**Chapter 14**

**Soil Resources**

**Lecture Outline:**

1. What is soil?
   1. *Soil* is the relatively thin surface layer of Earth’s crust consisting of minerals and organic matter modified by the natural actions of weather, wind, water, and organisms
   2. Soil-forming factors
      1. Soil is formed from parent material, rock that is slowly broken down, or fragmented, into smaller and smaller particles by biological, chemical, and physical *weathering processes* in nature
         1. This is a continuous process that can take thousands of years
         2. Organisms and climate both play essential roles in weathering
      2. *Topography* is also involved in soil formation
   3. Soil composition
      1. The soil system is composed of four distinct parts: mineral particles (45%), organic matter (5%), water (25%), and air (25%)
         1. *Humus* is a mix of many organic compounds, it helps to bind to nutrient mineral ions and holds water in the soil
         2. Both *soil water* and *soil air* are necessary to produce a moist, aerated soil that sustains plants and other soil-dwelling organisms
   4. Soil horizons
      1. Soils are organized into distinctive horizontal layers called *soil horizons*
      2. A *soil profile* is a vertical section from surface to parent material, showing the soil horizons
         1. *O-horizon* – uppermost layer, rich in organic material
         2. *A-horizon* – topsoil, dark and rich in accumulated organic matter and humus
         3. *E-horizon* – heavily leached, sometimes between the A and B-horizons
         4. *B-horizon* – zone of accumulation in which nutrient minerals that leached out of the topsoil and litter accumulate
         5. *C-horizon* – beneath the B-horizon, contains weathered pieces of rock; it is beneath the extent of most roots and is often saturated with groundwater
   5. Soil organisms
      1. Soil bacteria often number in the hundreds of millions per gram of soil
         1. Scientists have identified about 170,000 species of soil organisms
         2. They provide several essential *ecosystem services*
            1. Maintain soil fertility
            2. Prevent soil erosion
            3. Break down toxic materials
            4. Cleanse water
      2. Worms deposit *castings* on the soil surface, cycling nutrient minerals and aerating the soil; ants also aerate the soil and aid in plant reproduction
      3. *Mycorrhizae* help plants absorb adequate amounts of essential nutrient minerals from the soil
   6. *Nutrient cycling* helps cycle nutrient minerals from the soil to organisms and back again to the soil
2. Soil Properties and Major Soil Types
   1. Texture and acidity are two parameters that characterize soils
      1. *Texture* refers to the relative proportions of different-sized inorganic mineral particles of sand, silt, and clay in soil
      2. A *loam* (ideal agricultural soil) has an optimum combination of different soil particle sizes
   2. Soil acidity
      1. Most soils range between a pH of 4 and 8; optimum soil pH for plant growth is 6 to 7
      2. Soil pH greatly affects the leaching of nutrient minerals
      3. Soil pH affects plants partly because the solubility of certain nutrient minerals varies with differences in pH
   3. Major soil groups
      1. Soil taxonomy classifies soils into 12 distinctive orders and many subsequent series using color, depth, mineral content, acidity, pore space, etc.
      2. The U.S. alone has as many as 19,000 soil series
      3. Five common soil orders include
         1. *Spodosols* (coniferous forests)
         2. *Alfisols* (temperate deciduous forests)
         3. *Mollisols* (temperate, semiarid grasslands)
         4. *Aridisols* (arid regions)
         5. *Oxisols* (tropical and subtropical areas)
3. Soil Problems
   1. *Sustainable soil use* is the wise use of soil resources, without a reduction in the amount or fertility of soil, so that it is productive for future generations
   2. Soil erosion
      1. Water, wind, ice, and other agents promote *soil erosion*
      2. Erosion limits the growth of plants, causes a loss of fertility, and reduces the amount of soil in an area
      3. Humans often accelerate soil erosion with poor soil management practices
      4. Soil erosion results in an annual loss of as much as 75 billion metric tons of topsoil around the world
   3. Nutrient mineral depletion
      1. When organisms die and microorganisms decompose them, the essential nutrient minerals are released into the soil
      2. Mineral depletion in tropical rainforest soils
         1. Soils are somewhat nutrient-poor because the nutrient minerals are stored primarily in vegetation
         2. When the forest is cleared, its efficient nutrient cycling is disrupted
   4. Soil *salinization* often occurs in arid and semiarid regions due to the high natural concentrations of inorganic compounds (mineral salts) in the soil
   5. *Desertification* is the degradation of once-fertile rangeland or forest into nonproductive desert caused partly by soil erosion, forest removal, overcultivation, and overgrazing
4. Soil conservation and regeneration
   1. Conservation tillage
      1. *Conservation tillage* is a method of cultivation in which residues from previous crops are left in the soil, partially covering it and helping to hold in place until the newly planted seeds are established
      2. Conservation tillage reduces soil erosion, increases organic matter, and improves water-holding capacity
      3. N*o-tillage* leaves the soil undisturbed in the winter; it saves on fuel costs, machinery wear and tear, and labor time
   2. Crop rotation
      1. *Crop rotation* is the planting of a series of different crops in the same field over a period of years
      2. It lessens insect damage and disease, helps retain essential nutrient minerals, decrease erosion, and helps maintains soil fertility
   3. *Contour plowing, strip cropping*, and *terracing* help control erosion of farmland with variable topography
   4. Preserving soil fertility can be accomplished through the use of both organic and commercial inorganic fertilizers
   5. Soil reclamation involves two steps, stabilizing the land to prevent further erosion (seeding and eventual ground cover)and restoring the soil to its former fertility
      1. *Shelterbelts* are one of the best ways to reduce the effects of wind on soil erosion
      2. *Agroforestry* uses both forestry and agricultural techniques to improve degraded areas and offer economic benefits
   6. Soil conservation policies in the United States
      1. The Soil Conservation Act of 1935 authorized the formation of the Soil Conservation Service (now the NRCS); its mission is to work with U.S. citizens to conserve natural resources on private lands
      2. The Food Security Act (Farm Bill) of 1985 contained provisions for two main soil conservation programs
         1. Conservation compliance program
         2. Conservation Reserve Program (CRP)