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**GEOGRAPHY 1 FORM SIX LESSON NOTES**

**STUDY OF SOILS**

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**CONCEPT OF SOIL AND SOIL PROFILE**

It is the upper most part of the Earth’s crust that consists of unconsolidated (weathered) materials and consolidated (un-weathered) materials which support the plant growth.

It is a natural body of organisms, minerals, and organic constituents differentiated into horizons of variable depth which differ from the materials below in morphology, physical make up, chemical properties and composition, and biological characteristics.

The term soil has been derived from a Latin word of ***solum****,* which means ground.

The scientific study of a soil, on its origin, characteristics and distribution is called **pedology**.

**Pedology** is defined as the scientific study of soil on their origin, properties, significance and distribution. The soil scientists are called **pedologists**.

**Importance of a soil.**

1. Soil provides mechanical support to plants as their roots held within the soil body
2. Soil is important for the foundations of engineering structures, sewage disposal, gardens and lawns.
3. Soil is important for the foundations of engineering structures, sewage disposal, gardens and lawns.
4. Soil is important for industrial purposes that is it is extracted and used as raw materials to manufacture certain industrial goods. For example. pottery, tiles, brick industries use soils as the chief raw materials.
5. Soil forms the most important base for the life of organisms. Hence, it is among of the elements of the ecological system for living organisms. For instance, soil supports the life of plants and other organisms feed on plants.
6. Soil is used to bury died bodies of human being.
7. Certain soils contain minerals which can be extracted commercially. For example. Apatite mineral is extracted from the lateric soils and used as important raw material to manufacture phosphate fertilizers. This is done near Tororo in Uganda.
8. Soil makes the drainage of the surface as water supplied by the occurrence of rainfall is absorbed into it.

**SOIL COMPONENTS**

Soil components are the constituents of the soil body or materials that contained in the soil body.

**Mineral matters** Mineral matters in the soil body include all soil inorganic substances (particles) found in it. These materials are mainly the small pieces of rock of different size, derived from parent materials by weathering process.

The mineral particles present in the soil vary in size from smaller ones to larger ones. By considering the size of these mineral particles, soils recognized being distinctive as have particles of varied size. Thus; pedologists categorize soils into different types and include the following.

Gravel; 20mm-200mm.

Fine gravel; 02mm -20mm

Course sandy; 02mm -2mm

Fine sandy; 0.02 -0.2 mm

Silty; 0.02 -0.002mm

Clay; less than 0.002mm

Mineral matters in relation to others have volume of abundance of about 45% of the total soil components.

**Organic Matters** Organic matter includes the remains of died organisms (plants and animals) that have been fully or partially decomposed and mix with the soil mass. Part of the soil body largely consists of the organic matters is known as **humus.**

Soil supplied with organic matters from organic manures applied to a soil through agronomical practices. Other sources include died plants, died animals, and industrial organic waste products.

***Soil organisms***

The soil body contains living organisms. Life in the soil include; plants and animals. Plants are also known as flora, while the animals known as fauna.

*Fauna* is categorized into micro and macro fauna depending on the size of animal organisms present is in the soil body. Micro fauna include the smallest animals that cannot be seen by naked eyes unless a microscope is used for example protozoa. While macro fauna include the organisms which are relatively large in size and can be seen by naked eyes for example. all insects and worms.

Similar consideration prevails to flora as are also of varied size and categorized into micro and macro flora. Macro flora, include the plant organisms which are quite small in size and not seen by naked eyes, while macro flora are the plant-organisms of relatively large in size and are easily seen by naked eyes

**IMPORTANCE OF ORGANIC MATTER AND LIVING ORGANISMS IN THE SOIL**

1. By reducing the rate of evaporation from the soil
2. By limiting the water percolation process
3. Organic matters as well as living organisms influence various physical, chemical and biological processes taking place in the soil body. For instance;
4. Physical process like that of physical weathering done by the penetration of plant roots especially of big trees.
5. Chemical process like that of materials decomposition in the soil body by soil living organisms.
6. The presence organisms and organic matters in the soil, form biological role
7. Organic matters help the process of soil aggregation to bind soil particles together. The remains of died organisms act as a glue to bind soil particles together to form aggregates. Hence, soil structure through the aggregation of the particles.
8. Organic matters reduce the plasticity of the soil. Certain soil readily turns into plastic once excessively saturated with water and such soil pose a number of disturbances. But the soil that is with organic matters, the degree of plasticity much minimized.
9. The remains of died organisms provide good habitable environments for the life of the soil organisms. For instance, organisms of earth worms make life in soil habitable environment with organic matters.
10. Adding more plant nutrients to a soil body released from tissues of died plants. For instance; nitrogen, Sulphur, magnesium can be supplied and mostly act as the storehouse of exchangeable captions. The process for nutrients being released into the soil from the broken tissues of organic matters is known as mineralization.
11. Organic matters regulate the chemical condition for the soil through the release of minerals from their broken tissues.

**Soil air** Soil body contains air, which forms 25% the total soil components. Air in the soil occurs in pore spaces (open spaces) of both micro and macro pores. The amount of air in the soil body depends on two determinant factors.

The size of the soil particles. Usually the soil body of large size particles has more amount of air than that of fine particles.

The amount of water present in the soil body. When water occupies a pore space, reduces the amount of air in the soil body, because water also occurs in pore spaces. Hence; there is an inverse relationship between the amount of water and air in the soil body.

The kinds of air present in the soil body include

Oxygen; 20.25%

Carbon dioxide; 0.25%

Hydrogen and others; 79.5%

**Importance of soil air**

a) Air is needed to enable plants to manufacture their own food by photosynthesis process. In the process of photosynthesis, water absorbed by plants, is broken down by sunlight into hydrogen and oxygen, then hydrogen combines with carbon dioxide in series of reaction to manufacture carbohydrates.

CO2 + H2O C6(H2O)6 + O2

**Soil water** Soil body contains water which is derived from rainfall, stream flow and irrigation practices. The amount of water present in the soil is of about 25% of the total soil components.

**Types of soil water**

**Gravitational water:** It is the amount of water that enters the soil and passes out vertically through soil body by gravity. It normally causes the occurrence of leaching.

**Field capacity soil water;**

It is the percentage of water remains in the soil body after all gravitational water has been removed that is water retained in the soil despite the force of gravity.

**Wilting point soil water:** It is the amount of moisture remains in the soil, when the soil reaches a point where its moisture content is similar to that of soil to the extent plants fail to absorb enough moisture and start to wilt.

**Available soil water** It is the amount of water held in the soil between the field capacity and the wilting point levels. The water can be absorbed by the plants.

**Unavailable soil water** It is the amount of water in the soil body below the level of wilting point. The water cannot be absorbed by plants and eventually die.

**Importance of water in the soil body.**

1. Water acts as a solvent of various minerals in the soil body. The makes plants to absorb minerals easily from the soil in solution form.
2. It fastens the process of weathering.
3. Soil water is used by plants to manufacture their own food by the photosynthesis biological process.
4. Water regulates soil temperature.
5. It is needed for the activities of soil organisms to decompose the remains of died organisms that is water enhance biochemical processes taking place in a soil body.

***Soli components***

**SOIL FORMATION (SOIL DEVELOPMENT)**

Soil formation is defined as the evolution (genesis) of a soil from parent rocks under the control of both active and passive factors through a number of processes. The whole process for soil development is known as pedogenesis and it is continuous.

**Stages in the development of a soil**

The first in the development of a soil is the accumulation of a layer of loose, broken, unconsolidated parent materials called *regolith.*

Regolith can be derived from in situ or of the transported materials.

Regolith of in situ results as the exposed surface rocks in the environmental area broken into simpler materials by weathering process.

The regolith of transported materials brought into the environmental area by the running agents include; alluvium by fluvial action, till by glacier, loess by wind or volcanic ash.

The second stage is the formation of a true soil or top soil which results from the addition of other materials of water, gases, and organisms and died matters.

**PROCESSES FOR SOIL FORMATION**

These are the natural activities involved in the occurrence of a soil (soil formation) that is the activities which make a soil to develop. There are various processes of soil formation and broadly categorized into simple and complex processes.

**Simple processes** included those which organize on their own and play a particular function in soil formation. that is process which is sufficient to perform particular role without to involve others. Some of these result into the occurrence of soil horizons.

**The complex processes** are those which involve the combination of other processes in soil formation. These mostly produce distinctive soil types and operate in varied climatic regions.

**SIMPLE PROCESSES FOR SOIL FORMATION.**

**Weathering:** It involves the gradual weakening; and disintegration and decomposition of rocks into simpler particles under the influence of different weather forces of like rainfall and temperature changes.

Weathering makes the exposed surface rocks broken into simpler materials of regolith then into simpler materials of mineral substrates.

Weathering prepares the materials for other processes to take place to make a proper soil, and it is considered being the most fundamental process in soil formation.

Weathering is extremely varied as it causes rocks breakage in different ways. It is thus; categorized into the following forms.

*Mechanical weathering* The exposed surface rocks are gradually disintegrated into simpler substances without being altered or decomposed by chemical reaction. That is a rock is disintegrated into successively fragments by mechanical means without any change in chemical composition. It takes place through the processes of exfoliation, frost action, salt crystallization and slacking.

*Chemical weathering:* It is the decomposition of the exposed surface rocks by chemical reactions, which involve the combination of water, certain atmospheric gases, and certain atmospheric gases of like oxygen and carbon dioxide, penetrates the rocks and make them decomposed and gradually break apart. This takes place through the processes of carbonation, hydrolysis, oxidation, hydration and solution.

*Biological weathering*

By biological weathering, the exposed surface rocks are gradually disintegrated in simpler fragments by the organic activities like wedging action of the roots of big trees.

**Leaching:** It is the removal of materials in solution or suspension downwards as water move vertically through the soil body by the force of gravity. It results into the movement of soluble and suspended materials in water percolating.

Leaching has two folds of *eluviations* and *illuviation.*

*Elluviation*is a washing out of materials in solution or suspension from the overlying parts of the soil body.

*Illuviation,* is the accumulation of the materials taken from the overlying parts of the soil body. Eluviations is of two categories and include; chemical eluviations and physical eluviations. *Chemical eluviations* occurs if materials removed from the overlying parts in solution after to have been dissolved in water; while *physical eluviations* takes place when materials removed in suspension.

Leaching is considered being a process in soil formation as it may causes a soil body developed with some horizons particularly the A and B by eluviations and illuviation respectively.

**Humification:** It is process by which the remains of died organisms of both plants and animals accumulate, decompose and mix with soil to form humus in a soil body. The process is greatly done by the soil living organisms. It is one of the important processes in soil formation as it makes a soil to have humus, which is one on the soil components. The process occurs rapidly in tropical humid areas. It takes place gradually in cool regions.

