Food and Agriculture

CHAPTER 15

READING WARM-UP

Before you read this chapter, take a few minutes to answer the following questions in your ***EcoLog.***

1. How do people's food choices affect the environment?
2. What is the relationship between agriculture and soil?

This farmland in rural Pennsylvania is used to grow alfalfa, corn, and soybeans. Agriculture can be thought of as one of the most important relationships people have with the environment.

SECTION 1

Feeding the World

In 1985, lack of rain, loss of soil, and war had caused crops to fail in Ethiopia. This resulted in **famine,** widespread starvation caused by a shortage of food. Events like those in Ethiopia present a frightening picture of the difficulty of feeding the Earth's growing population. Modern agricultural practices provide most of the world's population with enough food to survive. However, some of these practices can cause environmental damage that eventually makes growing food crops more difficult. In this chapter, you will learn why feeding all of the world's people is so difficult and about efforts to increase food production.

Objectives

- Identify the major causes of malnutrition.
- Compare the environmental costs of producing different types of food.
- Explain how food distribution problems and drought can lead to famine.
- Explain the importance of the green revolution.

Key Terms

famine
malnutrition
diet
yield

Humans and Nutrition

The human body uses food both as a source of energy and as a source of materials for building and maintaining body tissues. The amount of energy that is available in food is expressed in *Calories*. One Calorie (Cal) is equal to 1,000 calories, or one kilocalorie. As shown in **Table 1,** the major nutrients we get from food are carbohydrates, proteins, and lipids. Our bodies need smaller amounts of vitamins and minerals to remain healthy.

Malnutrition is a condition that occurs when people do not consume enough Calories or do not eat a sufficient variety of foods to fulfill all of the body's needs. There are many forms of malnutrition. For example, humans need to get eight essential amino acids from proteins. This is easily done if a variety of foods are eaten. However, in some parts of the world, the only sources of food may be corn or rice. Each of these foods contains protein but lacks one of the essential amino acids. A type of malnutrition called *amino acid deficiency* can result from such a limited diet.

Table 1 ▼

Major Nutrients in Human Foods

Nutrient	Composition	Sources	Energy yield	Function
Carbohydrates	sugars	wheat, corn, and rice	4 Cal/g	is the main source of the body's energy
Lipids (oils and fats)	fatty acids and fatty alcohols	olives, nuts, and animal fats	9 Cal/g	helps form membranes and hormones
Proteins	amino acids	animal food and smaller amounts from plants	about 4 Cal/g	helps build and maintain all body structures

Connection to Biology

Essential Amino Acids Animals make their own proteins from amino acids. Essential amino acids are those that must be supplied in the diet because the body needs them but cannot make them from other amino acids. A lack of essential amino acids in the diet can lead to the human diseases kwashiorkor and marasmus, which can cause brain damage in children.

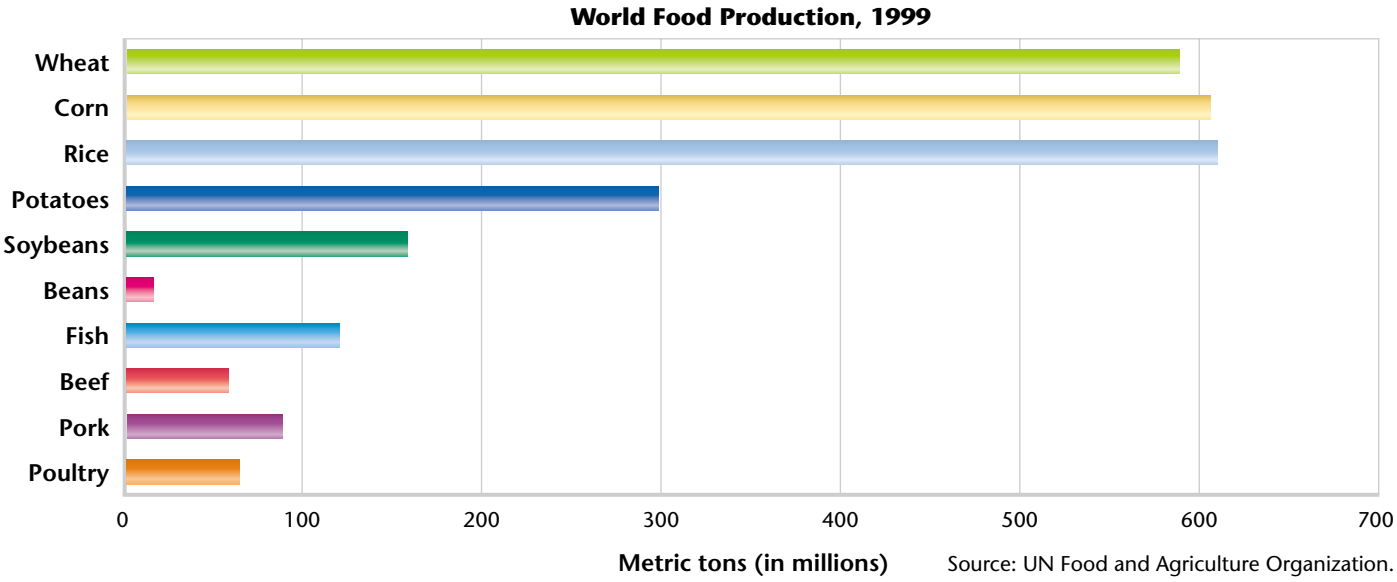
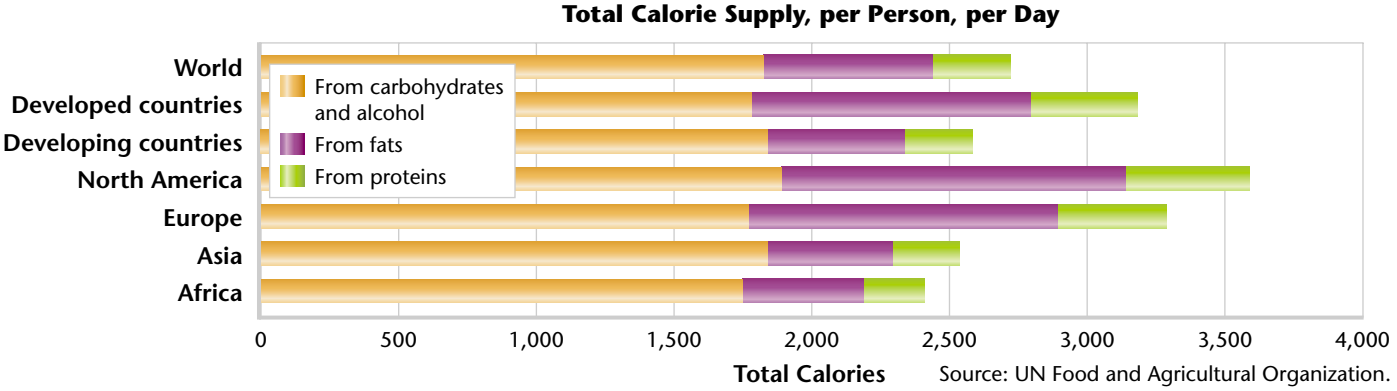


