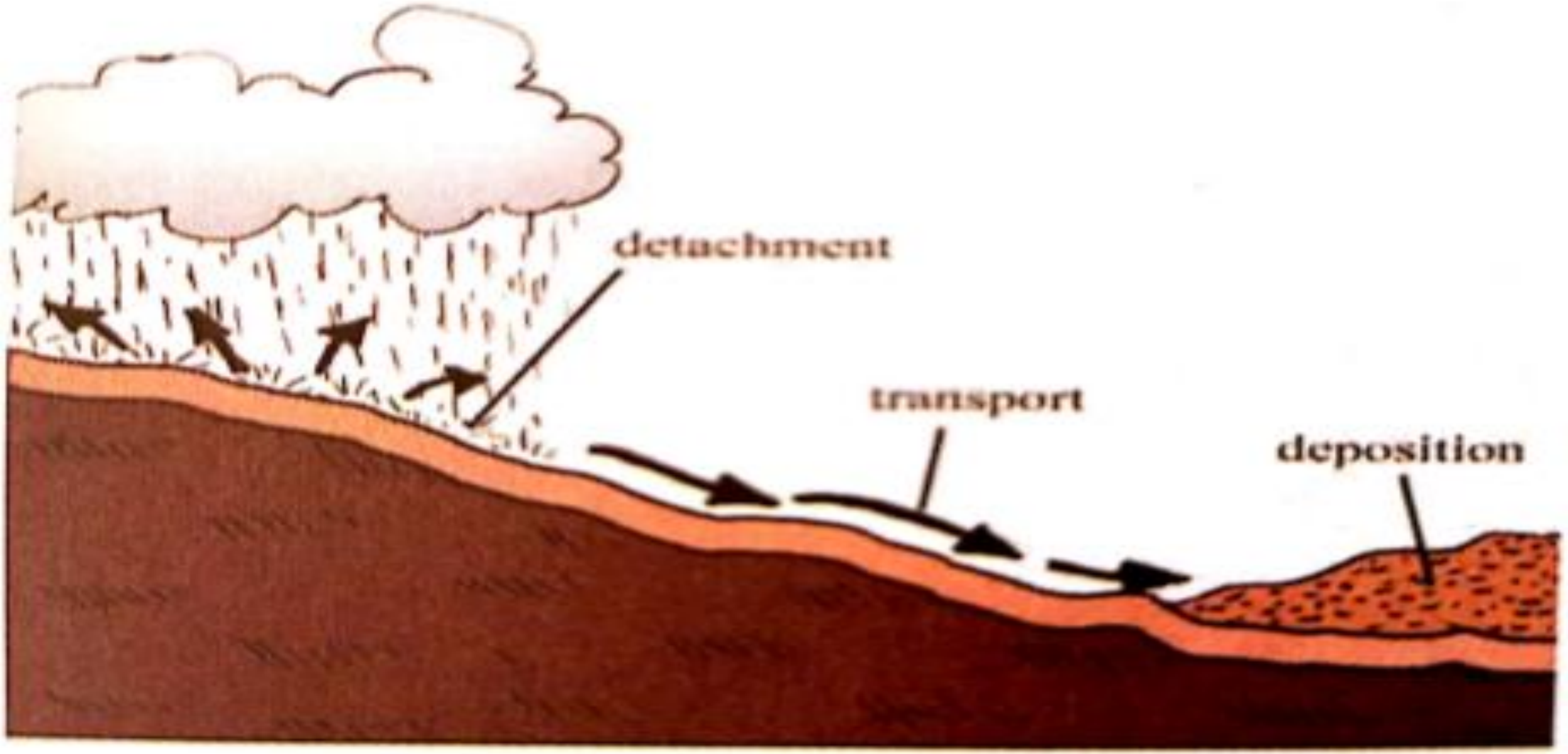


Figure 2.1: The process of soil erosion

Questions:

a) give the 5 types of soil erosion

b) identify 10 causes of soil erosion

c) what are the impacts of soil erosion?

Soln

- a)

➢Sheet, splash, rill, wind, gully

b)

✓Deep slopes of land coupled with intense rainfall

✓Overgrazing of animals which removes the grass cover and opens the soil to water erosion

✓Deforestation

✓Bush burning

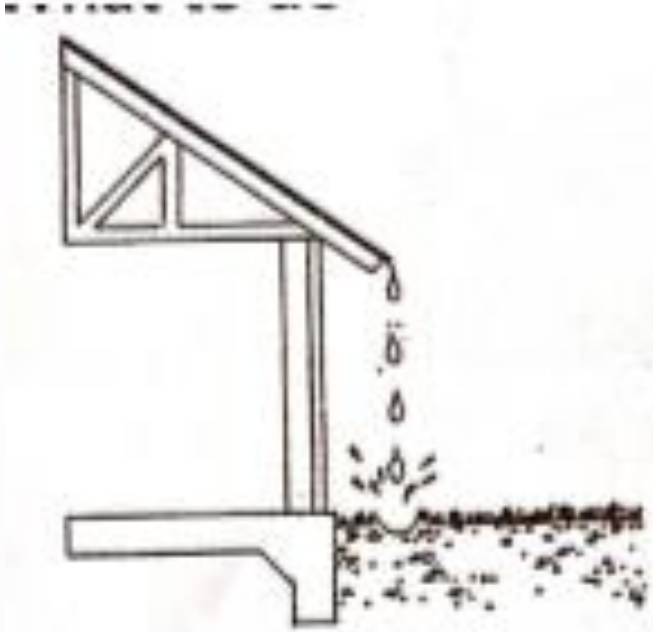
✓Over cropping and ploughing

c)