**Organic sorting** It is a process of re organizing the mineral particles and organic matters to form soil aggregates. This process improves soil structure.

**Mineralization** It is a process by which the dead plants and animals are broken down and mineral-nutrients which were present in their body tissues are released into the soil body and then taken by other plants.

**Cheluviation:** It is a process in which the minerals are dissolved and transported down wards under the influence of chelating agents. Chelating agents are the organic acids produced after the decomposition of organic matter.

**Capillary action:** It is an upward movement of water to a surface and may cause some materials deposited to form a layer materials depending on the nature of bed rocks from which the solution has been derived.

**COMPLEX PROCESSES FOR SOIL FORMATION.**

Complex soil forming process operates in different geographical regions with varied climatic conditions. They are so pronounced for forming distinctive soil types. These have been named in basis of soil types produced.

**Podzolization** It is a soil forming process which leads to the occurrence of podzols soils in cool wet climatic regions. It involves humidification, severe leaching of basic oxides and limited leaching of organic materials to form acidic ash-grey colored soils known as **podzols**.

The process mostly occurs in cool humid regions where the rate of organic matter decomposition is gradual due to the prevailing low temperature. The humid condition results into eluviations and illuviation of minerals, but most of the organic materials are not removed and remain nearly the surface to form soils with remarkable organic horizon called **podzols**.

**Laterization/ferralization** It is a complex soil forming process which leads to the occurrence of lateral soils in humid tropical and sub tropical regions. It involves a rapid rate if organic matter decomposition and severe leaching of both organic and inorganic materials from overlying soils. The water supplied by occurrence of rainfall makes most of the organic materials which have been well decomposed, and minerals easily washed from the overlying parts of the soil body as water percolate. This forms lateric soils with little organic matter nearly the surface. Such soils become hard in dry season and are reddish in appearance.

**Calcification:** It is a soil forming process that leads to the occurrence of calcific (calcareous soils) with calcific (Petroclacic) most top horizon in dry areas of semi arid. It involves limited leaching and severe upwards movement of dissolved calcium carbonates from the lower parts of the soil body. The calcium carbonate moves upward in solution by capillary action and reaches the surface or nearly the surface at where it evaporates making the solution to change back into original state of calcite deposits. Thus; **calcareous soils** with **calcite deposits** develop.

**Salinization** It is a process by which salts are drawn upwards to the surface in solution through capillary action to form saline soil in hot desert areas.

It takes place in regions where evaporation is greater than precipitation. It leads to the increase in soil salinity and hence gives to poor plants growth. Deposition of salt materials leads to the development of a hard crust on top which adversely affect the growth of plants.

**Gleization** It is a soil forming process which leads to the occurrence of immature soils (glei soils) in areas of poor drainage where both organic and inorganic matters incompletely decomposed.

Glei soils by Gleization develop commonly in areas of the following nature.

1. Cold climate where frost is common making incomplete materials decomposition.
2. Gentle sloped (depression area) where the underlying rock is impermeable.
3. Water tables is high enough to enter profile
4. Heavy rainfall where the underlying rock is impermeable.

**FACTORS OF SOIL FORMATION**

The rate and nature of a soil to be formed in environmental area is influenced by certain variables. The variables which influence the occurrence of soils are known as factors of soil formation.

The factors influencing soil formation are summarized as follows:-

Soil = f (PCROT) whereby:

**P-Nature of parent rocks**

**C-Climate.**

**R-Relief.**

**O-Organisms**

**T-Time**

The factors of soil formation are broadly categorized into two major groups of active and passive factors.

**The active factors** include those which exert their own energy to make the occurrence of soils and also other factors depend up on them. They include climate and organisms.

**The passive factors** include those which depend on other factors as do not exert their own energy to make occurrence of soils. They include; relief, time and nature of parent materials that is the factors which depend on others to give soil to give formation.

**The nature of parent rocks**

1. The nature of parent rocks has a lot of influence on the speed with which weathering occurs. Some rocks are more resistant to weathering than others.
2. Nature of parent materials influences physical soil properties like; texture, structure, water permeability, porosity and others. For instance; the rocks which are resistant to weathering, once weathered produce particles of relatively large size and produce a course textured soil. Such soils are relatively permeable have larger pore spaces and whose particles lie loosely. It is conversely to rocks which are less resistant to weathering.
3. The nature of parent materials from which soils form, influences mineralogical composition. That is kinds of minerals contained in a soil primarily derived from parent rocks.
4. The nature of the parent rocks makes the occurrence of certain types of soil. For instance, the limestone underlying bed rocks, may give to the development of calcareous soils of either terra rosa or rendzina.

**Climate**

1. Climate influences the disintegration of parent rocks through weathering to produce simpler particles which then mix with other materials of air, water and organic matter to form true soil body.
2. Rise in temperature and also exfoliation depends on temperature change. Rainfall also influences both chemical and mechanical weathering.
3. Climate influences soil formation indirectly by favoring the growth of vegetation which then plays following roles.
4. When plants die and decay release organic matter and minerals in the soil body
5. The roots of plants especially of the big trees influence biological weathering as their roots penetrate into the ground making rocks breaking apart.
6. Climate determines the types of soil at a global scale. That is the distribution of soils corresponds much closely to patterns of climate and vegetation.
7. Climate makes soils to have horizons formed by leaching and capillary action as water percolate or rise upwards respectively. Leaching makes a soil developed with A and B horizons, while capillary action makes a soil developed with calcite or saline layers depending on the nature of rocks from which the solution has been derived.

**Relief (topography)**

It is considered on the general physical appearance or surface form of the environmental area where a soil is formed. Relief has the following effects on soil formation

Relief by slope of the land determines the rate and depth with which a soil is formed as follows.

1. In steep sloped areas, soil formation takes place gradually (takes so long) as the running agents easily remove most of the soil forming materials. It has also to be noted that, a soil which formed in areas of steep slope, is shallow.
2. In gentle sloped areas the rate of soil formation is faster enough because the soil forming materials readily accumulate, and mostly result into deep soil.
3. Level lands are poorly drained and mostly develop into marshy. These do not make soil develop to maturity due to slow rates of leaching and decomposition of the soil forming materials.
4. Relief modifies the effects of climate on soil formation. In highland areas, temperature much lowered by higher altitudes and results to low rate of materials decompositions as it can compared to areas of low altitudes.

Relief by aspect influences the rate of soil formation as follows.

1. Wind ward side has higher rate of soil formation as materials rapidly decomposed by the adequate moisture as heavy rains experienced. Lee ward side has low rate of soil formation due to slow rate of materials decomposition made by scarcity of rains.
2. Relief makes variation of soil characteristics in the same area if it has contrasts. Such a soil is known as soil catena. Soil catena is defined as the sequence of soil types down a slope where each soil type (facet) is different from but linked to its adjacent facet.

**Organisms**

Organisms influence soil formation in the following ways

1. Organisms of plants particularly the big trees, cause biological weathering as their roots penetrate into the group to produce mineral substrates which then mix with other materials to form soil.
2. Organisms of like ants, worms, termites, mites, woodlice and others; cause decomposition of material in varied ways and some include the following
3. They burry leaf litter with soils.
4. They make eating some of the litter.
5. They secrete enzymes from their bodies which break down the organic compounds.
6. The soil living organisms respire out carbon dioxide gas which dissolves in water to form weak carbonic acids. The acids lead to decomposition of both organic and inorganic materials.

**Time**

The longer the time, the more the soil is matured. Soil usually takes long time to form. It perhaps up to 400 years for 10mm and it can take 3,000 -12,000 years to produce a sufficient depth of matured soil for farming.

**SOIL PROFILE**

Soil profile is defined as the vertical section of the soil body from its top part to the bottom where there is underlying bedrocks mostly characterized by having varied horizontal layers.

The hypothetical matured soil profile has the following horizontal layers of O, A, B, C, and horizons.

O-Horizon; (Organic horizon)

A -Horizon; (Horizon of eluviations)

B -Horizon; (Horizon of illuviation)

C -Horizon (Regolith horizon)

D -Horizon (Bed rock horizon)

**O-Horizon (Organic horizon);** It is the upper most layer of soil body formed by the accumulation of materials derived from plants and animals. It is highly consisting of organic materials and it is the most productive part of the soil body.

Organic horizon sub divided into

O1-It is recognizable to the unaided eyes. It is mainly consisting of organic materials, which have not been properly decomposed.

O2-It is organic horizon with materials which have been well decomposed. It is not so easily identifiable, and it is termed as humus.

O3-it is a sub part grading to A-horizon.

**A-Horizon (Eluviation horizon);** It is a zone of depletion and that is why, it is called eluviations horizon. It develops following the removal of materials to the underlying horizons by leaching.

The zone also consists of organic matters by being laid immediately after O- horizon.

It is sub divided into the following sections.

A1-A layer, which is still with organic matters. It is an organically rich layer and dark colored.

A2-Proper eluvial horizon and it is light colored.

A3-A layer grading into B- Horizon.

**B-Horizon (Illuvation Horizon)** It lies in between of A and C- Horizons. It consists of very little organic matters. It is the layer of accumulation by receiving all materials eluviated from O and A horizons and that is why, it is referred to a layer of illuviation.

It is sub divided into

B1-Upper illuvial horizon and it is considered as the transitional horizon having properties of both A and B horizons.

B2-The main depositional layer and it is the part of the soil body where maximum accumulation of the materials takes place.

B3-Illuvial horizon grading into C horizon.

**C-Horizon (Regolith horizon)** it consists of weathered parent materials at which soil starts to develop. It may also consist of materials accumulated by the transporting agents. There is no any organic activity taking place in this part of soil body.

The upper part of it has some properties of B horizon and recognized C1. The rest part is recognized as C2 being the main (clear) regolith horizon.

**D-Horizon (bed rock horizon)** It is largely consisting of bed rocks.

**Soil Cantena: -** Is where soils are related to the topography of a hillside a sequence of soil type down slope.

**Importance of soil profile**

1. It supports the life of both plants and micro-organisms in the soil.
2. Soil profile (depth of the soil) determines the penetration of plant roots. If the profile is shallow the roots have limited chances to penetrate as it can be compared on where the soil is deep, the roots may penetrate more into the soil.
3. Influences drainage in the soil. Deep profile makes good drainage of the soil as more water easily percolate into the soil.
4. It influences aeration in the soil body. Deep profile has more air compared to shallow profile.
5. It Determine water holding capacity. Deep profile holds more water compared to shallow profile.
6. It has ideal influence on soil fertility. Deep soil has a lot of nutrients, water and air than can be taken by plants to maintain their growth.

**SOIL PROPERTIES**

Soil has a wide range of varied nature and these are generally recognized as soil properties. Soil properties are so varied and broadly categorized into three group of the following:

1. Physical soil properties
2. Chemical soil properties
3. Biological soil properties

**Physical soil properties** Physical soil properties include; texture, structure, colour, temperature, porosity, density, and depth.

