Chapter

10 Food and Agriculture

What food is this African girl carrying? Page 353

Why is this field deliberately flooded? Page 363

KEY ISSUE 1

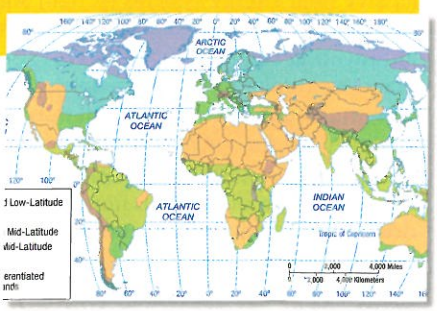
Where Did Agriculture Originate?

Inventing Agriculture p. 347

Agriculture was invented around 10,000 years ago in multiple hearths.

KEY ISSUE 2

Why Do People Consume Different Foods?



The Foods We Consume p. 352

Humans consume most of their calories through grains.

KEY ISSUE 4

Why Do Countries Face Obstacles to Development?

To develop more rapidly, developing countries must adopt policies that successfully promote development and find funds to pay for it.

LEARNING OUTCOME 9.4.1: Summarize the two paths to development.

- To promote development, developing countries choose either the self-sufficiency path or the international trade path.

LEARNING OUTCOME 9.4.2: Analyze shortcomings of the two development paths and give reasons international trade has triumphed.

- Self-sufficiency has protected inefficient businesses.
- International trade has increased dependency on declining resources and developed countries.
- Most countries have adopted international trade because of evidence that it promotes more rapid development.

LEARNING OUTCOME 9.4.3: Identify the main sources of financing development.

- Finance comes from direct investment by transnational corporations and loans from banks and international organizations.

LEARNING OUTCOME 9.4.4: Explain problems with financing development in developing and developed countries.

- Developing countries have been required to adopt structural adjustment programs.
- Developed countries have had to choose between policies that promote short-term growth and those that promote austerity.

LEARNING OUTCOME 9.4.5: Explain the principles of fair trade.

- Fair trade attempts to protect workers and small businesses in developing countries.
- Fair trade involves a combination of producer and worker standards.

LEARNING OUTCOME 9.4.6: Describe ways in which differences in development have narrowed or stayed wide.

- Developing countries have closed the gap with developed countries in some respects, such as health, but not in other respects, such as income.

THINKING GEOGRAPHICALLY 9.4: Some developing countries claim that the requirements placed on them by lending organizations such as the World Bank impede rather than promote development. Should developing countries be given a greater role in deciding how much the international organizations should spend and how such funds should be spent? Why or why not?

GOOGLE EARTH 9.4: A portion of the Trans-African Highway can be seen in the center of Voi, Kenya, running east-west in a curving arc immediately south of the center. Drag to street view, exit street view, and rotate so that north is to the right. For approximately what distance is the highway divided?

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Nonrenewable energy (p. 317) A source of energy that has a finite supply capable of being exhausted.

Passive solar energy systems (p. 326) Solar energy systems that collect energy without the use of mechanical devices.

Photovoltaic cell (p. 326) A solar energy cell, usually made from silicon, that collects solar rays to generate electricity.

Potential reserve (p. 319) The amount of a resource in deposits not yet identified but thought to exist.

Primary sector (p. 302) The portion of the economy concerned with the direct extraction of materials from Earth's surface, generally through agriculture, although sometimes by mining, fishing, and forestry.

Productivity (p. 303) The value of a particular product compared to the amount of labor needed to make it.

Proven reserve (p. 318) The amount of a resource remaining in discovered deposits.

Purchasing power parity (PPP) (p. 302) The amount of money needed in one country to purchase the same goods and services in another country; PPP adjusts income figures to account for differences among countries in the cost of goods.

Radioactive waste (p. 322) Materials from a nuclear reaction that emit radiation; contact with such particles may be harmful or lethal to people; therefore, the materials must be safely stored for thousands of years.

Renewable energy (p. 317) A resource that has a theoretically unlimited supply and is not depleted when used by humans.

