

The background of the book cover is a photograph of a lush green landscape. A large waterfall cascades down a rocky cliff in the center. In the foreground, a stone bridge with a metal railing spans a river. The title 'Man And ECOLOGY' is prominently displayed at the top. 'Man And' is in a white, outlined, serif font, while 'ECOLOGY' is in a bold, yellow, outlined, serif font set against a dark green rectangular background.

Man And ECOLOGY

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CHAPTER SIXTEEN

MAN AND THE STUDY OF THE SOIL

BY

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INTRODUCTION

Soil derived its original name from the Latin word 'SOLUM', meaning floor or ground. Soil can be defined as the loose surface of the earth associated with horizons of minerals and constituents of organic matter, microbes, air and water. The term Soil Science refers to the systematic study of soil as a natural body which encompasses its formation, distribution, conservation, physical, chemical and biological properties. The aspect of studying soil origin, classification and description of the soil with minor emphasis on its agricultural uses is referred to as Pedology. The study of various properties of soils as they relate to higher plants is called Edaphology. Edaphologist is mainly interested in food and fibre production. Over the years man believes that without the soil there will be no farming and without the farmer, no future yet the scientific study of the soil was unnecessarily delayed until about 18th century. This chapter reviews the work of the early soil scientists and emphasizes on the scope of the soil science and the importance of soil to man

GENESIS OF SOIL STUDY BY MAN

The scientific findings about soil are not spontaneous. The early Greek and Roman cultivators initiated the use of manure and legumes for soil improvement. As soon as agriculture was discovered the early farmers were able to distinguish between fertile and infertile soils. Brady (1974) pointed that the elaborate irrigation and drainage systems were not maintained in the Euphrates and Tigris valleys leading to salt accumulation and the once famous fertile soils became useless and the people migrated elsewhere. The

study of soil by man according to Brady (1974), Tisdale and Nelson (1975) and Uchi (1997) could be summarised under the listed sub-headings:

SOIL FERTILITY: The manuring of vineyards by the father of Odysseus as contains in a poem believed to be composed by Homer the blind poet dated back to 9BC IN Greece. Theophrastus (372 – 287 BC) recommended heavy manuring to poor soils. Archilochus observed that the dead bodies contributed to the growth of crops around 700 BC. J. B. Lawes and J. H. Gilbert in 1943 worked in agricultural experimental station at Rothamsted, England and found that soil fertility could be maintained for some years by means of chemical fertilisers.

SOIL SURVEY AND MAPPING: More than 42 centuries ago, the Chinese used a schematic soil map as a basis for taxation. As early as 1870 a team of soil scientists in Russia led by Dokuchaev found unique horizontal layering in soils based on climate and vegetation. This discovery led to soil classification based on field soil characteristics. Hilgard, Shaler and Whitney in United states of America in 1863 initiated the idea of soil survey. In 1893 the work on soil surveys in America became organised under the direction of M. Whitney. Whereas C. W. Robinson organised same in England and Wales. In West Africa, soil survey was introduced between 1920 and 1930.

SOIL BIOLOGY: Hellriegel and Wilfarth in 1886 observed that bacteria must be present in the nodules attached to legume roots. They gave the first specific information regarding nitrogen fixation by legumes. However, the isolation of the organisms was done by M. W. Beijerinck and named the organism *Bacillus radicicola*. In 1890 Vinogradski isolated the two groups of bacteria responsible for the transformation of ammonia to nitrate.

SOIL CHEMISTRY: E. W. Hilgard (1833 - 1916) experimented and found that the maximum solubility of soil minerals in hydrochloric acid was obtained when the acid was at a specific gravity of 1.115. This paved way for numerous soil analyses. In 1852 Thomas Way

observed that Yorkshire farmer was able to reduce ammonia losses from manure by the addition of soil. Julius Von Liebig (1803 – 1873) manufactured a fertiliser based on his ideas of plant nutrition. However, he made a mistake of fusing the phosphate and potash salts with lime. Though the fertiliser was a failure, yet Liebig was able to conclude among others that phosphates are necessary for seed formation and that carbon in plants comes from Carbondioxide of the atmosphere. Today he is recognised as the father of agricultural Chemistry.