- Nutrients and soil organisms are carried away in the top soil
- The soil left behind is unproductive
- Fields may be cut into irregular pieces by rill and gully erosion
- Floods carry away or submerge and suffocate crops and soil organisms

Types of soil erosion

- **QN:** Have you witnessed eroded fields in your community, what do you think could have caused that erosion?
- It might be the agents of erosion e.g. ……and ……..
- When heavy winds blow away top soil, wind erosion occurs and when running water carries away the top soil, this is referred to as ……
- ……erosion is classified depending on the mechanism by which water carries away the top soil



A

B

C

D

E

Figure 2.2: Different types of soil erosion

Forms of water erosion

- **Sheet erosion:** is the uniform removal of soil particles from an area without the development of clear water channels
- **Rill erosion:** is one that produces narrow shallow wavy channels called RILLS
- **Gully erosion:** is one that produces wide deep steep-sided channels as water continues to flow down the rills deepening them
- **Splash erosion:** this is the first stage of the erosion process. It occurs when raindrops hit the bare soil. The explosive impact breaks up soil aggregates so that individual soil particles are “splashed” onto the soil surface.

Factors that lead to soil erosion

- **Type of surface cover:** bare soils allow surface runoff carrying large volume of soil while soils covered with grass have a low rate of erosion and the speed of running water is reduced
- **Gradient of the slope:** steep slopes allow fast surface runoff carrying larger volumes of soil with it.
- **Type of soils:** more loose soils are easily carried away by water than less loose soils

Reducing soil fertility

- Many times, farmers have complained about the reduced crop harvests and they mostly attribute this to reduced soil fertility.
- What do you think could be the cause of the reduced soil fertility ?

- Use the images below

Figure 2.4: Activities that lead to loss in soil fertility

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- **A –** misuse of fertilizers through excessive application can alter the pH of the soil inhibiting plant growth
- **B –** soil compaction obstructs rain or water infiltration leading to surface runoff or erosion
- **C –** soil erosion removes top soil which contains most nutrients
- **D –** mining removes top soil which exposes sand. Top soil is always rich and supports plant growth
- **E –** poor disposal of wastes reduces soil aeration, drainage and water retention
- **F –** charcoal burning releases heat that kills soil micro organisms
- **G –** flooding leaches nutrients from soil surface to deeper layers where they cannot be accessed by plant roots
- **H –** bush burning leaves the land bare exposing it to agents of soil erosion

Ctd

- **I –** deforestation leaves land bare exposing it to agents of soil erosion
- Other activities include;

✓Over cultivation

✓Monocropping

✓And other poor farming practices like clean weeding

Conserving our soil

- Soil is a valuable resource. What do you think makes soil valuable ?
- The great pressure on land is due to the increasing human population that has resulted to soil degradation. This is because of the various human activities carried out on land, which have resulted into soil erosion e.g. deforestation
- **QN:** what is soil degradation?
- This is the reduction or loss of the biological or economic productivity and complexity of land, resulting from natural or human activities

Activity

- In your groups, discuss the steps or methods that the farmers and gardeners in your locality take to maintain the fertility of their soils (10marks)

Mulching –

- covering the soil in between crops with materials e.g. dry grass, plant leaves and saw dust. This protects the soil from rain drops and improves water infiltration, it also suffocates weeds. Mulches release nutrients into soil after decomposition

Manuring –

- organic manure is added to the soil, the humus present binds soil particles together and provides nutrients such as nitrates to the soil

Adding fertilizers –

- these are rich in nitrogen, phosphorous and potassium which replace lost nutrients and improve soil fertility

Crop rotation –

- this is where different crops are grown in succession on one piece of land over a number of years. Inclusion of deep rooted crops breaks up sub soil and legumes harbor rhizobium which adds nitrates to the soil

Composting –

- waste materials, leaves, weeds and grass cuttings are piled and left to decay forming compost which is dug into the soil hence adding nutrients to the soil

Intercropping –

- crops with poor ground cover e.g. maize are planted with beans that effectively cover the ground. This reduces the speed of water runoff and also suppresses weeds

Agroforestry –

- farmers manage and integrate crops, trees and/or livestock on the same plot of land. This conserves soil through controlling water runoff and soil erosion

ctd

- **Wind breaks –** trees are planted in rows across the direction of the prevailing wind to act as wind barriers hence reducing the effect of wind erosion
- **Read and make notes about the following;**