**Soil Texture;**

Soil texture is defined as the feebleness or fineness or coarseness of a soil determined by relative proportional of soil particles of different diameters.

The size of particles can make the soil course textured, medium textured, and fine textured.

Texture of the soil can be assessed by the following methods.

1. Sense of feel
2. Particles size analysis

**Sense of feel method**

The method is done in the field in which a soil sample is rubbed preferably in wet condition between the finger and the thumb, and may give any the following result

*Gritty feel:* Implies the soil is of course texture as whose particles large in size and recognize being sandy soil.

*Flour feel The* soil is slightly fine or medium texture as whose particles medium in size and it is recognized as silt soil.

*Plastic soil* The soil is of fine texture as whose particles quite small and it is confirmed as clay soil.

**Particles analysis method**

The particles size analysis is the most accurate method and it is done in the laboratory that is texture of the soil recognized by their size. The following is proper arrangement of soil type according to texture by particles size analysis.

|  |  |
| --- | --- |
| **Diameter of particles (mm)** | **Name of the soil** |
| Less than 0.002 | Clay |
| 0.002 – 0.02 | Silt |
| 0.02 – 0.2 | Fine sandy |
| 0.2-2 | Course sandy |
| 2 – 20 | Fine gravel |
| 20 – 200 | Gravel |

**IMPORTANCE OF SOIL TEXTURE.**

1. It determines the relative resistance penetration to plants root into the soil. Where the soil particles are large, roots can penetrate more easily than they do on fine grained soils which are usually compact.
2. It determines the infiltration rate of water into soil. Infiltration rate is easier to the coarse textured soils compared to fine textured soil as whose particles lie so compacted
3. It Influence soil resistance to erosion. Erosion is easier to soil which are coursed textured as particles lie so loosely.
4. It Influence soil fertility as it determines the ability of soil to hold nutrient and water for plant use.
5. It Influence other physical soil properties of like; soil permeability, compaction, structure, porosity, and water retention capacity.

**Soil structure**

Soil structure refers to the arrangement (aggregation) of individual particles according to their size into soil shapes. The way in which soil particles are grouped or bound to form soil shape.

Structure of the soil is of two kinds and includes; single grained and massive structure.

*The single grained structure*, each particle lies independently that is not cemented to other particles and forms its own structure. A good example of soil with single grained structure is that of sandy.

*The massive soil structure*, particles are cemented to one another to form crumps (lumps)

The formed crumps (lumps) can be large or small in size. The larger crumps (lumps) are called aggregates, while the smaller crumps are called peds.

The ability of a soil to form aggregates or peds largely depends on its texture. Whether course or fine. Usually the fine texture soil has higher ability to form aggregates than the course textured soil.

Soil aggregates produced as the particles cemented, are best explained in basis of their shape and include the following:

**Platy Aggregates:** The aggregates have more developed horizontally than the vertical dimension

**Prism Aggregate:**

The aggregate is more vertical developed than the horizontal dimension.

**Brocky Aggregate:**

All dimensions of the aggregate are nearly equal in size.

**Sphere Aggregate:** The soil aggregate is nearly (roughly) round.

**Importance of soil structure**

1. It has an influence on soil aeration. High degree of aeration is to a soil which less compacted compared to soil which is well aggregated.
2. It has an influence on soil drainage. Compacted soils like clay poorly drained compared to less compacted soils like sandy which is well drained.
3. It is an influence on seed emergence. Young plants easily emerge out where the soil is less compacted.
4. It has an influence on plant growth by influencing root penetration and water retention.
5. It has an influence on cultivation process. Soil is readily cultivated if is less compacted like sandy
6. It is good indicator of soil fertility. Compacted soil is assessed fertile as it has higher ability to retain much water and nutrient for the growth of plants.

**Soil color**

Soil colour understood as an appearance of the soil relatively to the influencing factors, Soils have varied colours .Soil have all colour expert pure blue and pure green The common colours of soil include ;white , red , brown, red -brown ,grey ,yellow , and black. However some greenish and bluish may occur.

**Causes of soil color**

**The amount of organic matters present in the soil body**. Always high content of organic matters gives dark colored soil or dark blown soil.

**Mineral composition of soil.** Minerals give soil colours. For example; the presence of hydrated iron minerals gives to the reddish colored soils. Presence of salt minerals makes the soil be lighter colored; manganese oxide makes black colored soil, glauconite makes the soil greenish, calcite makes the soil white.

**Leaching process** This makes the removal and accumulation of materials through eluviations and illuviation respectively. Eluviation gives to a lighter colored soil, while illuviation gives to dark colored soil.

**Climate** This has considerable influence on a soil colours. The humid tropical climate makes soils become reddish in colour .While colour humid climate cause soils to be grey in colour.

**Significance of soil colours.**

1. Soil colours tell the productivity of a soil for crops cultivation; for example, the dark colours soils gives an impression that, the soil is rich on organic materials (matters) and it is more productive.
2. Soil colour tells about the relative amount of moisture present in the soil.
3. Soil colours tell about the pattern of climate in place .For instance; Reddish colored soil indicates warm climate as such soil is formed by such climatic pattern.
4. It tells about the kinds of minerals present in the soil body. for example. Red colored soil, gives an impression (indication) that the soil has hydrated iron minerals.

**Soil porosity**

Soil porosity refers to the sum total space not occupied by solid matters in the soil body. Or sum of empty space in between of the particles.

The space are commonly known as pore space and usually filled with water and air.

There are two types of pore space basing on their size and include the following

*Macro pores (non capillary pores)* they are large in size and usually allow free air and water movement within the soil body. They do not make capillary action readily.

*Micro pores (capillary pores)* they are quite small in size. Soils with such pores hold much water.

Soil porosity is influenced by the following factors

**Size of the particles** Small sized particles easily bound and thus, make the soil to have micro pores. In contrast to large sized particles, make a soil to have micro pores.

**Organic matters present in the soil body** organicMatters may make soils to have micro pores as particles easily bound together.

**Importance of soil porosity**

1. Soil porosity has an ideal effect on drainage and water holding capacity.
2. It Influence aeration in the soil body. Macro pores make soil to hold more air compared to micro pored soil.
3. It Influences soil fertility as it determines the ability of a soil in holding water and nutrients for plants use.

**Soil temperature**

It is a degree of heat of a soil body. This physical soil nature is created as a body of soil warmed by heat radiated from the sun.

Soil temperature tends to vary considerably from places to places or even time to times due to certain determinant factor. The factors include the following

**Amount of heat energy** supplied to the soil surface. High amount of heat energy makes soil warm. It is unlike if there is low amount of heat supplied to a soil surface.

**Soil properties** relatively to heat energy absorption. For instance the dark colored soils absorb more heat than the lighter colored soil. Thus the Dark colored soils are comparatively warm than the lighter colored soils.

**Ground covers**, soil that are covered with vegetation are generally cooler than exposed soils.

**Significance of soil temperature**.

1. Soil temperature determines the existence of soil living organism. For instance, in extremely hot or cold conditions, the micro organism may not exist.
2. Soil temperature controls the bio- chemical process taking places in soil body.
3. It controls the amount of moisture in the soil body. Where there is high temperature, soil moisture is low due to excessive evaporation.
4. It Influence the occurrence of some horizon in the soil body like horizons of calcite deposit and salt crystals.
5. Soil temperature influences the growth of plants.

**Soil density**

Soil density refers to a weight per unit volume of soil. The density of the soil is expressed as follows

**Particle density** It is the weight per unit volume of soil solids. This is expressed as follow.

=gm/cm3

**Bulk density** It is the weight per unit volume of the whole soil by considering soil sample. Or the ratio of soil weight to soil volume. Bulk density is expressed as follow.

=gm/cm3

Bulk density of the soil is affected by the following factors.

1. Organic matter content.
2. Granulation.
3. Compactness of the soil.
4. Cultural practice

**CHEMICAL SOIL PROPERTIES**

Soil has considerable chemical properties. The pronounced chemical soil properties include the following

**Soil reaction** Soil body contains diverse of material .They include mineral water, gases and organic matters. The material are of varied chemical nature and their proportional amount in the soil, mostly make soils be in varied chemical condition like acidity, alkalinity, and neutrality. The chemical condition created by the material understood as soil reaction.

It is therefore soil reaction can be defined as the degree of alkalinity , acidity and neutrality of the soil relatively to the proportion amount of hydrogen (H+) and hydroxyl ions (-OH)

The soil to be in acidity, alkalinity, or neutrality depends on the concentration of hydrogen ions (H+) and hydroxyl ions (-OH) present in the soil body.

The soil solution with more hydrogen ions (H+) is made to be in acidic condition.

The soil with more hydroxyl ions (OH-) is in alkaline condition.

If the amount of hydrogen and hydroxyl ions present in a balanced ratio, the soil is made to be in neutral condition.

Soil reaction is expressed in terms of PH. **PH of the soil is defined as the negative logarithm of hydrogen ions concentration of the soil solution.**

Assessments of soil PH

The PH value of the soil is assessed by finding out, the concentration of the hydrogen ions (H+) in the soil solution. This can be done by using one of the following methods.

1. The electrometric method.
2. The colorimetric method.

*The electrometric method* By the electrometric method, the soil reaction is determined by means of PH meter, the hydrogen ions concentration of the soil solution is balanced against a standard hydrogen electrode then a reading is made.

If a reading is about below 7, the soil is in acidic condition that is (1-6.9). If a reading is above 7, the soil is in alkaline condition that is (7.1-14).

If a reading is 7, the soil is in neutrality.

The PH meter runs from 1-14, but most of soils have the PH values that range from 3.5 to 11.

*The colorimetric method;* It is done in the laboratory by using dyes. A dye is poured into a container with a soil solution. Dyes sink slowly into the soil solution, then develop a certain colour depending on the state of soil solution .The colour developed is by then compared to a standard colour chart with PH description.

The following are the common colours in standard colour chart and their interpretation.

* Red – The soil is very acid
* Pink –The soil is slightly acidic
* Green – The soil is neutral
* Blue – The soil is slightly alkaline.
* Purple- The soil is very alkaline.

**Causes of soil acidity**

* Leaching of bases (basic oxides) of calcium, magnesium, potassium and sodium. The basic oxide causes a soil being in alkaline. It is therefore, if removed as water percolate downward may cause the overlying soils become acidic. Leaching of the basic oxide may result from heavy rainfall and excessive irrigation.
* Microbial activities and decomposition of organic matters. These commonly produce organic acids and commonly intensified acidity.
* The use of the acidic forming fertilizers like that of ammonium sulphate.

**Cause of soil alkalinity.**

Soil alkalinity is mostly caused by the presence of the basic oxides in the soil.