SOIL PHYSICS/MECHANICS: Virgil (70 – 19 BC) believed that soil that was blackish and fat under the deep pressed shave, and whose mold is loosed and crumbling is generally best for corn. He wrote on the soil characteristics interpreted today as bulk density. This knowledge has direct bearing with soil Physics and Mechanics.

SOIL MANAGEMENT: Cato (234 – 149 BC) pointed that the best legumes for raising the soil fertility were field beans, lupines and vetch. Greeks and Roman writers described a reasonably elaborate system of farming which involved leguminous plants and the use of ashes and sulphur as soil amendments. These cultural practices were passed from generation to generation even before the advent of modern science.

IMPORTANCE OF STUDYING SOIL SCIENCE

(a) To improve the living standard of man by using scientific approaches to make soil more productive. This is through various investigations regarding the chemical reactions, biological status and physical components of soil.

(b) It serves as economic measure by determining the amount and type of fertiliser needed in the soil for improvement of crop yield. Consequently, farming becomes more productive and lucrative.

(c) Determination of what type of crop to grow successfully in a particular soil becomes possible through the study of soil. This minimises man's hunger and starvation.

(d) The soil is a limited and irreplaceable resource ... In its absence, the biosphere environment of man will collapse with devastating results for humanity (Holy, 1980). Therefore the scientific study of soil gives man the knowledge of its development, its delicacy and the necessity for its conservation.

SCOPE OF SOIL SCIENCE

SOIL FERTILITY

A fertile soil is a soil with sufficient and available amount of nutrients necessary to the growing plant. Soil fertility is a branch of soil science.

IDENTIFICATION OF FERTILE SOILS: PHYSICAL APPROACH

(i) **Type of Soil:** Fertility status of a soil has bearing with the soil types and its management practices. Loamy soil is richer than sandy soil. A clayey soil has high cation exchange capacity than sandy soil and it has low drainage capacity. Clayey loam soil retains more nutrients than sandy loam soil.

(ii) **Type of Weeds Infestation:** Most broadleaf weeds are generally dominant in a soil riched in organic matter. Weed like *Fleurya aestuans* survives in a soil high in organic matter or dumping areas, but if the fertility dwindles other weeds like *Euphorbia heterophylla* and other ephemeral weeds may be dominant. *Imperata cylindrica* and *Axonopus Compresus* are always dominant in a moderate to extreme poor soil.

(iii) **Soil Colour:** A dark soil may be an indication of humus content. A soil colour can look grey indicating low clay and humus. The soil colour is influenced by factors such as parent materials, presence of iron, effects of erosion, the topography and the predominance of mineral salts.

In Nigeria, the vertisol soils are dark colour and contained calcium, carbonate and gypsum (Ogboola, 1979). It contains a large amount

of clay and it is found around Lake Chad and parts of Gombe. The alluvial on marine deposit has grey colour and it is a poor soil. The regosols which extends on a strip from Kano to Potiskum and parts of Maiduguri is reddish to brown soil. It is not as fertile as the vertisols. The coastal plain soil of Akwa Ibom and parts of Cross River is sandy and may be sandy loam or sandy clay in some areas. The colour varies from grey, pale grey, brown etc. It is loosed and porous and can only retain fertilizer for a season. The ferralitic soils covered parts of Enugu, Imo, Abia, Ebony, Anambra, Rivers and parts of Warri, Sapele, Benin etc. The soils are acidic and the pre-dominant colour is red. It is friable porous sands and relatively moderate in fertility. However, soil colour cannot serve as a good indicator of a fertile soil.

(iv) **Topography:** A soil that is located along a slope either gentle or steep is bound to be washed and its nutrients status would be relatively lower than that of a flat land under the same management practices.

(v) **Plants Colour:** A soil that is inherently infertile produces vegetation that is yellowish in colour. This is an indication of soil deficient in Nitrogen. The shrubs found in such soil do not maintain the natural green colour, posses less foliage and are stunted.

(vi) **Plant Species:** Plants species that are capable of minimising erosion, produces abundant leaves and capable of fixing nitrogen in the soil indicate that the soil is not deficient in plant nutrient. Leguminuous plants such as *Centrosema*, *Mucuna* and *Pueraria* enrich the soil and therefore raise the agricultural value of such soil.