➢Terracing

➢ contour cultivation

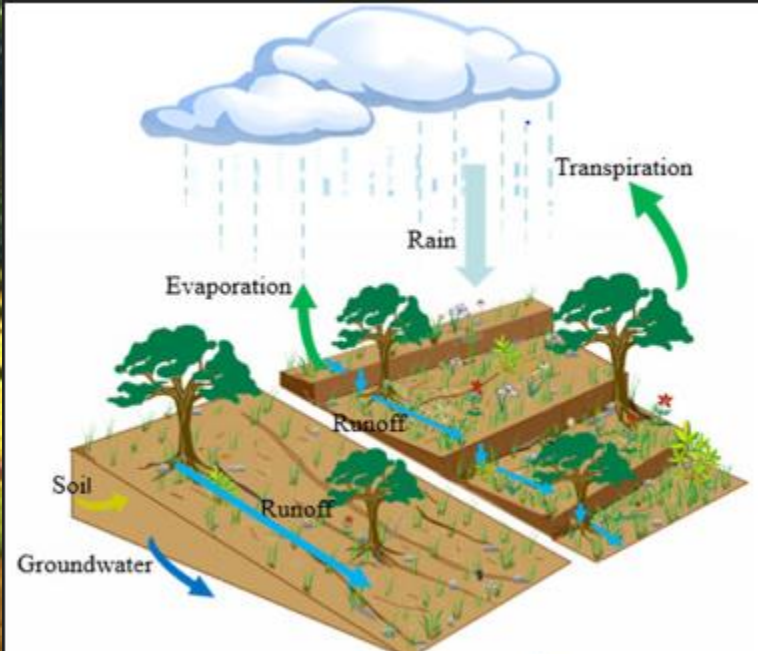
➢Minimum tillage

➢Fallowing

➢Irrigation

➢Cover crops

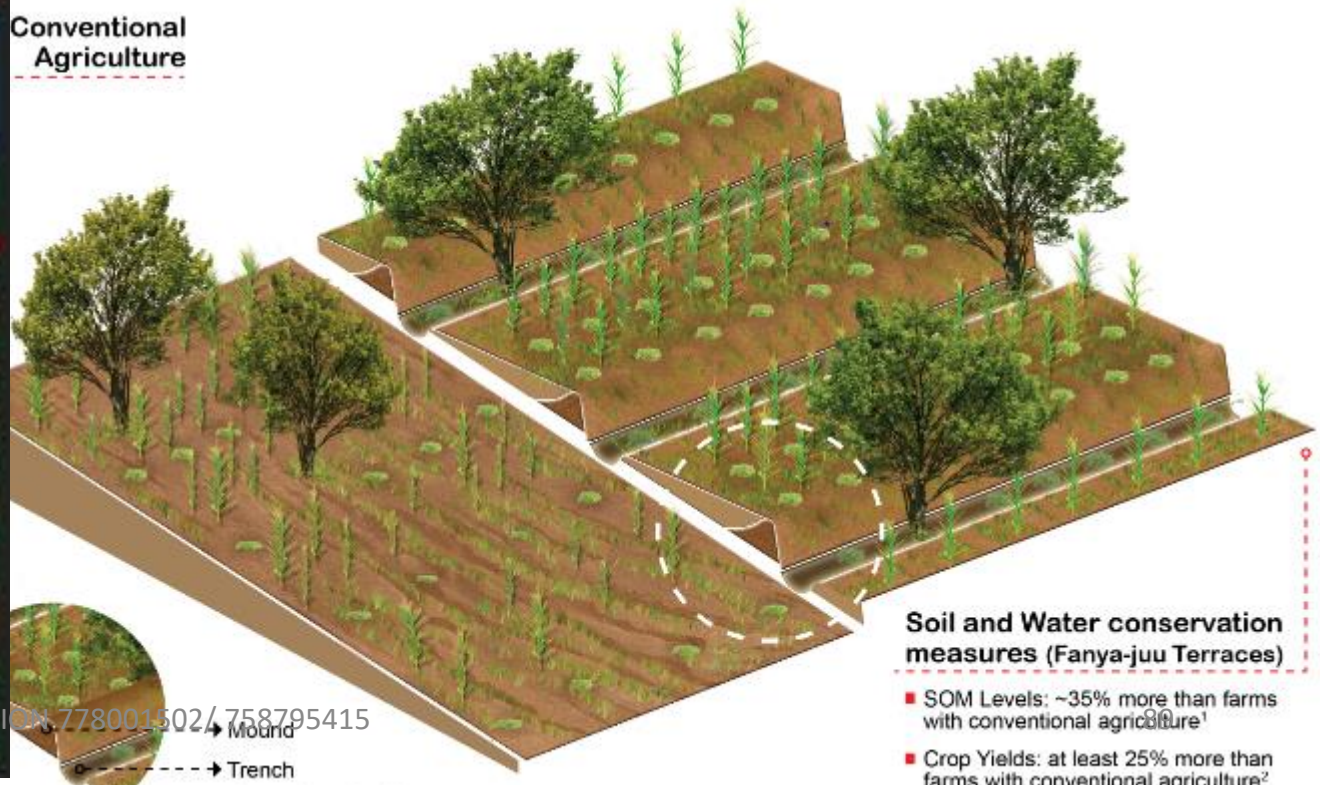
➢Soil testing, this is done to ascertain what nutrients are in poor supply in the soil



Water Balance

Plants consume some of rainfall in regions, and part of the water evaporates from the soil. The rest runs off the surface or recharges groundwater.

Terracing can change the specific hydrological pathways, increase soil roughness and vertical surface relief, and decrease the connectivity of overland flow.



Importance of micro organisms in Nitrogen and other cycles that keep soil fertile

- Some of these organisms are large (macroscopic organisms) and can be seen with unaided eyes while others are very small (microscopic) and can only be seen under a microscope.
- **QN:** What are the examples of soil microorganisms?