Insufficient amount of rains, the conditions which do not cause the severe removal of bases. Hence basic oxides steadily concentrate to make the soil alkaline.

**Agronomical significance of soil PH**

1. It determines the suitability of the medium for plants growth and micro organisms in the soil.
2. It determines the extent of organic in the soil body and selection of crops to be grown depending on their level of tolerance. For instance; if the soil is assessed acidic, the crops of sweet potatoes, groundnuts, millet, cotton and tea can be grown as they require acidic soils.
3. Soil reaction affects the availability of plants nutrients for example. nitrogen calcium, phosphorus and potassium are mostly available at PH range value from 6.5 to 7.5 as PH range favors a lot the decomposition of organic matter.
4. Soil PH being an indicator of degree of acidity and alkalinity gives an estimate amount of amendments to be done to a soil so as to bring favorable condition for plants growth.

**Amendments of soil pH**

The growth of plants and decomposition of materials in the soil body by micro organisms, largely depend on acidic or alkaline, does not pave a way for good plants growth or decomposition of material in soil body. It is therefore important for good methods to be taken to correct soil PH, if is too acidic or too alkaline.

The methods would be taken, depends on the prevailing PH condition.

**Lowering the soil acidity**

Since soil acidity results from the scarcity of exchangeable captions, the best thing to be done is to add to the soil materials which contain **metallic captions.** The materials are known as limes and the process is called liming.

The common materials for liming are of oxides and carbonates of calcium and magnesium. When these substances added to the soil, they add the amount of the exchangeable bases as a result the soil acidity reduced.

**Acidification of the soil**

**Eradication** It is a process of removing the sodium salts and other basic oxides from the overlying soils by passing a lot of water to cause leaching.

**Conversion** It is a process of adding materials to the soil which may cause acidity as they react with the basic oxides. These materials can be of like **gypsum** and **sulphate.**

**Leaching**

Leaching is a washing out of materials more particularly the minerals in solution or suspension down wards the soil body when water is percolating.

The process is of most dominant in humid regions for most of time like that of equatorial and other wet tropical and temperate areas. Leaching process is influenced by the following factors

1. Size of Soil Particles
2. Climate
3. Slope
4. Vegetation

**Effect of soil leaching**

1. It causes the decline of soil fertility due to the fact that most of the plant nutrients are washed away in solution from the plant roots zone. This causes the plants to get very little to absorb. Increases soil acidity as the exchangeable bases which would cause the soil be alkaline, leached away from the overlying soils.
2. It influences soil colour. This occurs as the materials influencing the soil colour might be removed in water percolation down wards.
3. It causes the occurrence of horizons in the soil body by the processes of eluviations and illuviation. Eluviations make the occurrence of a horizon as materials removed while illuviation makes the B horizon as the materials accumulate.
4. It decreases microbial activities due to the increase of soil acidity.
5. It affects proper plant growth due to the increase of soil acidity, decrease of microbial activities and depletion of nutrients.

**Cation exchange**

It is a process in which the cations (positively charge particles) of like calcium (Ca) magnesium (Mg) potassium (K) and sodium (Na) replace hydrogen ions in the soil. Replacement of mineral materials between the parts of the soil.

The Cation exchange can be between soil particles and soil solution and plant roots. Usually the Cation exchange in the soil body is influenced by the following factors.

* Concentration of ions that is ions move from high concentration to low concentration.
* Reactivity of ions. More reactive ions usually displace less reactive ions.

**Soil colloids**

These are minute substances, which when dissolved remain dispersed in liquid. They include both mineral based colloids and organic based colloids.

**Properties of soil colloids;**

**They are negatively charged.** This makes many positively charged ions called cations be attracted and adsorbed around each colloid particles.

**They exhibit ion exchange**

Ion exchange is a reversible process whereby cations or anions are exchanged between solid and solid or between solid and liquid phases.

**Soil nutrients**

These are the chemical elements found in the soil which are essential for plants growth and the maintenance of the soil fertility. The sources of nutrients in the soil include the following

1. The weathering of rocks from which minerals derived.
2. Application of the artificial fertilizers to the soil.
3. Rain water of rainfall may react with certain gases to from **nutrients.**

**BIOLOGICAL SOIL PROPERTIES**

Biological soil properties widely include the following;

Soil living organisms Organic matter

**Soil organisms**

Soil body has habitable system which supports the life of organisms in the soil vary in size from smaller ones to larger ones and all these inhabitants find their food in the soil. They carry out a number of biochemical activities. The name of plant kingdom is known flora, while that of animal kingdom is known fauna. Both plants and animals are categorized into micro and macro-organisms depending on their varied size.Microorganisms include: bacteria, algae, protozoa, fungi, virus, and eelworms: while macro organisms include; millipede, earth worms, tile, ants, slugs etc.

**Importance of microbial activities;**

**Nutrients supply**. Microbial activities break down the tissues of died plants and animals to release mineral nutrients which were absorbed into their body. The process for mineral nutrients be supplied from died plant and animal tissues by being broken down due to microbial activities **is called mineralization**.

**Nitrogen balances in the soil**, some organisms such as nitrogen bacteria, blue algae, have a lot of nitrogen in their bodies; with their presence in the soil body helps much to supply more nitrogen. The supplied nitrogen makes significant balance to the amount absorbed by plants.

Supply more organic matter by breaking down the residues.

**Improvement of soil structure**. The organic by products released in the process of organic materials, decomposition by micro organisms, help to bind soil particles together.

**They make symbioses with higher organisms**. Some micro organisms live within plants and animal tissues and benefit their host with symbioses for example. the legume bacteria which live in the tissues of legume plants supply more nitrogen to a plant by nitrogen fixation.

**Organic matters**

Organic matters refers to the remains of died plants and animals which have been fully or partially decomposed and mixed with soil.

**Sources of organic matters**

Organic matters present in a soil derived from the following origin sources.

Organic manures applied to a soil through the agronomical practices. Organic manures include:

1. Compost manure
2. **Farm yard manure**
3. **Plant remains.** Plant remains of tree roots, shoots and grasses are important origin sources of organic matter in the soil.
4. **Industrial waste products,** industrial waste products if added to a soil, undergo rapid decomposition. But it is basically to organic industrial waste products.
5. **Died animals,** these normally undergo decomposition and mix with the soil mass.

**FACTORS THAT INFLUENCE ORGANIC CONTENT IN THE SOIL**

The quantity of organic matter in the soil, and its rate of accumulation and decomposition are determined by numerous factors, and include the following;

1. **The degree OH Aeration** The greater the soil aeration, the faster and more complete is the decomposition of organic materials
2. **Soil Moisture and Temperature** Combination of adequate moisture and reasonable temperature condition ranging from  to  favours a lot the decomposition of organic matters.
3. Topography
4. Fertility Status of the Soil More organic content is to soil of high fertility degree and vice versa is true. This is because, a fertile soil supported greatly the growth of plants and then the plants release organic materials.
5. Soil Reaction High organic matter content is to soils with PH ranging from slightly alkaline to slightly acidic due to the fact that, such the soil PH range supports greatly the microbial activities in the soil.
6. Ecological System

**Importance of organic matter in soil**

1. Organic matter influence moisture in the soil. that is retain moisture in the soil body. This is by reducing evaporation and by limiting the rates of water percolation for example. mulch mostly reduces the rate of evaporation.
2. Organic matters help the process of soil aggregation to bind soil particles together. The remains of died organisms act as a glue to bind soil particles together to form aggregates. Hence organic matter mostly influences the building of soil structure.
3. Organic matters reducing the plasticity of the soil.
4. The remains of died organisms provide habitable environment for the life of the soil organisms.
5. Add more plant nutrients to a soil body released from broken tissues of died plants for examples nitrogen sulphur, magnesium can be supplied.

**SOILS CLASSIFICATION**

Soil classification is a science or an art of grouping soils into different types according to specific properties and factors.

It is a systematic categorization of soils based on distinguished characteristics as well as criteria that dictate their choices in use.

In classification soil, there are several criteria used such as texture, time, fertility, drainage, colour and orders. However; some of the systems have been employed by the pedologists to make soils classification. The most outstanding criteria include:

**Empirical systems**

It is the system in which soil is classified according to their properties like; texture, colour, depth and other however; texture of soil mostly used.

**Integrated classification systems**

It is the system which considers all aspects related to soil development especially the factors which have influenced their varied characteristics. It potentially considers the orders of soils.

**Soil classification according to texture**

Classification of soil according to texture has been devised by engineers according to their consideration on soil nature that needed to sustain structures. The most common engineering classification system for soil in North America is known as **unified soil classification system (USCS)**

Soils according to textures considered on the relative size of the particles which greatly make the soil with respect to this soil are classified into the following types

**Sandy soils** These are the soils whose particles are large in diameter ranging from 0.02 to 0.2mm. The soils which in a greater proportional contain larger particles, sandy have the following properties.

1. Easy for being cultivated.
2. Well-drained
3. Well-aerated
4. Vulnerable to erosion as particle loosely to one another.
5. Contain limited amount of organic matter.

**Silt soils** these are the soils of which over 70% contain the particles whose diameter size range from0.002 to 0.02mm

Silt soils have the following properties.

1. Retain more amount of moisture It is also vulnerable to erosion.
2. It may cement in time of heavy rain

**Clay soils** These are the soils of the over 70% contain the particles whose diameter size are less than 0.002mm. Clay soils are distinctive by having the following properties.

1. Have high -level of nutrients and organic matter Difficult to plough.
2. Prone to water logging
3. Difficult for plant roots penetration Expand when wet and shrink when dry.

**Loam soils** These are the soils which have 20% of clay to hold water, 40% of sand to prevent water logging and well aerated 40% of silt to act as adhesive holding sand and clay together.

**Soil classification according to order**

Soil classification by order, it considers the outstanding factors which have determined the characteristics of soils. This has been devised by the USDA and put soils into different types by considering the most outstanding factors which influenced the nature and occurrence of soils.

World wide soils according to order grouped into the following types.

1. Zonal soils
2. Intrazonal soils
3. Azonal soils

**Zonal soils**

Zonal soils are the ones whose characteristics have been principally influenced by climate than other factors and occur over wider areas with similar climate and vegetation patterns. These are also known as climatic soils.

Zonal soils have the following properties.

1. They are matured enough in exception of the tundra soils.
2. They result from maximum effect of climate and vegetation up on parent rocks.
3. Had enough time to develop distinctive profiles and usually clear horizons
4. They occur over a wider area under similar climatic condition.

Zonal soils broadly divided **into tropical, temperature and tundra soils.**

**Tropical Soils** Tropical soils include the following

**Ferralitic (Lato) soils** These are soils with thin layers of humus result from the high annual temperature and rainfall in equatorial region and tropical eastern margin, where organic matters and bed rocks rapidly weathered chemically.