(vii) **Presence of Snails and Earthworms:** A soil with high population of snails and earthworms has thick litter that attracts such organisms. The floor of such soil is cool and rich in organic matter and has great potential for agriculture. Generally the use of physical approach to assess soil fertility is carried out by rural farmers. Physical approach is not efficient and could not quantify the nutrients status of a given soil, hence soil testing (chemical approach) is commonly recommended

SOIL SURVEY

The systematic classification, description, provision of data on the composition and properties of soils, and the marking of different soils for agricultural purposes is considered as soil survey. A man who is knowledgeable in soil survey is called soil surveyor.

IMPORTANCE OF SOIL SURVEY

- To demarcate an area based on soil types and characteristics.
- To determine the essential characteristics of a soil.
- It is used for accurate predictions which assists agriculturist to make future plan on a piece of land.
- It provides information which helps in crop and soil improvement.
- It makes farming more profitable.
- It helps to determine the type of irrigation to be adopted in a particular farmland.
- It plays also a major role in the choice of farming system.

SOIL BIOLOGY

This refers to the study of soil living organisms and their effects in the soils of agricultural importance. A man who specialises in soil biology is called Soil Biologist.

IMPORTANCE OF SOIL BIOLOGY

- To identify the soil organism capable of causing harm to the crop plants.
- To advise on the practices to be adopted which may help to control the harmful soil organism. For instance actinomycetes are heterotrophic feeders and their survival is conditioned by the presence of organic substances.
- To study the relationship between living organisms and soil characteristics.
- To study the contribution of soil micro-organisms to soil fertility.
- To detect the symbiotic association between crops and micro-

organisms. It also involves the manipulation of soil organism for increasing crop production.

SOIL CHEMISTRY

This is a branch of soil science which studies the basic chemical reactions and their effects in the soil and crop plants. A specialist in this area of study is called soil Chemist.

IMPORTANCE OF SOIL CHEMISTRY

- To determine the type and quality of fertiliser to be applied in a specific soil.
- To determine the pH of the soil and to amend it accordingly.
- To detect hidden hunger in plants through the plant tissue analysis.
- To avoid economic waste of fertiliser by minimising luxury consumption by plants. The knowledge of soil chemistry helps to make a blanket recommendation of fertiliser application for a particular ecological zone.

(D) SOIL CONSERVATION

This is the branch of soil science that deals with the study of soil management practices and the purpose of land use aiming at conserving the soil. Planting of leguminous shrubs, application of organic matter, avoidance of bush burning and overgrazing are some of the soil conservation practices in the tropics.

(E) SOIL PHYSICS

The branch of soil science that deals with the study of the physical characteristics of soil is called soil physics. Examples are heat retention by different soil types, soil bulk density, particle analysis, porosity, consistency, soil structure, texture, etc.

IMPORTANCE OF SOIL PHYSICS

- To recommend the appropriate tillage method for a **particular soil** whereby soil moisture can be conserved and erosion **minimised**.
- To determine the permeability of a soil and its **drainage capacity**.
- To classify soils into types e.g. sandy, loamy, clayey soils.
- To determine the fertility potential of a soil based on **physical properties**.
- To recommend the methods of water conservation.
- To control soil aeration.
- To find out the relationship between the physical properties of soil and crop yields.

(F) SOIL MANAGEMENT:

This is a branch of soil science that deals with the treatment practices capable of improving and conserving the quality of soil. Such practices include; tillage, fertiliser and lime applications, etc.

THE IMPORTANCE OF SOIL MANAGEMENT

- To minimise soil abuse.
- To balance the combination of growth factors in various soil types.
- To achieve maximum crop yields.
- To maintain the proper chemical, physical and biological status of the soil.
- To maintain and improve the quality of the soil.
- To reclaim cultivable farmland.

ABUSE OF FARM MANAGEMENT PRACTICES BY MAN

Burning, continuous cropping, inappropriate fertilisation, bulldozing, poor irrigation, deforestation and injudicious use of herbicides applications among others contribute tremendously to the abuse of farm management practices.