Note:

- Decomposers break down chemical nutrients like carbon and nitrogen compounds in dead plants and animals to release them back into the environment. These are in turn released back into soil, there by improving soil fertility. These nutrients are then absorbed by plant roots for plant growth. Animals are able to obtain these nutrients when they eat plants. Activities of decomposers contribute to the **cycling** of carbon and nitrogen within the environment.

❑The process by which dead organic substances are broken down into simpler organic or inorganic matter such as carbon dioxide, water, simple sugars and mineral salts is called **DECOMPOSITION**

THE NITROGEN CYCLE

- Nitrogen makes up the largest percentage of AIR.
- **QN:** what is the percentage composition of Nitrogen in air?
- Surprisingly, much as nitrogen exists in abundance in air, it cannot be readily utilized by living organisms! This is because, for it to be used by living organisms it must be changed into various absorbable forms in a cycle of events called **Nitrogen cycle.** this describes how nitrogen circulates between plants, animals, the atmosphere and soil in the ground

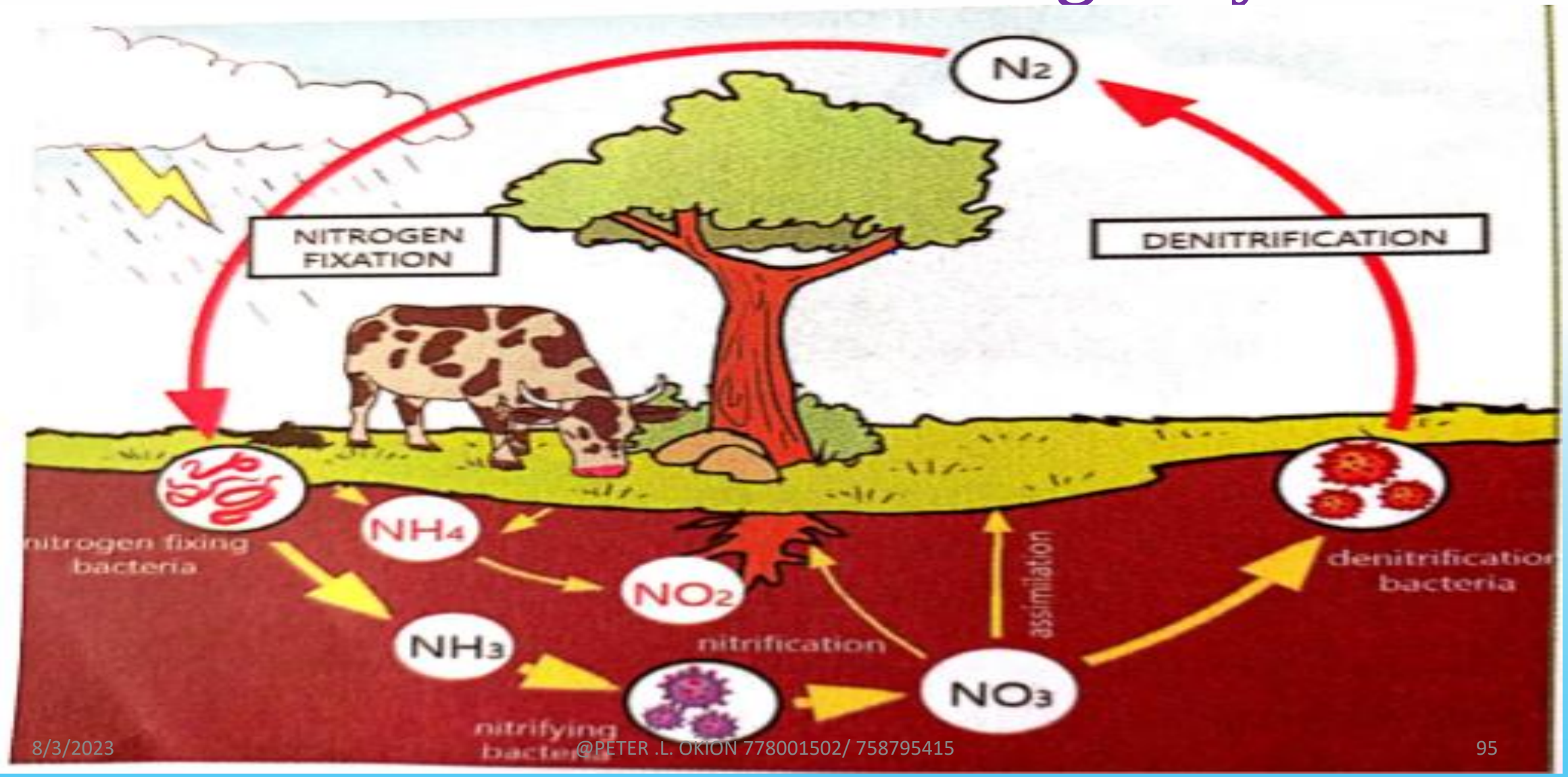
The script:

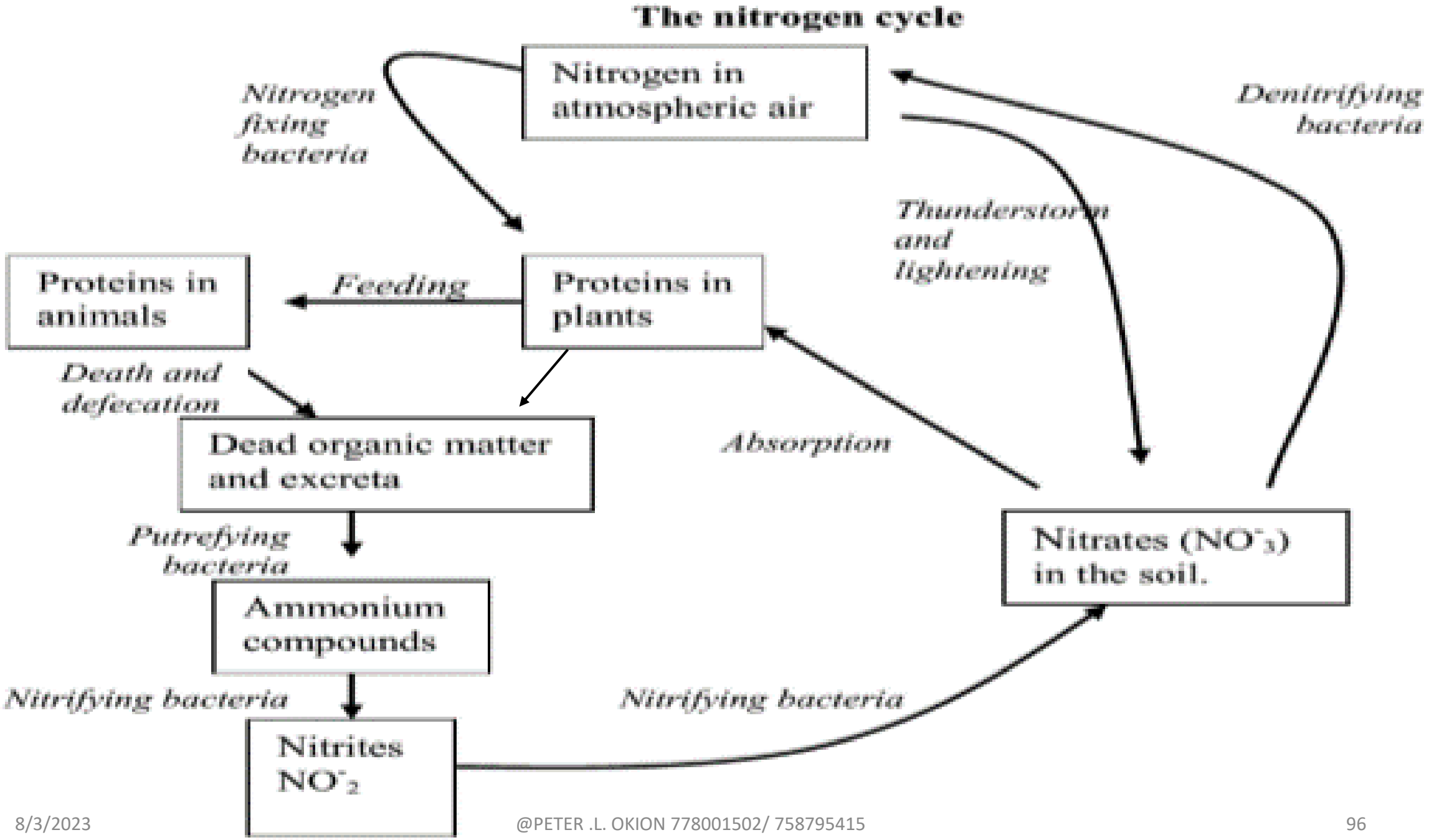
On a cloudy Monday morning, Leku a farmer, plants soy bean seeds in his field. With the little rain and sunshine, the seeds germinate within a few days. For the young plants to continue to grow and develop, they need nutrients. Theese will enable them to grow bigger and stranger. A cool breeze blows by, carrying nitrogen gas, a nutrient that the soy beans need to make their own food. The soy bean plants cannot absorb any of the nitrogen without a type of bacteria called rhizobium. Deep under the soil, the rhizobium moves to the root system of the bean. The rhizobium inhabits the root of the bean, but the soy bean plant doesn't mind. Soon, the rhizobium attaches itself to the roots and forms small nodules, filled with nitrogen. The bacteria and the plant form a relationship that benefits them both. As the bean plant keeps the rhizobium alive, the rhizobium helps the bean to turn nitrogen gas into a usable nutrient. Now, the beans to mature and grow big and produce bean pods. Eventually, the bean plants complete their life cycle and die. The farmer comes and harvests his field of beans, chopping up the dead plants in the soil. Decomposers break dawn the plant materials, releasing nutrients into the soil. These nutrients are absorbed by maize plants which the farmer planted in the same field. The maize plants are fed on by cows that pass out excreta. This excreta is decomposed to release nitrates into the soil. Denitrifying bacteria convert the nitrates in the soil into nitrogen which goes back to the atmosphere.

QUESTIONS

- 1. how did the bacteria help the plant?
- 2. can all plants get their nutrients from the soil, like the bean did?
- 3. how did the farmer use plants to make his soil healthy? Explain how planting different crops help to replace nutrients in the soil.
- 4. what would happen if the farmer only grew maize in his field, year after year?

