PRINCIPLES OF SOIL SCIENCE
SOILS, SOIL GENESIS AND FORMATION

DEFINITION OF SOIL

Loose material covering the earth’s surface and supporting the growth of plants.

Unconsolidated or loose combination of inorganic or organic materials.

Inorganic components—products of rocks and minerals broken down by weather, chemical action and other natural processes.

Organic components—debris from plants and animals, decomposition of many life forms inhabiting the earth.

A living system combining with air, water and sunlight to sustain plant life.
DOKUCHAEV, (1879)’S REVOLUTIONARY CONCEPT: surface mineral and organic formation

- Constantly manifesting themselves as a result of the combined activity of the following agencies:
- Living and dead organisms (plants and animals),
- Parent materials, Climate and Relief.
• RICHTOFER, (1888) : loose surface formation,
• A kind of pathological condition of the native rock.
• HILGARD, (1905) : loose and friable material,
• Through which plants may or may not find a foothold and nourishment as well as other conditions of growth using their roots.
• SOIL SURVEY STAFF, (1975) : collection of natural bodies on the earth’s surface,
• In places made by man of earthy materials ,
• Containing living matter ,
• Supporting or capable of supporting plants out-of-doors .
• CANADA SYSTEM OF SOIL CLASSIFICATION : a naturally occurring unconsolidated mineral or organic matter , at least 10 cm thick ,
• Occurring on the earth’s surface ,
• Capable of supporting plant growth
• BASIC TRUTH ABOUT SOIL: (a) Composed of mineral matter, organic matter (both living and dead), water and air,
• (b) Occurs at the interface between the **LITHOSPHERE**, the **HYDROSPHERE**, the **BIOSPHERE** and the **ATMOSPHERE**,
• The soil ecosystem contains components of all these **SPHERES** (IITA).
SOIL GENESIS AND FORMATION

- Buol el al (1980): **Soil Genesis or Pedology** is the phase of soil science that deals with the factors and processes of soil formation,
- Includes description and interpretation of soil profiles, soil bodies and patterns of soil on the surface of the earth.
- Main repository of the concept of soil.
- **SOIL PHYSICS** is the study of soil physical properties and processes.
The Classical Simonson’s ‘Outline of a generalized theory of Soil Science (Simonson, 1959)

• Soil genesis consists of two steps:
  • (a) The accumulation of parent materials,
  • (b) The differentiation of horizons in the profile.
• He placed emphasis on the operations of soil forming processes in combination, with some processes promoting and others offsetting or retarding horizon differentiation.
• Kubiena’s principle of micropedology, i.e. The principles of undisturbedness and functional investigation, in part by direct observation of function aptly summarized the concept of soil as a living entity (Kubiena, 1964).
• Simply put, Pedology is the study of different soil types and their properties.
• Soil genesis helps farmers to select and support the crops on their land,
• Helps farmers to maintain fertile, healthy ground for planting.
• Also helps in engineering and construction.
• Soil takes a long time to develop—thousands or even millions of years.
• Soil is effectively a nonrenewable resource.
FACTORS AND PROCESSES OF SOIL FORMATION

- Soil formation is an ongoing process through the combined effects of five soil forming factors: (a) Parent material, (b) Climate, (c) Living organisms, (d) Topography, and (e) Time.

- Each combination of the five factors produces a unique type of soil that can be identified by its characteristic layers called horizons.

- Soil formation is also known as pedogenesis (from the Greek word ‘pedon’ for ground and ‘genesis’ meaning birth or origin).
PARENT MATERIAL:

The first step in pedogenesis is the formation of parent material from which the soil itself forms.

About 99% of the world’s soils derive from mineral-based parent material that are the result of weathering— the physical disintegration and chemical decomposition of exposed bedrock.

The remaining % derives from organic parent material— the product of environments where organic matter accumulates faster than it decomposes, i.e. in marshes, bogs and wetlands.
• Bedrock itself does not give rise to soil.
• Gradual weathering of bedrock produces REGOLITH a layer of loose rock debris or mantle,
• Further weathering of this debris leading to increasingly smaller and finer particles ultimately results in the creation of soil.
• CLIMATE:
• Water, Ice, Wind, Heat and Cold are elements of climate causing physical weathering by loosening and breaking up of rocks.
• Climate also determines the speed or rate of chemical weathering.
• Climate also influences the developing soil by determining the types of plant growth that occur, i.e. low rainfall discourage the growth of trees but encourage the growth of grass.
LIVING ORGANISMS:

- As parent material accumulates, living things begin to grow marking the formation of true soil. Mosses, lichens and other lower plants appear first.
- As they die, the remains add humus to the soil for the growth of higher plants.
- Plants trap dust from volcanoes and deserts.
- Growing roots break up rocks.
- Animals mix soils by tunneling in them.
• TOPOGRAPHY or RELIEF:
• Degree of slope on which a soil forms helps to determine how much rainfall will run off the surface and how much will be retained.

• TIME:
• Soil formation time varies according to the action of the other soil forming factors. Young soils may develop a few days from alluvium or from volcanic ash eruptions. Other soils may take thousands or millions of years to form.
HORIZONS

- As soils develop, they are arranged in a series of layers known as horizons starting at the surface and proceeding deeper into the ground reflecting different properties and different degrees of weathering.
- A typical soil profile has the surface horizon as the O layer consisting of loose OM such as fallen leaves and other organic biomass.
- Below this is the A horizon containing a mixture of inorganic mineral materials and OM.
• Next is the B horizon in which iron, clays and other mineral materials have accumulated.
• Under this layer is the C horizon consisting of partially weathered rock.
• Lastly, is the R horizon of hard bedrock.
• Each horizon may have many subordinate names to describe the transitional areas between the main horizons.
HISTORY OF SOIL SCIENCE

• Began from the contributions of chemist Justus von Liebig, and others like Dokuchaev, Marbut, Hans Jenny and Guy Smith.
• Liebig, a German chemist, (1803-1873) worked on soil samples in laboratories, greenhouses and on small field plots.
• Soils rarely examined below the depth of normal tillage.
• These chemists held the ‘balance sheet’ theory of plant nutrition-storage bin for plant nutrients, i.e. soils could be used and replaced.
• Early geologists also held this view, and considered soils as products of geologic formations. Many of the early workers were geologists. This theory was taught until the late 1920s.

• Scientific basis of soil science as a natural science was established by the classical works of Dokuchaev, who considers soil as a natural body having its own genesis and its own history of development.
Thus, the Russian school of soil science under the leadership of Dokuchaev (1846-1903), developed this new concept of soil.

This concept made possible a science of soil.

This Russian concept was thus broadened and adapted for use in the USA, and gradually throughout the whole world.