**Lato soils** have the following profound nature

1. Whose parent materials almost completely decomposed
2. Silica has been entirely removed (leached) from the top soil.
3. Sesquioxides of iron and aluminum have accumulated in the soil as abundant and permanent residual materials.
4. Humus is almost or entirely lacking because of rapid decomposition and leaching of organic matters.
5. The soil is distinctively reddish because of the presence of iron sesquioxides.
6. Have great depth due to rapid weathering of the underlying rocks.

**Ferruginous soil:** Ferruginous are also known as Lateric soils. They are zonal soils with thin dark –brown layer of humus found in regions of tropical continental and monsoon climate where rains occur seasonally. The nature of soil is made by the rapid decomposition and leaching of grasses and bed rocks in which silica easily removed and the sesquioxides of iron and aluminum left behind.

Ferruginous soil has the following profound nature.

1. Like Lato soils, whose parent materials completely decomposed
2. They tend to be soft, but once exposed wet and dry seasons, they can harden to form a cemented crust known as lateric.
3. They are dark-brown colored.
4. They have thin layer of humus.

**Desert soils** These are the alkaline thin grey colored soil lacking moisture and humus. They are unproductive and formed under dry climate

**Temperature Soils** Temperate soils include the following

*Podzols grey soils* They are grey acidic soils, occurring in areas of high latitude with cold climate and coniferous forest. The needle shaped leaves, of coniferous forest fall to the ground and leads to the acidity.

*Brown earths soils (brown Podzols soils)* The soils are very rich in organic matter content and mostly found in regions of deciduous woodland of temperate cool climate. High organic matter content is derives from the accumulation and decay of leaves. They are much superior to the grey Podzols.

*Grey brown Podzols* The soils which are in transitional from grey Podzols to brown earth’s soil. They are widely found in Western Europe.

*Brown forest soils* They are brown soils formed in areas of warm wet temperate climate with deciduous forest. The soil is produced as leaf litter rapidly decomposed and leached leaving behind sequoisides of iron and aluminum.

*Chernozem soils* These are also known as black earth’s soil. They are rich in humus due to insufficient of rain to carry grass derived humus deeper. The soils are widely formed in areas of cool temperate continental climate with grasslands vegetation pattern. ie it is formed in area where the climate is moderately cool and moderately wet. Such soils are widely found in Eastern Canada where wheat is cultivated.

*Prairies soils* The soil is in transactional state between chernozems of sub humid warm temperate areas. The soils are dark brown. They are formed in area where the rains totals are moderately high.

*Chestnut soils* They are alkaline soils found in areas of arid and semi arid temperate climate. Alkalinity of the soil is caused by capillary action as the rate evaporation is greater than precipitation.

*Tundra soils* These are the soil with little humus in areas of very cold climate throughout the year with tundra vegetation.

**Intrazonal soils**

These are the soils whose characteristics reflect the dominance of a single local factor such as parent rocks or extremely drainage. ie soils which develop in a particular environment irrespective of climatic conditions.

Intrazonal soils have the following profound characteristics.

1. They are not related to general climatic control.
2. They are not found in zones
3. The soils occurred at a place where special material and relief condition have exerted strongly influence on soil formation and characteristics than the climate that is the characteristics of the soil depend much on the parent materials and relief condition.

Intrazonal soils include the following;

**Calcareous (Calcimorphic) soil** The soils which have developed up on limestone parent rocks that is soil formed from the accumulation of materials derived from disintegration of limestone rocks. They include the following;

***Rendzina;*** This develops up on softer limestone rocks or chalks as the parent materials and grasses form surface vegetation.

***Terra Rosa;*** It is a red colored soil found in areas of heavy seasonal reasons where calcium carbonate as parent materials chemically weathered by carbonation and silicates are leached out of the soil to leave a residue deposit rich in iron hydroxides.

**Hydrormorphic soils** These are the soils formed in water logged areas like marshes and have constantly high water content. The soils formed in local areas of general level topography making high water accumulation. They include the following;

1. Glei soil: Formed in saturated soils when the pore spaces become filled with water to the exclusion of air. The lack of oxygen leads to anaerobic condition.
2. Peat: Occur where a soil is water logged and the climate is too cold for organism to break down vegetation completely as a result layers of peat accumulate.

**Halomorphic soils** These are the soils which contain high level of soluble salts because of being derived from rocks that contained much salt minerals and have developed through the process of Salinization. The soils widely occur in hot desert. Halomorphic soils include the following

1. Solonchak soils: These have high salts accumulation on the surface.
2. Solonetz soils: These have more salt accumulation in B- horizon.

**Azonal soils**

These are the soil without well developed characteristics. They do not have a well developed soil profile and they are young soils. Most of these soils formed over steep slopes which do not offer enough time for the materials forming soil to become matured enough.

Azonal soils include the following

1. Litho soils (stony soils)
2. Rego soils- Including sandy dunes and gravely deposits
3. Mountain soils which are mostly shallow
4. Volcanic soils formed by lava deposition.

**SOIL EROSION**

Soil erosion is the wearing, detachment and removal of soil from one place to another by the action of running agents like water, wind and ice.

Is the process by which the top soil is detached and carried away by various agents at a rate that is faster than it is being produced by the soil forming processes.

It is the detrimental process that causes the decline of land value and mostly results into low crop yield. It is one of the major global environmental problems affection agriculture and environment.

**Types of soil erosion**

Soil erosion is classified according to its nature of occurrence, type of eroding agents and the appearance of the affected land.

According to the nature of occurrence, soil erosion is broadly categorized into two as follows:-

**Geological erosion** It is the erosion that takes place before the land has been cleared for any human activity like farming, mining and others. It is the smoothing downhill and counteracting great upheavals of the earth’s crust caused mainly by the movement of water, ice and wind.

**Accelerated erosion It** is type of erosion according to nature of occurrence which results by being aided through human activities of like deforestation, overgrazing and mining all of which weaken the stability of materials and pave a way for the running agents to operate fully.

**Wind erosion** It is the removal of top soil mainly caused by the blow of wind in dry areas in which, the dry unconsolidated materials are easily removed by wind force.

**Water erosion** It is the removal of materials by the water action it is sub divided according to the appearance of the affected land and includes the following diverse forms.

**Splash erosion** It is the type of erosion, by which the fine textured soil are easily dislodged by the impact of raindrops. The erosion is more significant to bare land than the soil protected with vegetation.

**Sheet erosion** The type of erosion involves the uniform removal of the upper layer of the earth’s surface. Such erosion occurs after the beating action of raindrops combining with the surface flow rainwater.

**Rill erosion** It is the type of erosion by water action which causes the land to be developed with small channels called rills formed by high, concentration of the surface flow of rain water that is The erosion occurs because run off is faster:

**Gully erosion** Gully erosion is the continuation of rill erosion. As the volume of water runoff increases, the rills change into gullies by being more widened and deepened

**FACTORS INFLUENCING SOIL EROSION**

The nature and rate of erosion is largely influenced by the following factor

**Natural factors**

**Climate** Climate influences erosion through precipitation and wind.

-Precipitation of rain and snow is forceful factor causing soil erosion through splash, sheet, rill and gullies. Heavy down pour of rains, causes severe soil erosion compared to slow drizzles. This is very common in humid areas.

-The blow of winds causes the removal of soil by deflation, abrasion and attrition processes especially in dry areas.

**Ground covers** Ground covers of vegetation (grasses and forests) retard soil erosion in a number of ways as proved to provide protection of soil than the cultivated crops.

-Ground covers vegetation reduces the impacts of rain drops and water surface runoff.

-The vegetation of big trees acts as windbreakers.

**Topography** It is considered on the degree of slope steepness of the land. The slope of land affects the extent and the rate of soil erosion particularly by the action of runoff water. The greater the slope, the greater velocity of flowing water. Therefore soil erosion is more severe to steep sloped land compared to gentle sloped land by water action.

**Soil characteristics (nature)** Soil characteristics such as texture, structure, organic matter content and others, influence soil erosion. For instance soil erosion is more severe to course textured soils, than the fine textured soils. It is so because the course textured soils whose particles lie so loosely to one another and more susceptible to be removed by the running agents.

**Man-made factors**

**Overgrazing** Overgrazing is a practice of keeping large number of animals than the range land carrying capacity. This causes severe destruction of vegetation and exposes the soil to the hazard of erosion.

**Monoculture** The practice of growing a single crop continuously is referred to as monoculture. The growth of the same crop over a number of years increases the hazard of soil it is therefore, advised to practice crops rotation.

**Burning** Some people have the tendency of burning vegetation for several reasons. The practices of burning vegetation expose a soil to the hazard of erosion.

**Deforestation** It is practice of removing the trees without replacement. Vegetation provides considerable protection to soil against erosion in the following ways. The leaf cover helps to reduce the force of raindrops which would otherwise loosen and remove soil particles if their force not checked.

The rate of infiltration of rain water into the soil is increased by plant covers and thus, reduces (decreases) runoff water.

The plant roots hold the soil more firmly.

Plant covers act as winder breakers to block the force of wind flow.

Reduce the impact of raindrops that would cause splash erosion.

The decayed vegetative matters provide humus which binds the soil particles together.

**Growing of crops in areas that receive little rainfall** If people cultivate crops in areas that receive little rainfall, after harvest the field is not likely to be covered with vegetation and gets more exposed to erosion hazard. Therefore it is advised to practice irrigation farming in areas that receive little rains.

**Ploughing to follow the slope** This practice accelerates much soil erosion to occur because soil erosion hazard is more severe on sloped land. It is therefore advised to practice contour farming on sloped potential agricultural land.

**Mining** Mining activities also expose the soil to a danger of being eroded in a number of ways and some include the following.

It is associated with removals of ground covers.

It weakens the earth’s materials and makes them easily removed by the running agents.

**Engineering works** Engineering works of like roads construction also weaken the stability of the earth’s materials and pave a considerable way for erosion to take place.

**EFFECTS OF SOIL EROSION**

1. **Loss of soil fertility** The top soil is most productive part as it contains over 90% of plant nutrient such as phosphorus, nitrogen etc. the subsoil is infertile. Therefore, soil erosion removes the most productive.
2. **Low crop yields** With the loss of soil fertility causes low crop yield. This results as the soil is with little moisture, nutrients and air to support reasonable growth of plants.
3. **Shallow soils** The pedological phenomenon causes the eroded land to have sallow soil as a lot of the top soil washed away.
4. Decrease forestland.
5. Soil left behind is thin and cannot hold plants firmly in the ground. The plants are easily uprooted and blown away by wind.
6. Destruction of houses
7. Erosion may cause destruction of houses and other structures this happen when the soil around them is eroded and thus weakening their foundations.
8. Difficult to cultivate the land:
9. Gully erosion renders the land to be cultivated. Deep gullies prevent the movement of farm machines something which causes great inconveniences and less efficiency in farm operation.
10. It hinders navigation Soil erosion proved to hinder navigation. The eroded soils and other materials may be deposited into streams, harbors lakes etc and reduce their depth. Hence the mentioned likely to have shallow water something which is not convenient for navigation.
11. Floods Soil erosion increases the hazard of flood as the eroded materials deposited into streams.
12. Water borne diseases.
13. Soil erosion causes the water borne diseases to occur after stored water in the reservoirs to be contaminated with the harmful materials that have been deposited into them by stream water.