Processes involved in the nitrogen cycle




The nitrogen cycle
Nitrogen in atmospheric air
Nitrogen fixing bacteria
Denitrifying bacteria
Thunderstorm and lightening
Proteins in animals
Feeding
Proteins in plants
Death and defecation
Dead organic matter and excreta
Absorption
Putrefying bacteria
Nitrates (NO^-_3) in the soil.
Ammonium compounds
Nitrifying bacteria
Nitrifying bacteria
Nitrites NO^-_2

Nitrogen fixation can occur through:

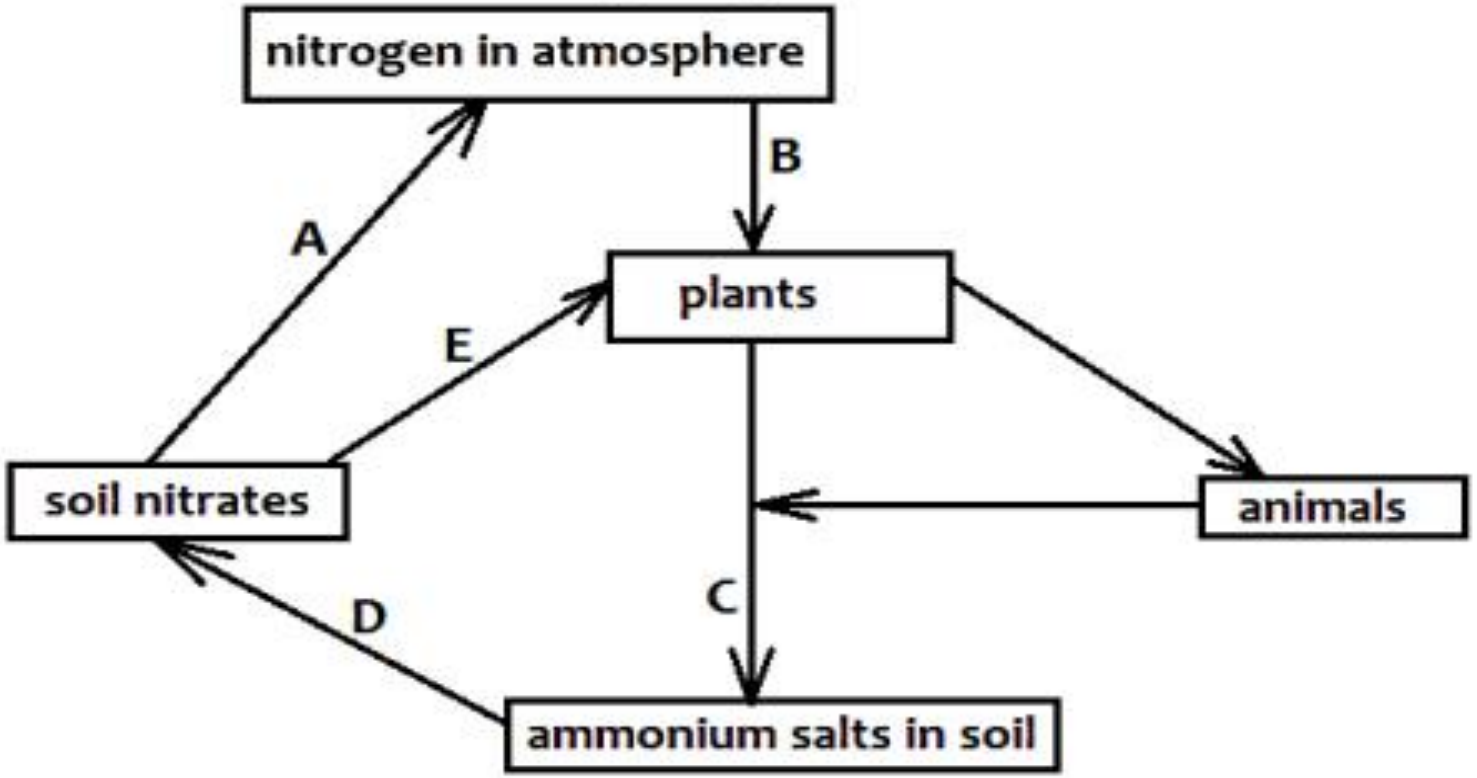
- 1) lightening: this breaks down nitrogen molecules into free nitrogen atoms that combine with oxygen, forming Nitrogen oxides. The oxides dissolve in rain and are washed into the soil where they form nitrates.
- 2) manufacture of artificial fertilizers: nitrogen and hydrogen react in an industrial chemical process, forming ammonia. The ammonia is used to make ammonium salts and nitrates, which are sold as fertilizers.
- QN: What examples of nitrogen containing fertilizers do farmers use in your area?
- 3) action of nitrogen fixing bacteria: these bacteria include; **Rhizobium**, **Azotobacter** and **Clostridium**. These bacteria use nitrogen gas from the air spaces in the soil and bind it with other substances to make nitrates and other compounds. QN: Which bacteria is found in root nodules of Leguminous plants?

