

Chapter 9

Testing Your Comprehension

1. It is hypothesized that hunter-gatherers noticed and propagated plants that produced better fruits, eventually learning to save their seeds to plant the next year—this constitutes artificial selection. Agriculture then encouraged a more sedentary lifestyle, a growing population, and economic specialization.
2. Traditional agriculture is biologically powered, with the work being performed by animal and human effort along with simple tools and machines. This can be done at a subsistence level, in which the farm family raises just enough food for itself, or intensively, in which an excess of food is produced for sale in the market. Industrial agriculture, by comparison, uses fossil fuel combustion to power much of the work on the farm: tilling, sowing, harvesting, irrigation, and fertilizer application. Efficiencies of scale encourage raising crop monocultures.
3. Soil is formed by the weathering of rocks and minerals and by the input of organic material. Physical or mechanical weathering breaks down rocks without changing them chemically. For example, ice wedges can form in small cracks in a rock, breaking it in two. Chemical weathering results from water or other substances chemically interacting with the parent material. Biological weathering occurs when living things are responsible for breaking down the parent material by either physical or chemical means. For example, root growth wedging cracks open, or organic acids dissolving some minerals.
4. The five factors influencing soil formation are climate, organisms, relief, parent material, and time. Warmer and wetter climates have accelerated rates of physical weathering. Differences in local vegetation alter the input of organic material. Steeper slopes lead to higher rates of erosion. Soil formed from the weathering of limestone will be different from that formed from granite. Recently formed soils will not be as well developed as older soils.
5. Soil horizons, or distinct layers, are created by the interaction of the processes of weathering, erosion, deposition, and organic matter generation and decay. Generally, the degree of weathering and the concentration of organic material decrease as one moves downward in the soil profile.
6. Erosion is considered a destructive process because local rates of erosion can greatly exceed local rates of soil formation. Erosion is increased by the overcultivation of fields, overgrazing of rangelands, and deforestation. Erosion by water may occur as splash erosion, sheet erosion, rill erosion, or gully erosion. The intensity of water erosion is greater in places that receive more precipitation, and where the slope of the land surface is steeper.
7. Hugh Hammond Bennett advocated soil conservation techniques such as contour farming, strip cropping, crop rotation, terracing, grazing management, reforestation, and wildlife management. Additional techniques include establishing shelterbelts, and using conservation tillage, or “no-till” farming.
8. Terracing converts a ramplike slope into a series of stair steps, with each step or terrace being level. No-till farming drills seeds and fertilizer into the stubble of the previous year’s crop without first plowing or cultivating the field. The old crop’s roots and aboveground stubble are left in place between the harvest and the next planting to hold the soil and protect it from splash and wind erosion.

9. Fertilizers boost crop growth if they supply required nutrients that were otherwise not sufficiently available to the crop plants. If more fertilizer is added to a field than the crop can take up, the excess nutrients may be leached from the soil into streams or groundwater. Some nutrients may also be converted to a gaseous form, mostly by bacteria. These gases may then be released to the atmosphere.
10. Overgrazing exposes the soil surface to erosion by wind and water and may cause soil compaction that limits water infiltration, soil aeration, and plant growth. Public land policies can be linked to the practice of overgrazing, as Garrett Hardin did in *The Tragedy of the Commons*. Grazing practices are sustainable if they do not decrease the amount and diversity of vegetation on the grazed lands over time.

Interpreting Graphs and Data

1. Soil savings are approximately 5 Mg/ha, or 31%. Organic carbon savings are approximately 65kg/ha, or 34%. Nitrogen savings are approximately 7kg/ha, or 37%.
2. Under conventional tillage, the ratio of soil lost to crop yield is approximately 4:1. Under reduced tillage, the ratio dropped to approximately 2.75:1.
3. Reduced tillage is a step in the right direction for Nepalese farmers, since it significantly reduced the rate of soil loss. The rate, however, is still high, and so the system is probably not sustainable. To be certain, one would also need information about local rates of soil formation. In steep terrain, terracing is an excellent method for reducing erosion rates.

Calculating Ecological Footprints

	Plant products consumed (lb)	Soil loss at 6:1 ratio (lb)	Soil loss at 4:1 ratio (lb)	Reduced soil loss at 4:1 relative to 6:1 ratio (lb)
You	365	2,190	1,460	730
Your class	<i>Answers will vary</i>	<i>Answers will vary</i>	<i>Answers will vary</i>	<i>Answers will vary</i>
Your state	<i>Answers will vary</i>	<i>Answers will vary</i>	<i>Answers will vary</i>	<i>Answers will vary</i>
United States	1.095×10^{11}	6.57×10^{11}	4.38×10^{11}	2.19×10^{11}

3. A sustainable rate of soil loss is one that does not exceed the local rate of soil formation. Measuring the amount of topsoil at a farm over time will reveal whether farm practices are sustainable.