Secondary sector (p. 302) The portion of the economy concerned with manufacturing useful products through processing, transforming, and assembling raw materials.

Structural adjustment program (p. 334) Economic policies imposed on less developed countries by international agencies to create conditions encouraging international trade, such as raising taxes, reducing government spending, controlling inflation, selling publicly owned utilities to private corporations, and charging citizens more for services.

Supply (p. 314) The quantity of something that producers have available for sale.

Tertiary sector (p. 302) The portion of the economy concerned with transportation, communications, and utilities, sometimes extended to the provision of all goods and services to people, in exchange for payment.

Uneven development (p. 340) Development of core regions at the expense of those on the periphery.

Value added (p. 303) The gross value of a product minus the costs of raw materials and energy.

KEY ISSUE 1

Where Did Agriculture Originate?

- Invention of Agriculture
- Comparing Subsistence and Commercial Agriculture

Agriculture is deliberate modification of Earth's surface through cultivation of plants and rearing of animals to obtain sustenance or economic gain. Agriculture originated when humans domesticated plants and animals for their use. The word *cultivate* means "to care for," and a **crop** is any plant cultivated by people.

Approximately one-half of the people in less developed countries are farmers. The overwhelming majority of them grow enough food to feed themselves, but little more. Developing countries are home to 97 percent of the world's farmers. In contrast, fewer than 2 percent of the people in the United States are farmers. Yet the advanced technology used by U.S. farmers allows them to produce enough food for people in the United States at a very high standard, as well as food for many people elsewhere in the world.

In each society, farmers possess very specific knowledge of their environmental conditions and certain technology for modifying the landscape. Within the limits of their technology, farmers choose from a variety of agricultural practices, based on their perception of the value of each alternative. These values are partly economic and partly cultural. How farmers deal with their physical environment varies according to dietary preferences, availability of technology, and other cultural traditions. Farmers select agricultural practices based on cultural perceptions because a society may hold some foods in high esteem while avoiding others.

Invention of Agriculture

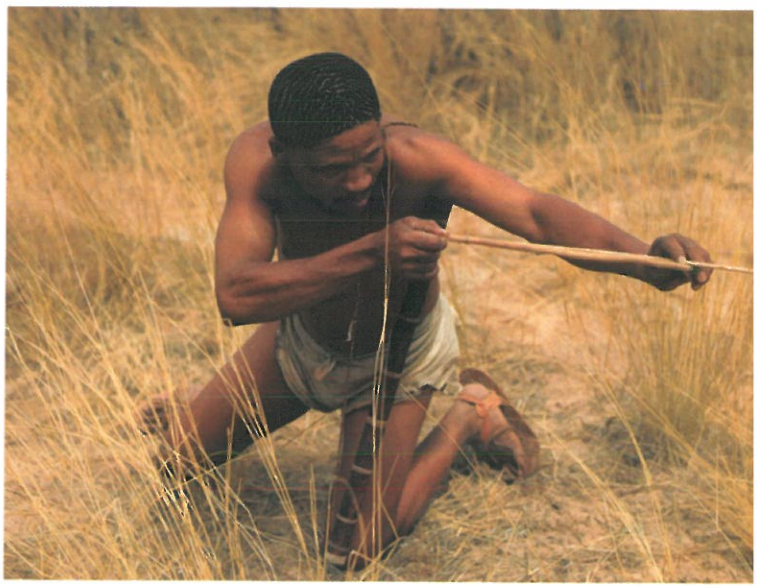
The origins of agriculture cannot be documented with certainty because it began before recorded history. Scholars try to reconstruct a logical sequence of events based on fragments of information about ancient agricultural practices and historical environmental conditions. Improvements in cultivating plants and domesticating animals evolved over thousands of years. This section offers an explanation for the origin and diffusion of agriculture.

HUNTERS AND GATHERERS

Before the invention of agriculture, all humans probably obtained the food they needed for survival through hunting for animals, fishing, or gathering plants (including berries, nuts, fruits, and roots). Hunters and gatherers lived in small groups of usually fewer than 50 persons because a larger number would quickly exhaust the available resources within walking distance (Figure 10-2). The men hunted game or fished, and the women collected berries, nuts, and roots. This division of labor sounds like a stereotype but is based on evidence from archaeology and anthropology. They collected food often, perhaps daily. The food search might have taken only a short time or much of the day, depending on local conditions.

