Some Facts About Soil Basics

This is a brief and simplified introduction to the origins of soils and how they influence capabilities and uses of soils.

IMPORTANCE OF SOILS

The earth is covered by a thin layer of soil, composed of minerals, organic matter, and living organisms. Within this layer is a record of the area's geological and climactic history, as well as information about the suitability of future use of the soil. Soils affect many areas of our lives; we depend on the soil to grow our food and support the buildings we live and work in. Soils form an essential element in the ecosystem. Human activities that damage soils threaten to disrupt the delicate balance that sustains life. It is important to have a basic understanding of the formation and properties of soils to determine their future uses and to manage soils wisely.

DEVELOPMENT OF SOILS

Minerals are the primary component of soils. These minerals are from weathered rock, called *parent material*. The source of parent material is sometimes the bedrock directly below, and sometimes material transported far from the original bedrock and deposited by ice, water, wind, and gravity. Many soil properties are determined by the type of rock the parent material came from. For example, we have sandstone soils, shale soils, and limestone soils, coming from different parent material and possessing different characteristics.

Another component of soils is organic matter—decomposed parts of plants and animals, as well as millions of microscopic soil organisms that help break down minerals and organic residues. Air and water are also found in pores in the soil, tiny spaces between the soil particles.

INFLUENCE OF TOPOGRAPHY

It is not surprising that the shape and geology of the landscape contribute to the properties of the soils. Pennsylvania is divided into different *physiographic provinces*, regions of similar geologic origin and shape. For example, the Ridge and Valley province in central Pennsylvania consists of folded sedimentary beds, which are layers of sandstone, shale, and limestone. Sandstone, the hardest and most chemically resistant layer, forms the ridge caps and is covered with coarse sandy soils. Limestone, however, weathers quickly; the calcium carbonate it contains dissolves in water and is carried away, leaving valleys of fertile limestone soils. The slopes are formed of shale, with intermediate resistance to weathering, or of *colluvium*, material (in this case sandstone fragments) that has been moved downslope by gravity. The shale soils are shallow, fine textured, acidic, and low in nutrients.

A humid, temperate climate provides adequate amounts of soil moisture to leach soluble substances through soil. Temperature and moisture changes enhance the development of subangular blocky structure. Climate induces many such different soil characteristics. Interacting with climate is vegetation, which also impacts conditions within the soil. Consider two examples. Under grass, soil accumulates organic matter from the dense fibrous, shallow, root system and becomes dark grayish brown to the depth of the roots, 12 to 30 inches. Under deciduous forest, leaves fall to the soil surface, are not incorporated into the soil, and form an organic mat above the mineral soil.

CHARACTERISTICS OF SOILS

Soil properties are used to distinguish different types of soils and to determine their potential uses.

Texture

One of the most obvious characteristics is texture, the distribution of particle sizes of the soil. The terms sand, silt, and clay refer to the particle size—sand is the largest and clay the smallest. Soil texture can be felt by rubbing the soil between the fingers. Sandy soil feels gritty, silt feels floury or silky, and clay feels slick and sticky. With practice, it is possible by this technique to estimate the percentages of each particle size in a soil. The texture of a soil can indicate the stability, strength, and drainage of a soil, which are important characteristics to know before farming the land, constructing buildings and roads, or installing waste disposal systems.

Water

After rainfall, excess water drains away; the rest is held in the soil pore spaces as a film coating the surfaces of the particles. With a continual excess of water, the soil pore

spaces have less air in the soil, and the soil is classified as poorly drained. Plant roots cannot obtain the oxygen they need and do not grow well. A wet soil also has low strength, so it cannot support structures. Drainage conditions can often be determined by soil color. Patches of gray, orange, and dark brown discolorations called *mottles* indicate poorly drained soils. On a hill, upper slopes are usually well drained, while the lower slopes may be poorly drained.

Chemistry

Although invisible to the naked eye, chemical activities also affect soil properties. The nutrients essential for plant growth that are attached to clay and organic matter make them the *chemically active fraction* of the soil. Complex chemical reactions occur in the soil; the state of this activity can be gauged by measuring the acidity, expressed in pH. Most soils in Pennsylvania are acidic, and require liming to raise the pH. They also require fertilizer for satisfactory crop production.

Other properties

Several other characteristics of soils indicate their suitability for different uses. One characteristic is structure, which is the specific arrangement of particles into aggregates. Other characteristics are color, depth to bedrock, and maturity. All contribute to identification of soils and their uses.

THE SOIL PROFILE

Over time, different-sized particles within the parent material are redistributed and separated into layers called *horizons*. These horizons can be seen in the soil profile, a vertical section of a soil visible when a pit is dug three to six feet deep. The *topsoil*, rich in organic matter, is called the A horizon. *Leaching* is the loss of materials from the A horizon when water carries clay and soluble matter downward. These leached materials accumulate in the B horizon, called *subsoil*. Below that is the C horizon, the parent material of weathered rock and minerals.

Underneath the parent material lies bedrock, called the R horizon. The number of horizons and their thickness vary with different soils.

SOIL CLASSIFICATION

Soil scientists use the properties discussed above to group soils by their characteristics. However, the presence of one or more of those properties can change soil capability and uses, gradually or dramatically. A landscape has many different soils and many complex properties. The Soil Conservation Service of the U.S. Department of Agriculture conducts soil surveys and publishes soil survey reports, usually one for each county. The soil survey report provides information on soil properties associated with the landscape, valuable to all who plan to use the land, from farmers to construction companies to homeowners. Copies of these survey reports are available from the Soil Conservation Service and from Penn State Cooperative Extension.

SOURCES OF MORE INFORMATION ABOUT PENNSYLVANIA SOILS

This is only a brief introduction to the important science of soils, and there are many sources of additional information.

The Land Analysis Laboratory, a research lab within the Department of Crop and Soil Sciences at Penn State, has computers and other advanced technologies to improve the understanding of soil resources, their assessment for management, and their land-use potentials.

The Penn State Soil Characterization Database System is a program that can retrieve and deliver information about all the soils of Pennsylvania.

Undergraduate and graduate programs of study in soil science are offered by the Department of Crop and Soil Sciences (116 ASI Building, University Park, PA 16802; phone 814-865-6541).

Other sources of information are the Penn State Cooperative Extension offices in every county, the U.S. Soil Conservation Service in every county, and the Pennsylvania Association of Professional Soil Scientists (P.O. Box 223, Harrisburg, PA 17108).

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