Figure 1 ▶ This bar graph shows that in 1999, grains (wheat, corn, and rice) were produced in greater amounts than was any other food. Wheat and corn are eaten by humans and are fed to farm animals.

Sources of Nutrition A person's diet is the type and amount of food that he or she eats. A healthy diet is one that maintains a balance of the right amounts of nutrients, minerals, and vitamins. In most parts of the world, people eat large amounts of food that is high in carbohydrates, such as rice, potatoes, and bread. As shown in **Figure 1,** the foods produced in the greatest amounts worldwide are *grains,* plants of the grass family whose seeds are rich in carbohydrates. Besides eating grains, most people eat fruits, vegetables, and smaller amounts of meats, nuts, and other foods that are rich in fats and proteins.

Diets Around the World People worldwide generally consume the same major nutrients and eat the same basic kinds of food. But diets vary by region, as shown in **Figure 2.** People in more-developed countries tend to eat more food and a larger proportion of proteins and fats than people eat in less developed countries. For example, in the United States, almost half of all Calories people consume come from meat, fish, and oil. The Japanese, whose diet traditionally included a mix of rice, vegetables, and seafood, have started to consume more beef in recent decades.

Figure 2 ▶ People in developed countries generally eat more food and more proteins and fats than people in less developed countries eat.



The Ecology of Food

As the human population grows, farmland replaces forests and grasslands. Feeding everyone while maintaining natural ecosystems becomes more difficult. Different kinds of agriculture have different environmental impacts and different levels of efficiency.

Food Efficiency The *efficiency* of a given type of agriculture is a measure of the quantity of food produced on a given area of land with limited inputs of energy and resources. An ideal food crop is one that efficiently produces a large amount of food with little negative impact on the environment.

On average, more energy, water, and land are used to produce a Calorie of food from animals than to produce a Calorie of food from plants. Animals that are raised for human use are usually fed plant matter. Because less energy is available at each higher level on a food chain, only about 10 percent of the energy from the plants gets stored in the animals. Thus, a given area of land can usually produce more food for humans when it is used to grow plants than when it is used to raise animals. The efficiency of raising plants for food is one reason why diets around the world are largely based on plants. However, meat from animals generally provides more nutrients per gram than most food from plants.

Old and New Foods Researchers hope to improve the efficiency of food production by studying plants and other organisms that have high yield—the amount of food that can be produced in a given area. Researchers are interested in organisms that can thrive in various climates and that do not require large amounts of fertilizer, pesticides, or fresh water. As shown in **Figure 3,** some organisms have been a source of food for centuries, while other sources are just being discovered.

MATH PRACTICE

Extra Calories An active man who weighs 70 kg maintains his weight if he eats 2,700 Cal per day. Unused Calories are converted into stored fat at the rate of 1 kg of fat per 9,000 Cal that are unused. If this active man consumes 3,600 Cal per day, how much weight does he gain each year?

Figure 3 ▶ Glasswort (top) is a salad green that may become an important food source in the future because it can grow in salty soil. Seaweed (bottom) is a multicellular organism called a *protist* and has been harvested and eaten by humans for centuries.