The group traveled frequently, establishing new home bases or camps. The direction and frequency of migration depended on the movement of game and the seasonal growth of plants at various locations. We can assume that groups communicated with each other concerning hunting rights, intermarriage, and other specific subjects. For the most part, they kept the peace by steering clear of each other's territory.

Today, perhaps a quarter-million people, or less than 0.005 percent of the world's population, still survive by hunting and gathering rather than by agriculture. Examples include the Spinifex (also known as Pila Nguru) people, who live in Australia's Great Victorian Desert; the Sentinelese people, who live in India's Andaman Islands; and the Bushmen, who live in Botswana and Namibia. Contemporary hunting and gathering societies are isolated groups that live on the periphery of world settlement, but they provide insight into human customs that prevailed in prehistoric times, before the invention of agriculture.



▲ **FIGURE 10-2 HUNTING AND GATHERING** A Bushman in Botswana prepares his bow and arrow for hunting.

AGRICULTURAL REVOLUTION

Learning Outcome 10.1.1
Identify the major crop and livestock hearths.

The **agricultural revolution** was the time when human beings first domesticated plants and animals and no longer relied entirely on hunting and gathering. When did the agricultural revolution occur? About the year 8000 B.C., the world's population began to grow at a more rapid rate than it had in the past. Geographers and other scientists believe that the reason for the sudden population increase was the agricultural revolution. By growing plants and raising animals, human beings created larger and more stable sources of food, so more people could survive.

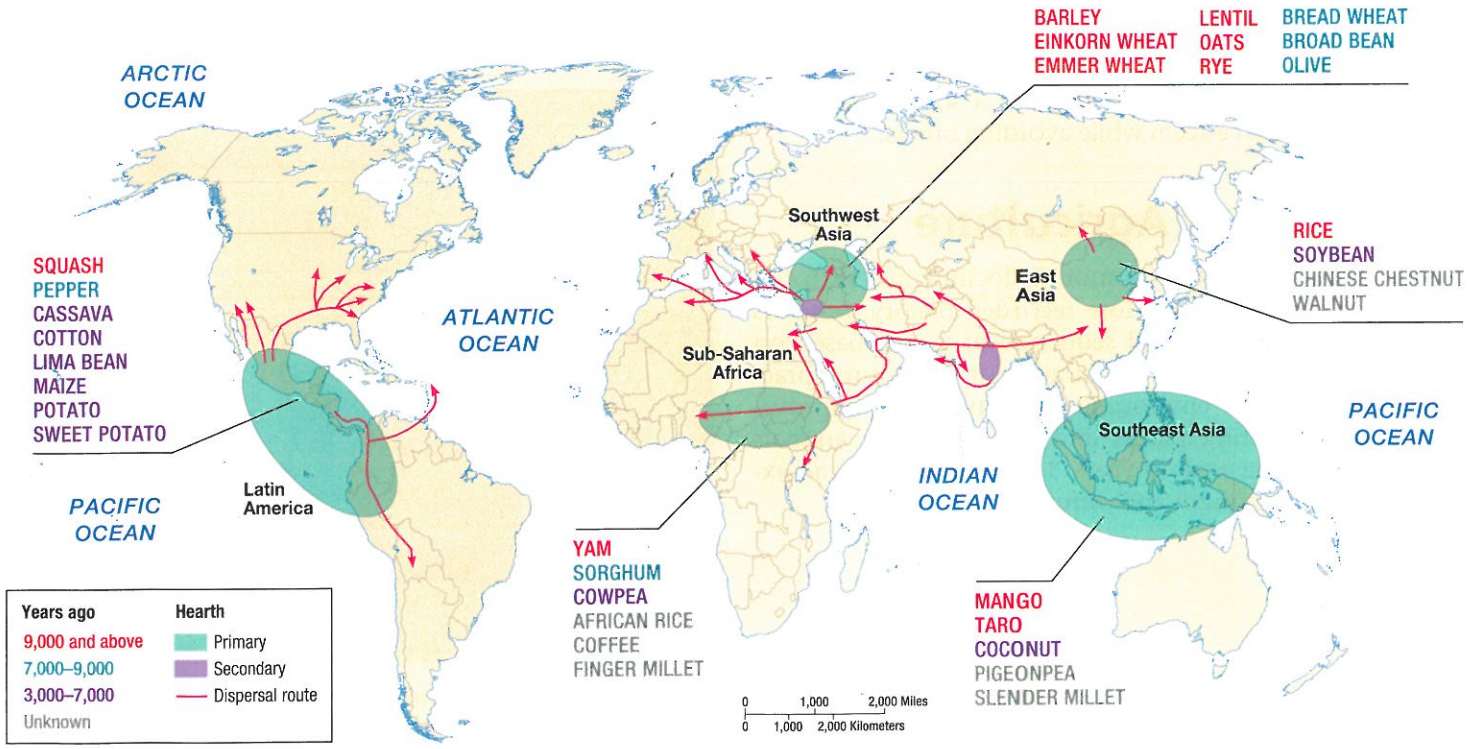
Scientists do not agree on whether the agricultural revolution originated primarily because of environmental factors or cultural factors. Probably a combination of both factors contributed:

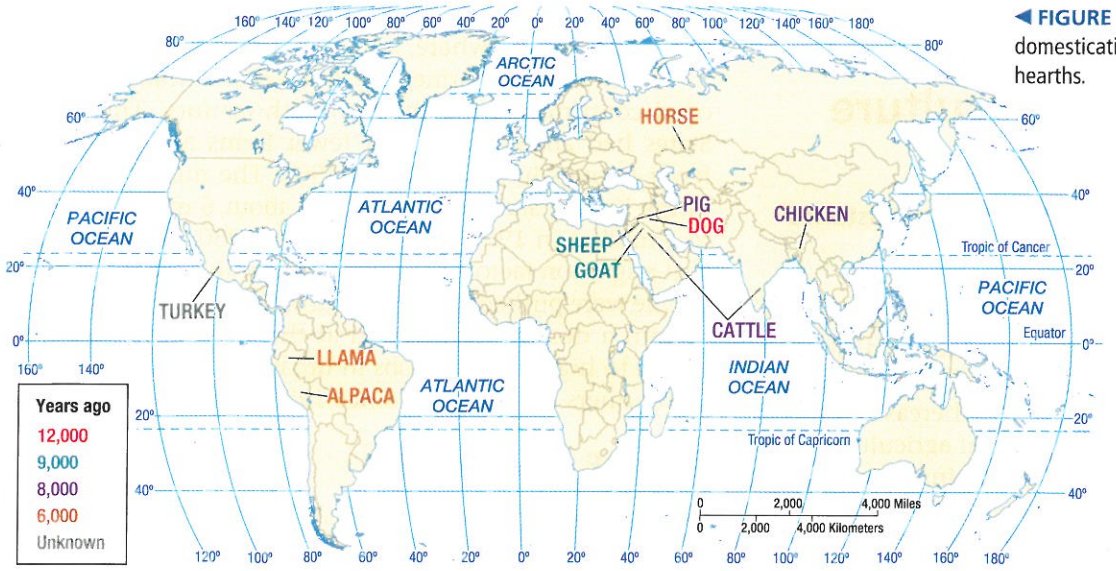
- **Environmental factors.** Those favoring environmental reasons point to the coinciding of the first domestication of crops and animals with climate change around 10,000 years ago. This marked the end of the last ice age, when permanent ice cover receded from Earth's mid-latitudes to polar regions, resulting in a massive redistribution of humans, other animals, and plants at that time.
- **Cultural factors.** Human behavior may be primarily responsible for the origin of agriculture. A preference for living in a fixed place rather than as nomads may have led hunters and gatherers to build permanent settlements and to store surplus vegetation there. In gathering wild vegetation, people inevitably cut plants and dropped berries, fruits, and seeds. These hunters probably observed that, over time, damaged or discarded food produced new plants. They may have deliberately cut plants or dropped berries on the ground to see if they would produce new plants. Subsequent generations learned to pour water over the site and to introduce manure and other soil improvements. Over thousands of years, plant cultivation apparently evolved from a combination of accident and deliberate experiment.

