Chapter 15

Optimizing Food Production

THE MAIN IDEA

Agriculture employs much chemistry.

15.6 Past Agricultural Practices

Over the past 100 years, there have been dramatic increases in crop yields. An acre of U.S. farmland in 1900 yielded about 30 bushels of corn. Today, that same acre yields on the order of 130 bushels of corn. This increased efficiency has meant a significant drop in the number of people needed to farm. In the early 1900s, about 33 million people in the United States lived and worked on farms. Today, with a much larger population, only 2 million people are engaged in commercial farming in this country, raising crops and livestock.

Many of the farming methods used to obtain high yields have significant disadvantages. Pesticides and fertilizers, for example, pose certain risks. Pesticides are inherently toxic, and each year thousands of people working in agriculture are poisoned by the mishandling of these dangerous compounds. Fertilizers help plants grow, but major portions of applied fertilizer are washed into streams, rivers, ponds, and lakes, where they upset ecosystems, especially by promoting excessive growth of algae (see Section 16.3). Fertilizer runoff from fields, illustrated in **Figure 15.24**, can

CHEMICAL CONNECTIONS

How is the salinity of the ocean connected to photosynthesis?

< Figure 15.24

The water running off this farm field contains many pesticides and fertilizers that can be harmful to ecosystems and human health.

Λ Figure 15.25

Poor soil conservation practices in the early 1900s contributed to the loss of much topsoil to wind storms thick with dust.

Λ Figure 15.26

The San Joaquin Valley of California has subsided by more than 35 feet since the pumping of groundwater began in the 1920s.

also contaminate drinking water supplies and thus affect human health. An ailment known as blue-baby syndrome, for example, results from drinking water containing high concentrations of nitrate ions, a main ingredient of most fertilizers. Nitrate ions in the bloodstream compete with oxygen for the positively charged iron ions of hemoglobin molecules. This leads to a form of anemia known as *methemoglobinemia*, to which babies are particularly sensitive. Aside from shortness of breath, one of the major symptoms is a bluish color of the skin.

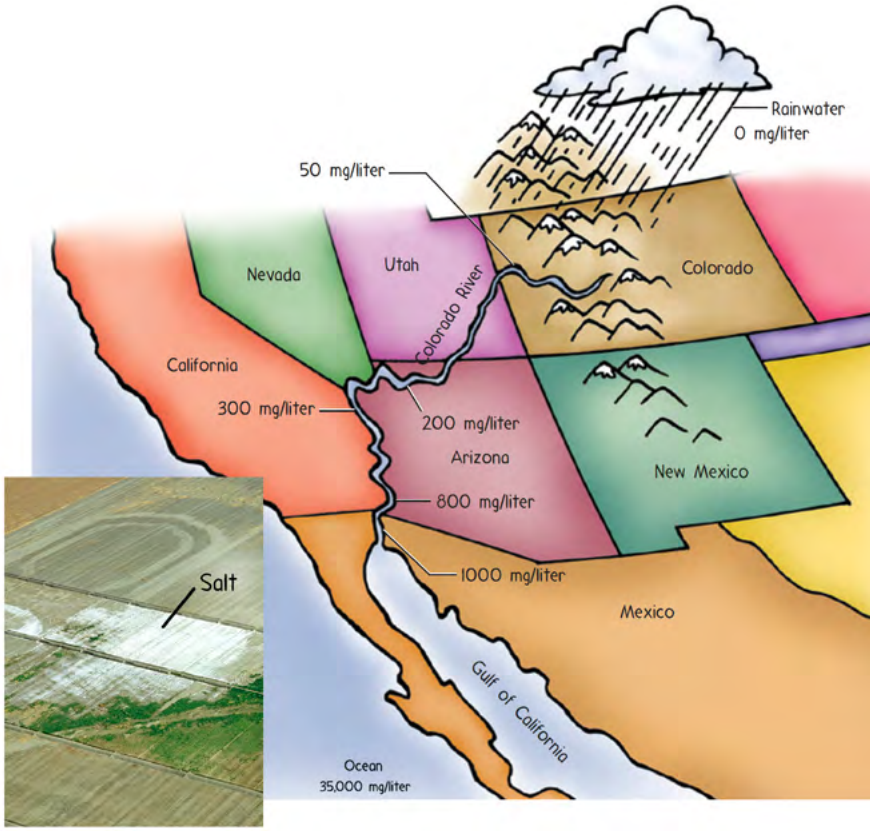
Poor maintenance of topsoil is also a major concern. Synthetic fertilizers have no organic bulk and do not provide a food source for soil microorganisms and earthworms. Over time, a soil treated with only these fertilizers loses biological activity, which diminishes the soil's fertility. Soils void of organic bulk become chalky and susceptible to wind erosion. Chalky soils lose their capacity to hold water, which means that more applied fertilizer is leached away. Ever-increasing amounts of fertilizer are thus needed.

Over the past 100 years, damaging farming practices have decreased the amount of topsoil in parts of the United States by as much as 50 percent. During the 1930s, farming practices and drought conditions created giant dust storms, such as the one shown in **Figure 15.25**, that removed major portions of the topsoil in Kansas, Oklahoma, Colorado, and Texas. In one storm, large dust clouds were carried all the way from the Midwest to Washington, D.C., and then into the Atlantic Ocean. Politicians in that city observing the effects of poor soil management right outside their windows quickly passed legislation that created the Soil Erosion Service, which became the National Resources Conservation Service; it continues to this day in its efforts to help protect the nation's topsoil for future generations.

Another limited key resource required for farming is fresh water. In regions where rainfall is insufficient to support large crops, water is either channeled into fields from lakes, rivers, and streams or pumped from the ground. In many areas, groundwater is the primary source of fresh water, but excessive use of groundwater can lead to land subsidence, illustrated in **Figure 15.26**.

Any source of water other than rainwater requires an irrigation method to deliver water to the fields. Flooding is a common method, but it is not efficient because most of the water is lost in runoff and evaporation. Sprinkler systems are an improvement over flooding because they do not cause soil erosion. Such systems also lose large amounts of water, however, because a significant portion of the airborne water evaporates before reaching the ground.

All liquid water on the Earth's surface, no matter how fresh, contains some salts. After irrigation water evaporates from farmland, these salts are left behind, and over time, repeated irrigation causes the salinity of the soil to increase. This process is known as **salinization**, and it leads to a rapid decrease in productivity. To counteract growing soil salinity, farmers flood the land with huge quantities of water. As the water drains into a river, it washes the unwanted salts—along with significant amounts of topsoil—into the river. Thus, a river passing through farmlands gets saltier and saltier as it runs to the sea, as depicted in **Figure 15.27**.



< Figure 15.27

As a river flows along, runoff from agricultural fields can add to the river's natural salinity. By the time the Colorado River reaches the Gulf of California, for example, it is too salty for productive farming. A typical safe drinking water standard for salt content is 500 milligrams per liter. Agricultural damage occurs when soil salinity reaches a concentration of about 800 milligrams per liter. The inset photo shows salt deposits accumulated in an irrigated field.

READING CHECK

What happens to farmland after repeated irrigation?