**Control of soil erosion**

Erosion seriously affects soil productivity and the land value. Therefore it is important that good methods of conserving the soil to be introduced. The main methods of controlling soil erosion include the following

1. Crop rotation
2. Contour farming
3. Terracing.
4. Planting trees and grasses
5. Mulching
6. Hill side ditching
7. Cover cropping
8. Green manuring
9. Controlled grazing.

**SOIL FERTILITY**

Soil fertility refers to the ability of a soil to support the growth of plants by supplying all plant nutrients, water and air in a sufficient and balanced ratio. The soil that supports the growth of plants by having nutrients, water and air is described as **fertile soil**.

**FACTORS INFLUENCING SOIL FERTILITY**

Soils are considerably varied in the degree of fertility. Some are fertile enough, while others are less fertile. The variation in the degree of soil fertility is by certain factors which determine the sufficient supply of water, air and nutrients to be taken by the plants. The main factors include the following

**Soil texture**

Soil texture bears importantly on soil fertility due to its influence on water and plant nutrients holding capacity and aeration. The fine textured soil as whose particles quite small and lie so closely, retain reasonably water and nutrients for plants. The course textured soils as whose particles large and lie loosely to one another, allow free percolation of water and the nutrients easily leached from the plant roots zone.

**Depth of the soil profile.**

The depth of the soil profile determines the extent of plant roots penetration and more supply of nutrients, water and air. Deep soil increases the volume through which plant roots can spread to take water and nutrients. Therefore shallow soils are infertile because of being with little nutrients, water and air and suffer from drought very quickly.

**The position of ground water table**

High water table interfere the profile of the soil and thus results into poor drainage which causes exclusion of air from the soil. Hence plants lack air from the soil in exception of the plants that are adaptive to such edaphic condition.

**Soil structure**

Soil structure affects moisture and aeration in the soil body. Hence; it has similar significant role to soil texture.

**Soil reaction**

This bears importantly in influencing soil fertility as determines the rate of organic matter decomposition in the soil. Soil that is slightly acidic or slightly alkaline is more fertile because of having great extent of plant nutrients as organic matters greatly decomposed.

**Organic matter**

Organic matter acts as a soil conditioner by influencing soil moisture, aeration and structure. Beside it is an important source of plant nutrients supply. It is thus, soils with a lot of nutrients are reasonably fertile.

**The composition of parent materials**

The composition of parent materials influences the natural supply of inorganic nutrients. The nutrients that released from the parent materials include; potassium, calcium and magnesium

**LOSS OF SOIL FERTILITY:**

Loss of soil fertility refers to the decline in the soil ability to support plant growth through the failure to provide necessary nutrients for plant growth. The level of soil fertility may not remain the same all the time. It may decline because of some causal factors.

**Soil degradation (loss of soil fertility)**

Soil degradation refers to the deterioration or destruction of the quality of the soil. Soil degradation takes place through the loss of fertility, pollution and erosion.

Soil degradation renders the soil useless for human development, agricultural activities. It is the result of human failure to understand and manage soil.

**Soil erosion:** Soil erosion is a removal of the soil by the action of the running agents like water and wind. The process tends to wash away the top most part of the soil which contains over 90% of all plant nutrients. What remains is the infertile subsoil.

**Leaching**  It is a process by which nutrients are dissolved and they carried down wards in solution away from the plants roots zone through soil profile. When this happens plants fail to get sufficient nutrients as their roots do not reach to the sub soils

**Water logging** This occurs when all the pore space in the soil, filled up with water. This causes air to be driven out as a result, plant fail to get sufficient air from the soil land eventually die.

**Flooding** This causes the nutrients to be carried away in water. It is so severe on a sloped land

**Burning** The practice of burning vegetation kills the soil living organisms which are very important to cause the decomposition of organic matters. More importantly, burning exposes the soil to the hazard of soil erosion.

**Weeding** It is a practice of removing the unwanted plants (weeds) from the field when this is done all nutrients that have been taken by them from the soil lost in weeds as thrown away.

**Harvesting** It is a removal of crops from the field after maturity. It plays the same role to that of weeding as far as the issue of soil fertility loose is concerned.

**Mass Wasting Mass** wasting causes the top soil layer to be washed down the slope in response to the force of the gravity making the subsoil exposed out. This is also causes a soil to loose its fertility so long the exposed sub soil has very little materials necessary for plants growth.

**EFFECTS OF SOIL DEGRADATION**

Soil degradation may have a great effect ranging from an individual to the entire country such effects include;

**Threat on marginal areas** Soil degradation may prompt people to encroach on the marginal areas like forests wetland. This is because such areas maybe believed to be more fertile compared to the degraded areas.

**Lower productivity** Since degradation deprives the soil of the fertility; the crops grown cannot get sufficient nutrients. Therefore further agricultural practices yield less output discouraging the farmers.

**High costs of agriculture:** Soil degradation compels farmers to use more input like fertilizers in order to have more yields. This is done to enhance the yield level of agriculture for that case therefore agriculture becomes more expensive for the local farmer.

**Land conflict** Most of the developing countries depend on land as are source such that it is regarded to be more valuable. Therefore any encroachment on one’s land land made may spark off a conflict.

**Down Stream flooding**  In cases where degradation is associated to erosion degradation in water quality may be one of the most probable effect .This can be brought about by sedimentation in river, lakes and siltation of reservoirs as surface run-off dispose off the load to the nearby water bodies.

**Slump of economy** Soil Degradation slumps the agro-based economies since their export will decline due to the deficit int he output.

**Over Cultivation of the available land** Soil degradation will prompt the over cultivation of the prevailing fertile areas which will later affect them negatively.

**Terrestrial Biodiversity** Since all plants depend on soil, the distortion in the quality of soil will automatic affect the quality of the resulting vegetation. Therefore given that vegetation is a habitat as well as a vital component of the food chain effect a full ecosystem will be affected negatively in case of any tamper with vegetation.

**Methods of maintaining soil fertility**

1. The use of agronomical practices
2. Addition of materials containing organic matters
3. Addition of inorganic measures (artificial fertilizers)
4. The control of soil erosion

**The use of agronomic practices:**

The farmer can improve and maintain the fertility of soil by adopting good farming methods. Usually agronomic practices maintaining reasonable level of organic matter in the soil. The main agronomical practices include:

**Crop rotation**

It is a practice of growing different types of crops in different seasons. The practice helps the maintenance of nutrients to be exchanged in the soil as mostly, the shallow rooted crops are rooted crops throughout the year. More importantly if the nitrogen bearing crops are involved, the nitrogen supply is maintained.

**Mulching** it is a practice of covering the soil with the vegetative materials.

The vegetative material used to cover the soil is called mulch. Mulching helps to add organic matter in the soil. Alongside this mulching provides a protection to a soil from the hazard of erosion by the eroding agents of water, wind and others.

**Green manuring** Green manuring is a practices where by a crop is grown on a piece of land then incorporated into the soil while it is still green and tender. In most cases legumes are used for this purpose. Green manuring also helps to increase organic matter content. More importantly, supply a lot of nitrogen in the soil.

**Cover cropping** It is a practices which involves the use or growing of cover crops. Crop is the one that grown in the empty spaces between the rows of plants specifically to cover the spaces. In most cases the legumes are used for this purpose such as beans and cow beans. Cover crops help much to maintain soil moisture and organic matter content.

**Addition of materials containing organic matter** Materials containing organic matter are **called organic manures**. When such substances are added to soil, the organic matter content is improved. Also organic manures add more plant nutrients.

**Organic manures include the following** Farm yard manures. Manures made of animals dung such as cattle and goats.

**Compost manure.** The manure made from mixture of many things and supplied to the field. This also helps to add more nutrients.

**Addition of inorganic manures** In organic are also known as artificial fertilizers. If inorganic manures added to soil, help to add more plant nutrients. Inorganic manures include the following;

1. Sulphate of Ammonia NH4SO4.
2. Ammonium sulphate nitrate.
3. Calcium ammonium nitrate.
4. Urea.
5. NPK

**SOIL CONSERVATION AND MANAGEMENT**

Soil conservation is a positive strategy of maintenance, enhancement and wise management of soil from being naturally or culturally depleted through the adaptation of both curative and preventive measures.

The process of controlling the processes and activities that would cause deterioration of the soil depending on the condition of the soil.

Soil conservation entails the proper utilization of a soil resource by adopting sound management practices aimed at controlling any apparent depletion by agents of erosion to achieve sustainable development. that is to maintain maximum productivity for the present and future development.

Mostly, soil conservation is practiced so as to prevent the occurrence of soil erosion and the maintenance of soil fertility.

**Soil conservation techniques;**

**Crop rotation;** crop rotation is a practice of growing a different type of crop on each piece of land each year or each growing season. This is done in a cycle so that after several years, the circle is repeated.

**Principles of practicing crop rotation**

1. A crop of different kind should be grown in each plot during each year or growing season for example. Legume should be rotated with non-legume crop
2. Shallow rooted crop should be rotated with the deep rooted crop.
3. Crops which included in the programmed should be of different families.
4. Valuable crop should if possible, follow legumes in the programmer in order for it to have good harvest.
5. A follow period can be included in the rotation for instance grasses can be grown on it.
6. The programmed should involve only the annual crops.

SEASON 1.

|  |  |
| --- | --- |
| Cotton | Beans |
| Maize | Cassava |

**SEASON 2.**

|  |  |
| --- | --- |
| Maize | Cotton |
| Cassava | Beans |

**SEASON 3.**

|  |  |
| --- | --- |
| Cassava | Maize |
| Beans | Cotton |

**SEASON 4.**

|  |  |
| --- | --- |
| Beans | Cassava |
| Cotton | Maize |

**SEASON 5.**

|  |  |
| --- | --- |
| Cotton | Beans |
| Maize | Cassava |

**ADVANTAGES OF CROP ROTATION.**

1. The land is protected from being eroded by any agent. This is because a wide range of crops is grown and therefore land is not left bare in any season.
2. Helps to maintain soil fertility. This is because the system involves the growing of the nitrogen bearing crops and more importantly, the shallow rooted crops are rotated with, the deep-rooted crops something which offer a reasonable exchange of plant nutrients.
3. Crop rotation is a good way of controlling weeds. Some weeds grow more easily when a certain crop is cultivated, and therefore, if a different crop is grown, such a weed is difficult to grow.
4. Crop rotation is a good way of controlling plant pests and diseases. Usually similar diseases and pests attack plants of the same family. But if a crop of different family is grown, pests and diseases may not attack it.
5. Crop rotation provides a diversification of crops something which is of more advantageous commercially.
6. Some plants take a lot of nutrients from the soil and are called heavy feeders. While others take in only a little amount of nutrients and are called light feeders by rotating such crops on the field the level of nutrients in the soil is maintained at a reasonable level.

