The Soil-Forming Factors

Five soil-forming factors are generally recognized: *parent material, organisms, climate, topography,* and *time.* It has been shown that Bt and Bhs horizon development is related to the clay and sand content within the parent material and/or the amount of clay that is formed during soil evolution.

Grass vegetation contributes to soils with thick A horizons because of the profuse growth of fine roots in the upper 30 to 40 centimeters of soil. In forests, organic matter is added to soils mainly by leaves and wood that fall onto the soil surface. Small-animal activities contribute to some mixing of organic matter into and within the soil. As a result, organic matter in forest soils tends to be incorporated into only a thin layer of soil, resulting in thin A horizons.

The climate contributes to soil formation through its temperature and precipitation components. If parent materials are permanently frozen or dry, soils do not develop. Water is needed for plant growth, for weathering, leaching, and translocation of clay, and so on. A warm, humid climate promotes soil formation, whereas dry and/or cold climates inhibit it.

The topography refers to the general nature of the land surface. On slopes, the loss of water by runoff and the removal of soil by erosion retard soil formation. Areas that receive runoff water may have greater plant growth and organic matter content, and more water may percolate through the soil.

The extent to which these factors operate is a function of the amount of time that has been available for their operation. Thus, soil may be defined as:

unconsolidated material on the surface of the earth that has been subjected to and influenced by the genetic and environmental factors of parent material, climate, organisms, and topography, all acting over a period of time.

and landuse.

According to **Buckman** and **Brady** (1969) five major factors largely control the soil types. These are: climate, living organism (natural vegetation), parent material, topography and time (involved in soil formation). Differences in climatic conditions give rise to different soils. Soils also exhibit variation in chemical properties. Therefore, is necessary to take into account the chemical conditions of the soils which provide the required nutrients for plants. The chemical composition of soils depends on the mineral composition of their parent or transported material, weathering, and biotic activity.

1. Climate—Climate is the most effective factor in soil formation and its fertility. Temperature and rainfall govern rates of weathering of rocks and the decomposition of minerals. Climate functions directly in the accumulation of soils' present materials and the differentiation of horizons. Indirect effects of climate include its control over the plants and animals in a region.

The soils of different climatic regions differ in their properties and characteristics. The great soil belts of the world are associated with climatic types. The amount of humus in soil also depends on the climatic conditions. Soils of moderately warm climate have more humus than those of cold or arid climates. The soils that correspond to the great climatic belts are called **Zonal soils**, those that depart from the surrounding zonal soils because they are derived from parent materials having special characteristics (*e.g.* limestone) are called **Intra-zonal soils;** while those in which time has not been sufficient for recently deposited materials to weather in the form appropriate to the climatic zone are called **Azonal soils.** Soils in which the layered structure is well developed and distinct are called zonal, while those without this well developed vertical profile are called azonal.

From the agricultural point of view the zonal soils are classified into **pedalfers** and **pedocals.** The pedalfers are characterized with excessive leaching of iron, together with calcium carbonate and other substances from the upper horizons, while pedocals

have lime accumulated in their upper parts. In the pedocal soils, acidity decreases as precipitation fails to meet the needs of potential evapotranspiration. In the semi-arid and arid climates alkaline compounds accumulate near the surface and the amount of organic matter diminishes progressively with drier conditions. These soils are lighter in colour and have shallower top layer.

2. Parent materials—Soils are formed by weathered igneous, sedimentary and metamorphic rocks. Igneous and metamorphic rocks disintegrate slowly. Heating and cooling, freezing and thawing, wetting and drying, all tend to weaken the rock structure. Finally, the rocks are broken up into small pieces. Loose and weathered rock material forms parent material.

3. Living organisms—Living organisms of the plants, animals, insects, bacteria and fungi are important because they improve soil fertility by breaking down plant and animal tissues. During this process the nutrients released and the minerals fixed are incorporated into the soil. The quantity of organic matter and nitrogen in the soil, gain or loss in plant nutrients and changes in its structure and porosity are caused by living organisms.

The plants largely determine the kind and amount of organic matter that go into the soil under natural conditions. Some plants take their nitrogen from the air and add it to the soil as they die. The deep rooted plants check soil erosion. Bacteria and fungi live mainly on the plant and animal residues. They breakdown complex compounds into simpler forms, as in the decay of organic matter. Some micro organisms fix nitrogen from the atmosphere and add it to the soil when they die.

Organic matter added into the soils by plants and animals improves soil chemically. Various organic and inorganic acids are produced in the soils when organic matter decays and they have a pronounced dissolving effect on soil minerals. Moreover, the organic matter and humus content in the soils increase the water retention capacity of soils, decrease runoff losses, improve aeration, and produce better soil structure. Some soil microrganisms, called *pathogens*, are harmful and cause root rots in higher plants.

4. Topography—Topography directly affects soils and their properties. It affects runoff and drainage. The run off is large on steep slopes, while drainage is rapid in the mountainous tracts. The amount of water that moves through the soil depends partially on topography. As a rule the more the water runoff, the less its absorption in the soil on steep slopes. The runoff also washes away more of weathered rocks on steeper slopes. The depth of soils on steeper slopes is shallower than on gentle slopes. Stagnant water on the surface causes peat formation. Topography thus influences the moisture regime in the soil and the erosion rate that determine the properties and fertility of the soil.

Soils are also influenced by altitudes. The soils of mountains and valleys vary greatly over short distances. Many soils in the hill tracts are shallow and immature. The soils, having well-developed profiles, are found on gentle slopes or in broad valleys. The altitudinal zonation of mountain soils coincides broadly with highland vegetation.

5. Time—Soil formation is a slow and gradual process. Some rocks such as limestone take much time to mature into soils. Millions of years may pass before the parent materials assimilate to form good soil. Therefore, soil age has a great influence on soil properties.