Ctd

- Once nitrogen has been fixed, it can be absorbed by plants in the form of either ammonium salts or nitrates used to build up proteins. Animals obtain nitrogen by eating plants or other animals.
- When plants and animals die, their bodies are decomposed by bacteria and fungi. Nitrogen in proteins is converted to ammonia by **Putrefying bacteria** before being released.
- **Nitrifying bacteria** e.g. **Nitrosomonas** and **Nitrobacter** convert Ammonia into Nitrates for plant re-absorption and re-use
- The nitrates and ammonia in the soil are converted into Nitrogen gas, which goes into the atmosphere by the action of **Denitrifying bacteria** e.g. **Pseudomonas** and **thiobacillus**, thus completing the nitrogen cycle

Sample question

The figure below shows the nitrogen cycle.



(a). Name the processes taking place at **A**, **B**, **C**, **D** and **E**. *(05 marks)*

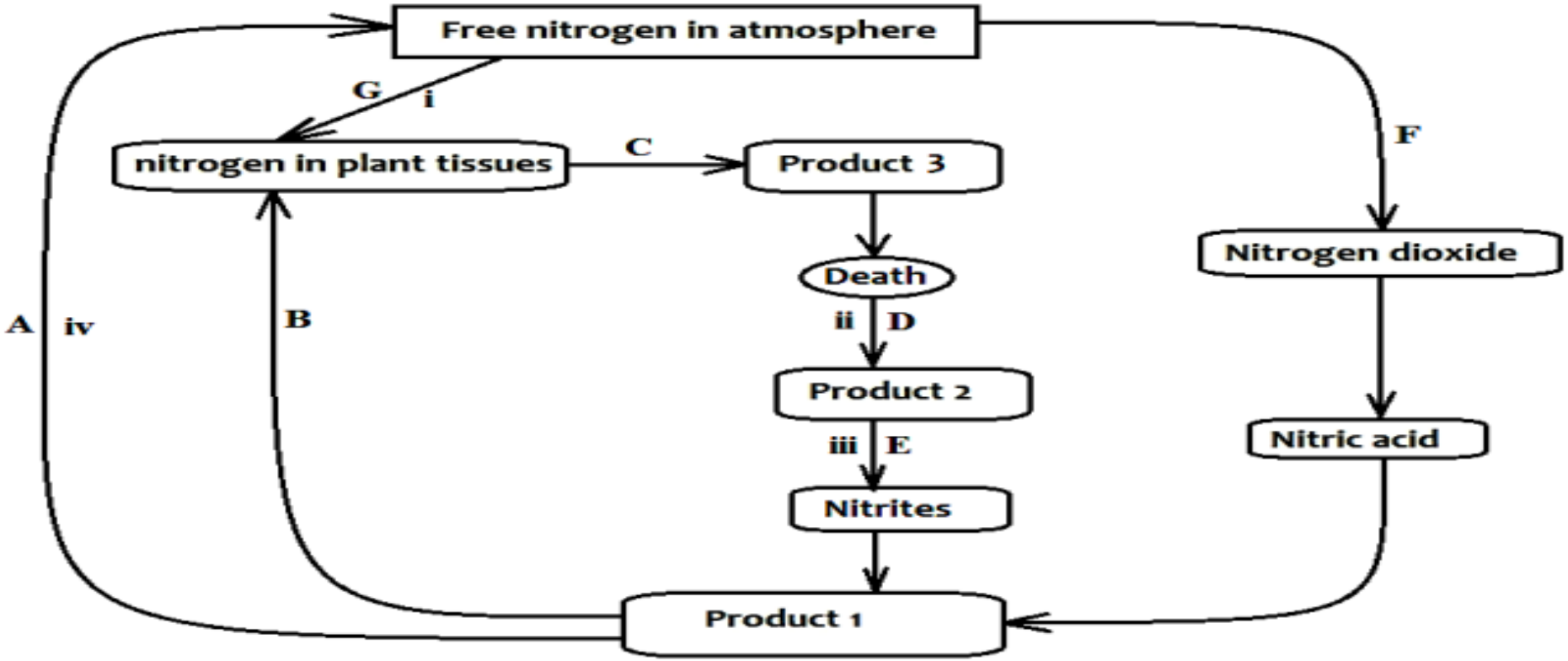
(b). (i). How is the process at B useful to plants? *(02 marks)*

(ii). What organisms are responsible for the process at C. *(01 mark)*

(c). State the importance of the process at A in the cycle. *(02 marks)*

Sample question

The figure below shows the nitrogen cycle.



(a) Name the processes taking place at **A** to **G**. *(03½ marks)*

(b) Name the products **1**, **2** and **3** . *(01½ marks)*

(c) Give the general names of the bacteria represented by **i** to **iv**. *(02 marks)*

(d) List **4** different ways in which nitrogen may be lost from the soil. *(02 marks)*

(e) Explain why water logged soils are usually deficient in nitrates. *(02 marks)*

Microorganisms in the root nodules

Figure 2.8: Root nodules on roots of a leguminous plant

Ctd

- When you uproot a bean or soya bean plant, you notice round swellings on the roots .
- QN: what are they called ?
- Are the swellings on these roots important to the plant? What do the above features contain?

Exercise

1) The pictures in *Figure 2.9* show individuals carrying out activities on land.

