CHAPTER 12
Soil and Agriculture

YOUR WORLD
YOUR TURN
Possible Transgenic Maize in Oaxaca, Mexico

• In 2001, genetically modified (GM) transgenes were found in native Oaxacan maize.

• Anti-GM activists worry that transgene “contamination” will threaten the genetic diversity of the planet’s food supply.

• The GM industry defends its safety and proclaims that GM crops are necessary to meet growing food demand.

Talk About It What are the costs and benefits of genetically modified food crops?
About 38% of Earth’s land surface is used for agriculture.
Soil Composition

- Soil is made up of minerals, organic matter, air, and water.
- Soil composition is influenced by climate, organisms, landforms, parent material, and time.
Lesson 12.1 Soil

Soil Formation

- **Weathering**: Physical and chemical breaking of rocks and minerals into smaller pieces

- **Erosion and deposition**: Pick-up, transport, and drop-off of material from one place to another

- **Decomposition**: Breakdown of waste, organisms, and organic material into simple molecules
Soil Horizons

- Soil horizons are distinct layers of soil.
- A cross-section of soil horizons is a soil profile.

**Did You Know?** In general, organic matter is concentrated in the O and A horizons, making them the most critical for agriculture.
Soil Characteristics

- U.S. soil scientists define 12 major soil groups.
- Soil groups are further classified according to properties such as color, structure, pH, and texture.
- Soil texture is based on particle size.
Some estimates predict that 50 million people could be displaced in the next 10 years due to desertification, a form of soil degradation.
Lesson 12.2 Soil Degradation and Conservation

Erosion

- The process by which material, such as topsoil, is moved from one place to another
- Caused by natural processes and human activities
- Often occurs faster than soil is formed, depleting fertile topsoil
- Crops, trees, and other plant communities protect soil from erosion.

Did You Know? More than 19 billion hectares (47 billion acres) of the world’s croplands suffer from erosion and other forms of soil degradation resulting from human activities.
Farming Practices That Reduce Erosion

• **Intercropping**: Different crops mixed together

• **Crop rotation**: Crops are alternated.

• **Shelterbelts**: Tall plants block wind.

• **Conservation tillage**: Soil turnover is reduced.

• **Terracing**: Steep slopes turned into “steps”

• **Contour farming**: Planting perpendicular to hill’s slope
Ranching Practices

- Ranching is the raising and grazing of livestock.
- Overgrazing causes and worsens many soil problems.
- Range managers encourage grazing limits and enforce them on publicly owned land.
Forestry Practices

- Forestry practices, such as clear-cutting, can increase erosion.
- Today, practices that reduce soil erosion, such as selective logging, are increasingly common.
Desertification

- Loss of more than 10% of soil productivity
- **Causes:** soil compaction, erosion, overgrazing, drought, or other factors
- Arid and semi-arid lands are most prone.
- Affects large amounts of Earth’s land areas—up to one third, according to one estimate
- The Dust Bowl was a major desertification event in the 1930s.
Lesson 12.2 Soil Degradation and Conservation

Soil Conservation Efforts

- **U.S. Soil Conservation Act (1935):** Established the Soil Conservation Service, today called the Natural Resources Conservation Service.

- **Farmer-Centered Agricultural Resource Management Program (FARM):** A United Nations effort that focuses on resource challenges in developing nations.
Soil Pollution

- Too much, or carelessly timed irrigation can waterlog crops and lead to salinization—a buildup of salts in upper soil horizons.

- Toxic pesticides can remain in soil for a long time, eventually filtering to groundwater.

Did You Know? Salinization costs farmers $11 billion in crop income a year worldwide.
Humans have been practicing agriculture for about 10,000 years.
The Beginnings of Agriculture

- People were hunter-gatherers through most of human history, until agriculture developed about 10,000 years ago.
Selective Breeding and Settlement

- In early agriculture, people began planting seeds from plants they liked most, a form of selective breeding.
- Crop cultivation enabled people to settle permanently, often near water sources, and raise livestock.
- Agriculture and livestock provided a stable food supply, which allowed the development of modern civilization.
Traditional Agriculture

- Agriculture “powered” by people and animals
- Does not require fossil fuels
- Practiced widely until the Industrial Revolution
Industrial Agriculture

- Agriculture that requires the use of fossil fuels
- Involves mechanized farming technology, manufactured chemicals, and large-scale irrigation
- To be efficient, large areas are planted with a single crop in a monoculture.

Did You Know? Today, more than 25% of the world’s croplands support industrial agriculture.
The Green Revolution

- Introduced new technology, crop varieties, and farming practices to the developing world in the mid- to late 1900s

**Benefits:**
- Increased crop yields and saved millions of people from starvation in India and Pakistan
- Prevented some deforestation and habitat loss by increasing yields on cultivated land

**Costs:**
- Led to a 7000% increase in energy used by agriculture
- Worsened erosion, salinization, desertification, eutrophication, and pollution
Pests and Weed Control

• **Chemical pesticides:**
  Effective and cheap, but can lead to resistance

• **Biological pest control:**
  Permanent solution, but can harm nontarget organisms

• **Integrated pest management:** Increasingly popular solution, combines chemical and biological pest-control methods

Cactus moth larvae are used to control prickly pear cactus, but also threaten many rare, native cacti around the world.
Pollinators

- Pollination is the process by which plants reproduce sexually.
- Agriculture relies on pollinators, such as insects.
- Native and domesticated pollinator populations have declined due to pesticide use, parasites, and other as-of-yet unknown causes.

Did You Know? Bees and other insects pollinate 800 species of cultivated plants.
Each year, Earth gains 75 million people and loses 5–7 million hectares of productive cropland.
Food Security

- Since 1960, our ability to produce food has grown faster than the human population, but 1 billion people are hungry worldwide.

- Malnutrition and undernourishment are most common in the developing world.

- Agriculture scientists and policymakers are working toward food security—the guarantee of an adequate food supply for all people at all times.

This woman suffers from Kwashiorkor, a disease caused by protein deficiency.
Genetically Modified Organisms

• Organisms that have had their DNA modified

• Commonly engineered traits include rapid growth, pest resistance, and frost tolerance.

• In the United States, 85% of corn and 90% of soybean, cotton, and canola crops come from GM strains.
Risks and Benefits of GM Crops

**Risks:**
- Potential for “superpests” that are resistant to pest-resistant crops
- Contamination of non-GM plants

**Benefits:**
- Insect-resistant crops reduce the need for insecticides.
- Herbicide-resistant crops encourage tillage conservation.
Industrial Food Production: Feedlots

• Alternative to open grazing in which energy-rich food is delivered to a concentrated group of livestock or poultry

• **Benefits:** Reduces soil degradation and fertilizer use

• **Costs:** Requires antibiotic use; potential for water contamination and animal stress
Industrial Food Production: Aquaculture

- Fish farming in a controlled environment
- **Benefits**: Can be sustainable; reduces by-catch; reduces fossil fuel use
- **Costs**: More difficult to control spread of diseases; produces a lot of waste; potential for farm-raised animals to escape into wild

**Did You Know?** Aquaculture is the fastest-growing type of food production.
Sustainable Agriculture

• Does not deplete soil faster than it forms
• Does not reduce the amount or quality of soil, water, and genetic diversity essential to long-term crop and livestock production
• Organic agriculture is sustainable agriculture that does not use synthetic chemicals.
• Local, small-scale agriculture reduces the use of fossil fuels and chemicals used for transportation and storage.

Did You Know? Organic food purchases increased 200% from 1999 to 2008.