**Contour farming.**

Contour farming is a system of cultivation in which planting, ploughing and other practices of related done in ridges or rows across a slope from the top to the bottom following the system of contours.

With the contour ridges made across a slope offers the following advantages.

1. It helps much to check the speed of runoff water and thus reduces the hazards of erosion.
2. Soil moisture is retained in the furrows between the ridges and got absorbed by the plants. Involving heavy work in making the ridges across the slope from the top to the bottom.

**Terracing.**

Terracing is a practice of making terraces across a slope. A terrace is an embankment of earth’s stones or any suitable materials or combination of these made across a slope for a purpose of controlling runoff.

The system has advantages of checking soil wash out.

It has also disadvantages of involving heavy work in making the terraces.

**Mulching.**

Mulching is the process of covering the soil particularly the cultivated ground with vegetative litter (plant remains).the main vegetative materials commonly used includes; maize stalks, grasses, banana leaves and others.

The practice is mainly used in the tree plantation, vegetable gardens, and pineapple plantations and others of strongly like.

Mulching being an agronomic practice for soil conservation offers the following **advantages.**

1. Mulching helps to conserve moisture in the soil by reducing evaporation from the soil.
2. Mulching helps to reduce loss of soil by erosion.
3. When mulch rots add more organic matter in the soil.
4. When a litter decomposes supply more plant nutrients in the soil and hence improve soil fertility.
5. It improves soil structure.
6. It helps to control weeds mulch suppress the weeds likely to grow.

**Disadvantages (problems of mulching)**

1. Heavy work is involved in carrying and spreading of the mulch.
2. Mulching materials may uncertainly catch fire and leads to crops damage.
3. If the soil is deficient in nitrogen most of the soil nitrogen is used by organisms which break down the mulching materials, hence the soil organisms compete with plants for nitrogen as a result the growing plants gets little of it.
4. In order to get more mulch you need more land to grow them and it is so as some of the mulching materials are grown.

**Destocking.**

Destocking is the practice of reducing the number of livestock to be grazed to meet the range of the land carrying capacity. This is done because overgrazing has been one of the longstanding causal factors of soil degradation in areas where rain is only sufficient for the growth of pasture; hence in order to alleviate the advance of soil erosion hazards it is mostly appropriate to control grazing.

**Afforestation and reforestation.**

A forestation is a practice of planting trees in areas that had no vegetation while reforestation is a practice of growing trees to replace those which have been exploited.

The practice offers the following advantages.

1. It prevents unnecessary floods that would occur after the clearance of forests
2. Forests slow rate the clearance of runoff.

**Fertilization.**

It is a practice of improving soil fertility by adding either organic or inorganic manures.

Fertilization helps an area to be occupied with good plant covers and in turn reduces the hazard of erosion which might be caused by the running agents.

Organics measure for fertilization purpose includes the following:

1. **Farm yard manures**: manures made of animals dung such as cattle, goats, pigs as well as poultry
2. **Compost manure**: the manure made from mixture of many things and applied to the fail

**Advantages of organic manures**

1. They add more nitrogen and other elements from the broken tissues.
2. They improve soil structures through the formation of humus.
3. They assist the conversation of the organic matter
4. They encourage, the microbial activities

**The limitation of the organic manures**

1. They have high content of organic matter and these gives difficult in storage and transport.
2. They do not have a well-defined chemicals composition hence its nutrients content is not guaranteed.
3. The nutrients elements are not in a balanced ratio hence may not render high crop yield.

In organic manures for fertilization purposes include the following.

1. Sulphate of ammonia
2. Ammonium nitrate
3. Urea
4. Single super phosphates
5. Potassium sulphate
6. NPK

The use of the artificial fertilizers has the following limitations.

1. They do not assist the conservation and build up of soil organic matters.
2. They do not contribute to the improvement of soil structure.
3. They do not encourage the microbial activities.

**Adaptations of irrigation technology.**

Irrigation practices have many advantages to soil:

1. It makes a soil to have enough moisture for most of time.
2. It makes the land to be renewed with vegetation which in turn reduces the hazard of erosion.

**Cover cropping**

Covers cropping is a practice of growing cover crops. A cover crop is the one that grown in the empty space between the rows of plants specifically to cover such space. In most cases the legumes are used for this purpose.

Qualities of a good cover plants (crops)

1. It should not compete with the crops plants for nutrients, water, rooting space or light.
2. It should be able to grow well even on poor soil.
3. It should be drought resistance crop.
4. It should be not an alternate host of insects, pests or diseases causing organisms.

**Advantages of cover crops**

1. They protect the soil from evaporation and erosion and therefore improve the infiltration of water into the soil.
2. Covers crop help to control weeds that is they usually suppress the weeds likely to grow.
3. Because most covers are legumes, they help to improve the nitrogen content in the soil.
4. When they rot more organic matter is added to a soil.

**Problems of cover crops**

1. Cover crops may compete with the plant crops for water especially during dry season. This makes the grown crop plants which are in a target to get insufficient water.
2. They may act as alternate host of insects, pests and disease-causing organisms.
3. They may compete with the crop plants for nutrients and root spacing.

**Strip cropping.**

It is a practice of planting crops and trees in alternative strips parallel to one another. Usually different plants and crops are planted in each strip and them ripe at different time and harvested at varying interval.

The practice prevents the entire field from being left bare at any time which would lead to sheet erosion or wind erosion.

**Fallowing**

Fallowing is a practice of which the field is left to rest for some years after intensive use. It is the process of cultivating the land for a period and then allowing it to stay idle without cultivation for a number of years

Fallow period helps the soil to restore its fertility during the period of rest. However the practice is only possible to regions where population density is not a problem that is it is largely practiced in regions of low population density.

**Green manuring.**

Green manuring is a practice where by a crop is grown on a piece of land and then incorporated into the soil while it is still green and rotten. In most cases the legumes are used for this purpose.

Qualities of green manuring crops

1. It should be able to grow on poor soil.
2. It should be a drought resistance crop.
3. It should be able to grow quickly and produce large quantity of vegetative materials.

**Advantages of green manuring**

1. It helps to improve the fertility of the soil by improving the organic matters, nitrogen, and other elements into the soil.
2. Roots of the green manuring crops absorb nutrients from the sub soil and bring them to the surface.

**Problem of green manuring**

If annual rainfall is low almost all the water is used up by the green manuring crops as the result the crops suffer from the shortage of water.

**Land cultivation before rain season.**

The practice of ploughing the land before the rain season helps to check the effect of running water on the surface of soil. The rain water sinks into the soil when it has been already ploughed.

The practice offers the following advantages.

1. It minimizes the hazard of soil erosion
2. It maintains soil moisture by preventing its loss through runoff.

**Hillside ditching.**

It is a practice of making hill side ditches. A hillside ditch is a small ditch made with a gradient of a half to one percent, with the earth removed from the ditch placed on the lower side to form a bund or ridge. The ditches are usually 30 centimeters deep and are dug along the contour line about 20 to 30 meters apart. Crops are grown on the strip of land between the ditches but not on the binds.

The technique offers the following advantages,

1. It is good way for controlling erosion as a speed of water runoff is checked.
2. It is also a good way of maintaining moisture for plants as water retained in the furrows between the bunds (ridges) the method has a disadvantage of involving heavy work in making the bunds.

**Inter cropping**

This is because certain crops and plants especially leguminous species such as peas, beans which are capable of fixing atmospheric nitrogen to soil, thus improving its quality.

**Government policy:**

The government should formulate policies which advocate community participation, proper use of land, induce following of the restrictions.

**Soil pollution**

Soil pollution refers to the introduction or presence of any substance in the soil which adversely affect the soil quality. The substance which pollutes the soil is called a pollutant.

**SOURCES OF SOIL POLLUTION**

Pollution can be from the atmosphere, industries, home stead and agriculture areas.

1. **From the atmosphere:** The pollutants are introduced through the acid rain. These make the soil become acidic and hence destroy the soil structure and killing the plant. Acidic rain is predominant in the industrialized areas like Germany.
2. **From the industries**: Some chemicals, radioactive material can be introduced into the soil and render the soil unfit for agriculture. Some of the chemicals are poisonous therefore they kill plants after getting into the soil.
3. **From the homesteads:** Some wastes like metal materials, bottles, plastic bags, cans etc lead to the pollution of the soil.
4. **From the Farms**: Chemicals like pesticides for example. DDT, crop remains, fertilizers can be produced and get into the soil under the influence of rainfall.
5. **Irrigation:** agriculture encourages the accumulation of salt (Stalinization) in the upper soil layer. Also agricultural activities can cause negative pollution of soil through the depletion of vegetation.

**EFFECT OF SOIL POLLUTION**

1. Decline in fertility because of addition leading to the decline in crop production
2. Destruction of soil structure and texture.
3. Death of soil biota (organisms), which are very important in the decomposition of organic matter.
4. It can lead to water logging or flooding due to poor drainage. It interferes with aeration making the soil unproductive.
5. It makes man incur a lot of costs when trying to fight against the problem of soil pollution. For example liming for reducing acidity in the soil and flushing so as to reduce soil salinity.
6. Soil pollution can also lead to people’s migration to the areas, which are not affected by pollution.
7. Crop failure yields caused by pollution leads to the occurrence of famine, which in turn causes poor health, and death of people.

**SOIL CONSERVATION AND MANAGEMENT**

**Soil management:** refers to the skillful or wise use and control of the quality of the soil (land) resource.

**Soil conservation**: refers to the process of preserving the soil for proper and sustainable use.

**REASONS TO UNDERTAKE SOIL CONSERVATION**

1. To maintain the quality of the land preventing it to get exhausted and become totally unproductive.
2. To improve or restore the quality of the land where there has been exhaustion as to promote production.
3. To get more land and produce more products for satisfying the burgeoning population in the countries.
4. To ensure that the coming generation can benefit from the same land used today.