(A) A woman harvesting crops

(B) People weeding a garden of beans

(C) Men felling trees in a forest

Figure 2.9: Human activities that affect soil nitrogen content

Ctd

- **a)** which activities are likely to improve on the nitrogen content of the soil? How?
- **b)** which activities are/is likely to reduce on the nitrogen content of the soil? How?
- **2)** how can each of the following activities affect the nitrogen content of the soil;

a) use of chemicals to spray fields

b) rearing a cattle on a piece of land

c) burning of bushes to prepare land for planting crops

Activity of integration

At the beginning of each growing season, the farmers in your area prepare their seed gardens by;

- Collecting and burning the plant remains
- Gathering plant remains and using them to make boundaries
- Planting crops while with plant remains are still in the garden

Support material

A B C

Figure 2.10: Ways of preparing gardens for planting

Task

- Design a poster you will use to advise the people in your home area, on the potential risks or benefits of their activities towards maintaining soil fertility and conservation

TEST YOURSELF

- **1.** mention four indicators of a fertile soil
- **2.** describe how each of the following is involved in soil erosion

  a) Detachment b) Transport c) Deposition
- **3.** Suggest how the following conditions are likely to affect the rate of soil erosion

  a) area with light soils b) hilly areas c) soil with much vegetation
- **4.** state how soil fertility can be conserved in the following regions of Uganda;

  a) Lake Victoria basin b) Karamoja region

  c) Kigezi highlands

The figure below represents the Nitrogen cycle

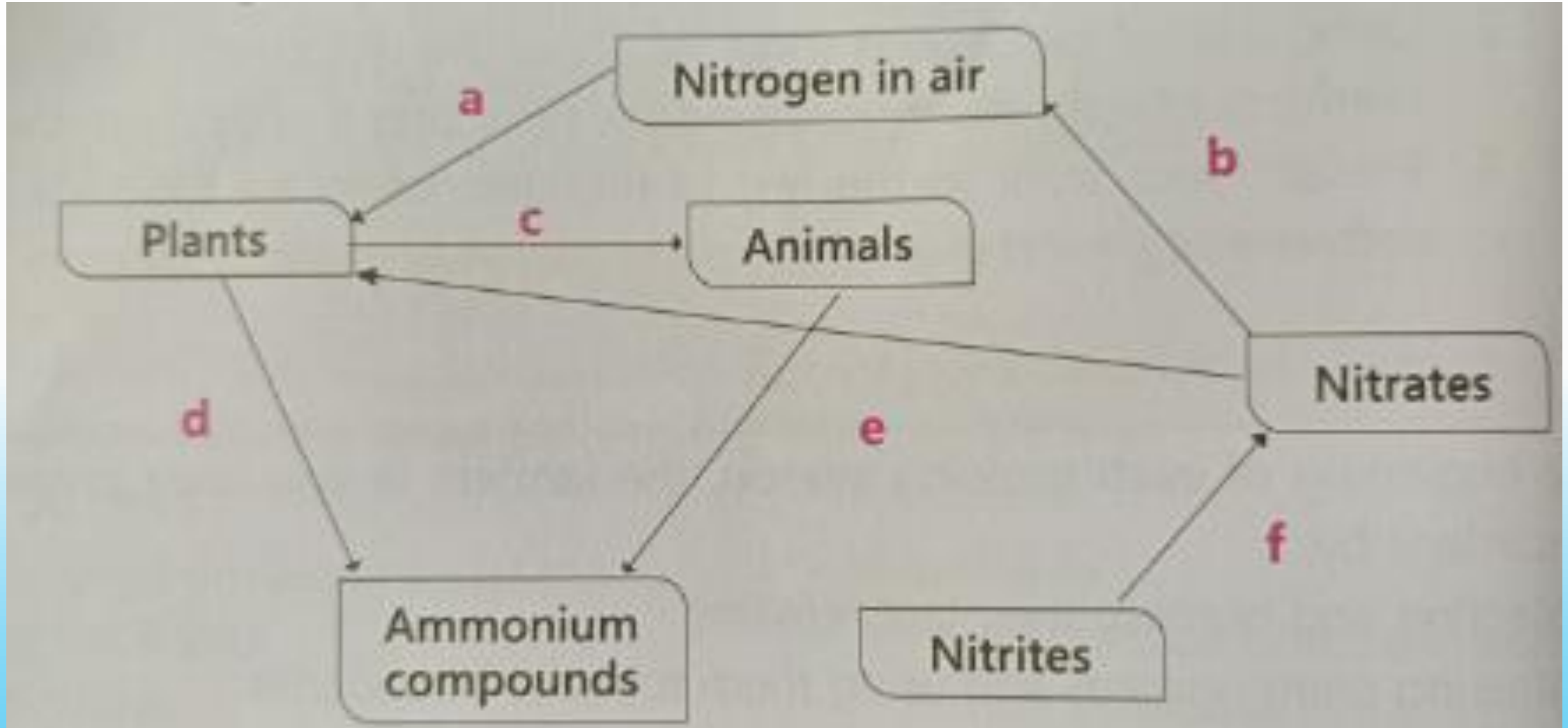


Figure 2.11: The nitrogen cycle

QNS.

- a) name the processes **a** to **f**
- b) how do the processes **a** and **b** affect fertility of soil
- c) identify the microorganisms involved in processes **a**, **b**, **d** and **f**

END

BIOLOGY IS LIFE

SLIDES PREPARED BY TR. OKION .L. PETER