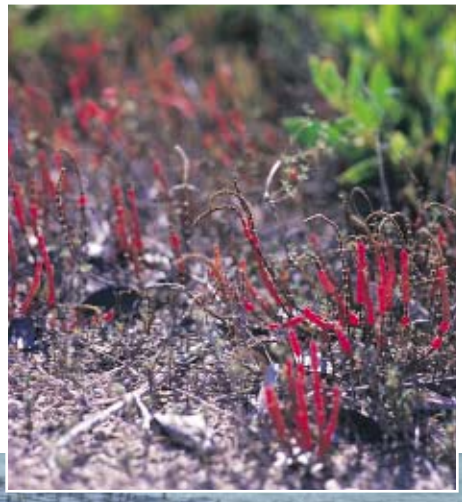


Figure 4 ▶ Malnourished citizens in Bangladesh (a country in Asia) wait for food assistance.

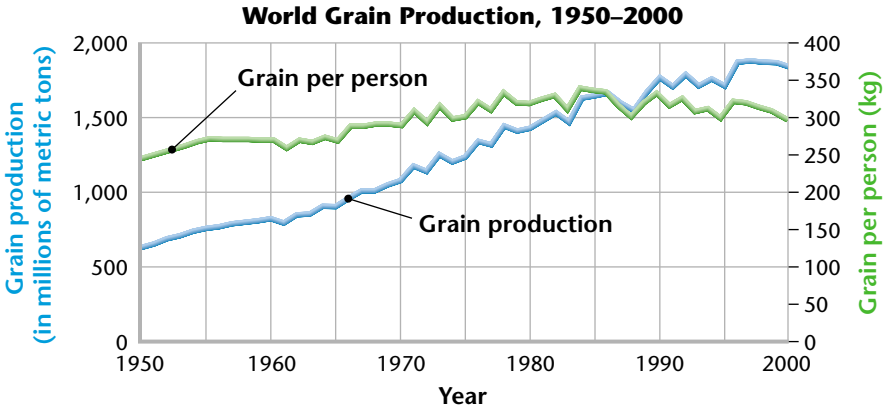
World Food Problems

As shown in **Figure 4,** some people become malnourished because they simply do not get enough food. More food is needed each year to feed the world's growing population. As shown in **Figure 5,** world food production has been increasing for decades, but now food production is not increasing as fast as the human population is increasing.

Unequal Distribution If all the food in the world today were divided equally among the human population, no one would have quite enough food for good health. But food is not divided equally. And malnutrition is largely the result of poverty. Even in the United States, many poor people suffer from malnutrition. Wars and political strife can also lead to malnutrition because they interrupt transportation systems. During wars, even if food is available, it often cannot be transported to the people who need it.

Droughts and Famines A *drought* is a prolonged period during which rainfall is below average. Crops grown without irrigation may produce low yields or fail entirely. A drought is more likely to cause famine in places where most food is grown locally than in places where most food is imported. If a drought occurs, there may be no seed to plant crops the following year. The effects of a drought can continue for years.

People in a given area can usually survive one crop failure. They may have saved enough food from previous seasons, or they may have systems for importing food from elsewhere. But several years of drought cause severe problems for any area of the world. After a long drought, the soil may be less able to support the production of food crops.



Source: U.S. Department of Agriculture.

Figure 5 ▶ Worldwide grain production has increased steadily, but not as rapidly as the population has grown.

The Green Revolution

Between 1950 and 1970, Mexico increased its production of wheat eight-fold and India doubled its production of rice. Worldwide, increases in crop yields resulted from the use of new crop varieties and the application of modern agricultural techniques. These changes were called the *green revolution*. An example of one of the new varieties of grain is shown in **Figure 6.** Since the 1950s, the green revolution has changed the lives of millions of people.

However, the green revolution also had some negative effects. Most new varieties of grain produce large yields only if they receive large amounts of water, fertilizer, and pesticides. In addition, the machinery, irrigation, and chemicals required by new crop varieties can degrade the soil if they are not used properly. As a result of the overuse of fertilizers and pesticides, yields from green revolution crops are falling in many areas. Grain production in the United States has decreased since 1990, partly because the amount of water used for irrigation has decreased during the same period.

In addition, the green revolution had a negative impact on *subsistence farmers*—farmers who grow only enough food for local use. Before the green revolution, subsistence farmers worked most of the world's farmland. But they could not afford the equipment, water, and chemicals needed to grow the new crop varieties.

Figure 6 ▶ New rice varieties and farming methods developed during the green revolution are used to increase yield in this experimental farm in China.

SECTION 1 Review

1. **Identify** the major causes of malnutrition.
2. **Compare** the environmental costs of producing different types of foods.
3. **Explain** how drought and the problems of food distribution can lead to famines.
4. **Describe** the importance and effects of the green revolution.

CRITICAL THINKING

5. **Identifying Relationships** Study the graph in Figure 5. World grain production peaked in the mid-1990s. Why was the amount of grain per person declining?
6. **Inferring Relationships** Write a short paragraph that explains how a decrease in the production of grain worldwide could lead to a shortage of other food sources. WRITING SKILLS