(G) SOIL MECHANICS AND ENGINEERING

The application of Engineering principles and physical forces in solving the soil problem is called soil Mechanics and Engineering. The study addresses agricultural questions like:

- what type of machine could be used for ploughing the soil?
- what engineering approach can be used to reclaim a flooded area?
- what type of irrigation can be recommended to a particular soil?

IMPORTANCE OF SOIL TO MAN

The soil is the life wire for the existence of plants, animals and man. Food, clothing and shelter are the basic needs of man.

Their sources are traced to the soil as follows:

FOOD:

Crops are planted in the soil to provide food for man. Tuber crops such as cassava, yams, potatoes etc. are the main cheapest sources of carbohydrates which provides energy for man. Similarly cereals such as rice, wheat, sorghum, millet, barley etc. are also sources of carbohydrates which provide energy for man. Leguminous crops are sources of cheapest protein in the developing nation. The animals which provide protein depend on the soil for forage both wild and domesticated ones. If man were to depend only on fish in water, life would be difficult while human and fish population would be drastically reduced. Vitamins and minerals are

naturally obtained from both vegetables and fruits and oil from groundnut, oil palm etc. Good health depends on good food. Food comes from the crops which grow in the soil.

SHELTER AND CLOTHING

Timber trees are raised in the soil. Wood is used for building. Only very few well-to-do people can afford iron in place of wood. Textile materials are products from cotton and other fibre plants which depend on the soil. Soil also provides beds for foundation of houses and road transport.

WASTE DISPOSAL:

Soil serves as a reservoir of wastes from urban, industrial and animal sources. In Nigeria over 90% of waste materials are not recycling for use. The wastes are buried to serve the environment from health hazards, discomfort and inconveniences.

SETTLEMENT:

Fertile soils were centre of early civilisation. Soon after the discovery of agriculture there was a settled life. Without settlement there would have been no civilisation. Brady (1974) made reference to the settlement within valley soils of the Tigris and Euphrates rivers in Mesopotamia and of the Indus, Yangtse, and Hwang-Ho rivers in India and China. These valleys were habitats for flourishing civilisations due to frequent replenishing of their fertility by natural flooding. Nile in Egypt was not exception. No wonder why African civilisation started in Egypt.

PETROLEUM AND COAL: Petroleum is sometimes derived from the decomposition of vegetative matter overtime. It is organic in origin and occurs in the pore spaces of sedimentary rocks. Suppose there is no soil to produce the vegetation this source of mineral oil would not be possible. Coal comprises mainly carbon of vegetative origin and it is the oldest form of power which was used as the main determiner for location of industries (Adeleke and Leong 1978). Coal depends on vegetation which in turn depends on the soil.

EMPLOYMENT: Many industries depend on crop products as sources of raw materials. Soil is the home for crop plants. Over 60% people in nearly all African countries earn their living as farmers. Soil is therefore an employer of labour for man. Soil scientists are also employed in Companies, Academic institutions, International organisations, agricultural Ministry etc.

The importance of soil and the injustice carried on the soil by man is presented in the prayer rendered by soil to man in the following words:

SOIL'S PRAYER

I am the oldest in planet earth
No one lives without me
I provide for man even in death
Shelter over his head.

In attempt to feed a man
Exposed to sun and rain I am
Organic matter can keep me safe
Man remains unsatisfied.

As a family we together live
With the roots of plants
Uprooting the trees becomes the hobby of man
Leaving loneliness only with me.

In tillage and planting
Weak and wounded my body becomes
Raindrops and turbulent wind
Tear me far apart.

My skin becomes eroded
Sometimes to destination quite unknown
The rivers, streams and oceans
Swell in volume and sing in joy.

I become thin and lean
 Live painful and unproductive life
 Man equally shares the experiences with me
 For what you sow is what you reap.

This is my prayer to man
 Protection from you I need
 Otherwise your generation
 Will live in fear, hunger and death.

REVIEW QUESTIONS

1. No soil, no farming. Discuss.
2. (a) What is the difference between soil fertility and conservation.
 (b) What is soil abuse?
 (c) List soil Management practices that are often abused by farmers.
 (d) State and discuss the importance of soil survey and soil chemistry?

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