**CONSERVATION METHODS**

1. **Educating people** so as to promote the land management ideas among the people. This should be undertaken by the government and some committed individuals.
2. **Training and encouraging the farmers to use proper farming methods** like crop rotation, inter cropping, use for organic manure, Strip cropping, Contour ploughing and deep ploughing.
3. **Planting of cover crops, afforestation and reforestation** in order to check soil erosion by reducing the speed of water on the surface.
4. **Reducing and stopping the use of pesticides** like dieldrin, DDT, and artificial fertilizers, which tend to destroy the soil.
5. **Recycling of wastes** rather than dumping them into the soil.
6. **Restocking** in order to avoid overgrazing that leads to the destruction of grass.
7. **Encouraging dry farming** that involves mulching in order to reduce Loss of water through excessive evaporation especially in the dry areas.
8. **Land filling** with brushwood should be used where the soil has been severely eroded production gullies.
9. **The population should be controlled** so as to discourage the excessive exploitation of resources, which leads to land degradation.
10. **Alternative sources of energy** should be explored and used to avoid the excessive use of forest materials and oil, which cause hazard to the environment.
11. **Radioactive materials** should be dumped very deep in the soil to prevent the upper soil layer from being highly affected.
12. **Terracing, construction of stone lines** (in Burkina Faso) and **check dams** (in China) so as to control the movement of water and force to get into the ground rather than flowing like the surface run-off.
13. Developing other economic activities rather than depending on agriculture only especially in the developing countries.
14. **The government should formulate good policies** which advocate community participation, land tenure and encourage the proper use of the land. Where possible people should be given financial support so as to invest in scientific agricultural techniques (which are not precarious to the soil.)

**SOIL CONSERVATION IN TANZANIA**

Tanzania has also been experiencing the problem of soil erosion in many part. This has been affecting agriculture in a negative way through the loss of fertility and the reduction in the size of arable land. **Poor cultivation methods on the** slopes, overgrazing in some places, deforestation because of cutting trees and **over cultivation are some of the causes** which have been responsible in the occurrence of soil erosion in different parts of Tanzania. The problem of population pressure in some places has been so instrumental in the facilitating deforestation and land fragmentation.

**Soil Erosion and Conservation in Kondoa (Tanzania)**

Kondoa is the one of the areas, which has been affected by severe soil erosion. It was caused by:

1. Unstable soil due to semi aridity.
2. Sporadic heavy rains that tend to wash away the loose of soil materials.
3. High population in the area led to the destruction of vegetation.
4. Hilly landscape on which water runs fast.
5. High animal population that led to overgrazing.

**STRATEGIES TOWARDS SOIL CONSERVATION IN TANZANIA**

1. Contour ridging on the slopes of the highland and hills. This is practiced widely in Rukwa, Tabora , some parts in Mbeya (Mbozi and Rungwe) and Iringa.
2. Using farm yard manure to restore fertility. The use of farm yard manure is common among the Sukuma, Ukara-Ukerewe and Sumbawanga Where people collect cow dung from the grazing areas or cattle sheds.
3. Fallowing is also practiced whereby people leave the land uncultivated for sometime especially after exhaustion so as to regain its fertility.
4. Resettlement scheme or villagization programs were introduced with the aim of improving the land use and stop shifting cultivation, which is a poor method and detrimental to the environment.
5. Encouraging crop rotation so as to stabilize the soil.
6. Planting drought resistant crops in the widely cleared dry lands.
7. The use of leguminous plants like sun hemp (marine) and cultivation of groundnuts as well as beans so as to maintain fertility. Sun hemps are used in Ruvuma (in Namanjule villages), Dodoma, Mbulu, Tanga, Rukwa, Iringa, Songea, Mbeya Especially in Mbozi and Kigoma sun hemp is used as a weed killer.
8. The use of Ngoro farming system in Umatengo (Mbinga) District in the southern part of Tanzania. In this system the crop are planted on the ridges and all the waste matter is thrown into the pit so as to get rotten future use as manure.
9. Inter cropping in which perennial crops are combined with food crops. The perennial crops add up fertility through shedding the leaves. Inter cropping help in stabilizing the soil hence checking soil erosion.
10. Encouraging the restocking commercial ranching and rotational grazing in paddocks.
11. Afforestation programs like HADO ‘Hifadhi Ardhi Dodoma” were introduced in which the trees were planted to prevent soil erosion and combat the drought conditions.
12. Mulching is also used to prevent erosion and excessive evaporation when the grass decays it adds to the soil fertility.
13. Terracing is also used in some areas associated with planting of grass, which provides a uniform cover, and reduces the speed of the running water down the slope.
14. There are some programs for educating people both in schools and in adult classes such programs are also disseminated on the radio, through newspaper, printing on the vests and matchboxes which carry information that encourage environmental conservation.
15. Introduction of irrigation schemes in some places like in Usangu, Dodoma, Kilombero and Nyumba ya Mungu etc.

**DRAWBACKS HINDERING SOIL CONSERVATION IN TANZANIA**

1. Financial problems due to poverty among the farmers they therefore can’t invest in the modern programs of oil conservation.
2. Low commitment among the members of the local government and individuals reforestation programs. The National tree planting Campaign that was stated in 1999 has not yet realized good progress so far.
3. The problem associated with the tree planting campaign is that the trees, which were planted, were not carried for they were forgotten and literally abandoned to die; thereby sabotaging the conservation campaign.
4. Lack of effective and efficient coordination of the soil conservation activities both at a local level and at a national level.
5. Rapid population increase creating pressure on the land and its resources the land is cheap resource; any need for excessive population (like food) is met by exploiting land resources especially through agricultural activities. Most of necessary information is confined in urban areas and people in rural areas are not yet reached due to transport problems.
6. Political problems siphon a lot of money in the process of solving them. So most money is directed to these problems rather than solving environmental problems, which use extravagant amount of money that could helping soil conservation.
7. There low international support.

**PROBLEMS OF AGRICULTURE IN TANZANIA:**

1. Soil erosion: This destroys the land in many parts of Tanzania especially increase like Usambara, pare and Kondoa–Iringa areas.
2. Unreliable and poorly distributed rainfall: sometimes there long droughts leading to crop failure while at times it is too much leading to flood is unevenly distributed due to relief, wind and the over head sun.
3. Temperature, diseases and pests: The tropical climate encourages the trivial of diseases and pests, which harm people, crops and animals in the farms. For example fungal diseases, bacterial diseases and malaria are a rampant problem in Tanzania. Pests include army worms, quell, locusts, and grasshoppers and stalk borers. Animals like monkeys and pigs attack crops in the farms.
4. Too seasonal rivers: There is a big problem with rivers such that sometimes they go dry leading to problems of water availability in the irrigation schemes. Dams are not constructed due to the lack of capital.
5. Land shortage: In some places due to overpopulation like in the Chagga land and Umatengo etc, some people are landless. In those areas land is highly fragmented and hence mechanization is difficult. Apart from

overpopulation other areas are swampy mountainous have mining pits, etc leading to problems in cultivation.

1. Poor knowledge and low technology: Most of the farmers use poor farming methods due to poor knowledge and low technology. In some places the farmers are illiterate and hence they cannot learn new methods of farming easily since they are still conservation and adamant to accept new and positive changes.
2. Poor marketing system: The internal market is poor due to low purchasing power among them is bought on credit without being paid early. The international market is also poor due to price fluctuation. Sometimes the prices are very low discouraging the farmers to a great extent.
3. Gender discrimination and inequality: Women are the ones who are involved more in agricultural products and land. They are not involved in the decision making process, they are not well trained and do not own land because of poor cultural traditions. This contributes to the decline of agricultural production in Tanzania.
4. Poor transport and communication: Some areas are like Rukwa, which is one of the granaries of Tanzania, experience great problems of transport and communication. Hence, ferrying of agricultural products, disseminating information on new agricultural techniques and distributing important services that support agriculture become difficult.
5. Poor storage facilities: Most of the farmers in rural areas do not have good storage facilities such that they cannot store properly their produce. Most of the agricultural products go bad leading to great losses.
6. Too much selectivity and dependency in one crop: Some communities are used to certain type of food crop and are not ready to switch to another type of crop. Such that once that crop fails they get problems of hunger while they could as well grow another crop that could serve the same purpose.
7. Agricultural policies: They have not been so emphatic on agriculture due to the diversification of priorities. Unlike in the USA and China, the policies have been so soft such that agricultural development has been dwindling time from time in the rural areas. This has led to food shortage such that Tanzania has been importing some food from outside despite having great potentials for producing adequate amount of food.
8. Rural- urban migration: People especially the young ones, are so mobile moving from rural to urban areas Rural–urban migration has negatively affected agriculture in Tanzania. Many young people are living in the village and flood the towns leaving the rural areas with young children and the old people who cannot effectively and efficiently engage themselves into agriculture.

**STRATEGIES TO IMPROVE AGRICULTURE IN TANZANIA**

1. There should be comprehensive schemes for undertaking soil conservation by the methods like crop rotation, controlled grazing, contour, farming, dry farming (mulching), terracing and strip cropping as well as facilitating the processes of restocking, afforestation and reforestation.
2. Educating people both in the school system and out of school (formal and non–formal education) on how to apply sustainable method of cultivating.
3. There should be high disease and pests control by cleaning the thickets, draining water, from the ponds and marchers, spraying the crops with chemicals, improving health care centers and developing researches on different disease.
4. Introduction of irrigation schemes. Hence reservoirs or dams should be constructed to ensure constant supply of water in the farms, such attempts have been made in Tanzania like the Nyumba ya Mungu dam, Mtera dam, Mindu dam in Morogoro etc.
5. Construction of better roads, good storage facilities etc. International linkages should be improved so as to facilitate the diffusion of new technology to our country.
6. Land reallocation and resettlement schemes should be reviewed, for example during vulgarization there were problems of sending some people to which were not fertile. Hence, before establishing a settlement anywhere, there should be profound preliminary surveys so as to assess land suitability for settlement.
7. Rural-Urban migration should be reversed. This can easily be done through investing in the rural areas. Great economic projects should be launched in the villages so as to promote the living standard of the people in rural areas and make people stay instead of moving to towns. Once rural areas are more developed some urban dwellers can be attracted to rural areas.
8. Improvement in the marketing system. Internal market can be improved through the development of cooperative boards the way it was with NMC, establishing local industries that are agricultural oriented like textile industries and food processing industries. Good price should be set and the payments should be done immediately. External market can be improved by trading with other countries with high quality crop products, uniting to promote bargaining power in the world market, diversification in the world market etc.
9. Empowering women so that they can also have more rights and greater room for participating in giving their own views on the way of improving agriculture. Women should also be given land to own in order that they can take of it and hence produce effectively. Men also should be actively involved in the agricultural activities so that the great burden or work low that women are having can be reduced.
10. Maintaining peace in the country so that people can settle and concentrate on production rather than keep on the fleeing as, refugees to other countries. Peace can make people engage effectively in agriculture since they will be feeling secure but when there are conflicts a lot of time and resources are wasted in wars and famine becomes a common factor dominating the country’s course of life.
11. Comprehensive guidance and counseling programs should be launched in order to educate, especially the young people on the dangers of the killer disease HIV/AIDS which is claiming the lives of a large number of young and energetic producers.