CROP HEARTHS. Scientists also do not agree on how agriculture diffused or why most nomadic groups convert from hunting, gathering, and fishing to agriculture. They do agree that agriculture originated in multiple hearths around the world:

- **Southwest Asia.** The earliest crops domesticated in Southwest Asia are thought to have been barley and wheat, around 10,000 years ago (Figure 10-3). Lentil and olive were also early domestications in Southwest Asia. From this hearth, cultivation diffused west to Europe and east to Central Asia.
- **East Asia.** Rice is now thought to have been domesticated in East Asia more than 10,000 years ago, along the Yangtze River in eastern China. Millet was cultivated at an early date along the Yellow River.
- **Sub-Saharan Africa.** Sorghum was domesticated in central Africa around 8,000 years ago. Yams may have

▼ **FIGURE 10-3 CROP HEARTHS** Agriculture originated in multiple hearths. Domestication of some crops can be dated back more than 10,000 years.





◀ **FIGURE 10-4 ANIMAL HEARTHS** Animal domestication also originated in multiple hearths.

been domesticated even earlier. Millet and rice may have been domesticated in sub-Saharan Africa independently of the hearth in East Asia. From central Africa, domestication of crops probably diffused further south in Africa.

- **Latin America.** Two important hearths of crop domestication are thought to have emerged in Mexico and Peru around 4,000 to 5,000 years ago. Mexico is considered a hearth for beans and cotton, and Peru for potato. The most important contribution of the Americas to crop domestication, maize (corn), may have emerged in the two hearths independently around the same time. From these two hearths, cultivation of maize and other crops diffused northward into North America and southward into tropical South America. Some researchers place the origin of squash in the southeastern present-day United States.

Pause and Reflect 10.1.1

Which crops appear to have reached the present-day United States first, according to Figure 10-3?

ANIMAL HEARTHS. Animals were also domesticated in multiple hearths at various dates. Southwest Asia is thought to have been the hearth for the domestication of the largest number of animals that would prove to be most important for agriculture, including cattle, goats, pigs, and sheep, between 8,000 and 9,000 years ago (Figure 10-4). Domestication of the dog is thought to date from around 12,000 years ago or possibly earlier in Southwest Asia, East Asia, and/or Europe. The horse is considered to have been domesticated in Central Asia; diffusion of the domesticated horse is thought to be associated with the diffusion of the Indo-European language, as discussed in Chapter 5 (Figure 10-5).

Inhabitants of Southwest Asia may have been the first to integrate cultivation of crops with domestication of herd animals such as cattle, sheep, and goats. These animals were used to prepare the land before planting seeds and, in turn, were fed part of the harvested crop. Other animal products, such as milk, meat, and skins, may have been exploited at a later date. This integration of plants and animals is a fundamental element of modern agriculture.

That agriculture had multiple origins means that, from earliest times, people have produced food in distinctive ways in different regions. This diversity derives from a unique legacy of wild plants, climatic conditions, and cultural preferences in each region. Improved communications in recent centuries have encouraged the diffusion of some plants to varied locations around the world. Many plants and animals thrive across a wide portion of Earth's surface, not just in their place of original domestication. Only after 1500, for example, were wheat, oats, and barley introduced to the Western Hemisphere and maize to the Eastern Hemisphere.

▼ **FIGURE 10-5 HORSES IN KAZAKHSTAN** The horse is thought to have been domesticated in this region roughly 6,000 years ago.

Comparing Subsistence and Commercial Agriculture

Learning Outcome 10.1.2

Describe the major differences between subsistence and commercial agriculture.

The most fundamental differences in agricultural practices are between those in developing countries and those in developed countries. Farmers in developing countries generally practice subsistence agriculture, whereas farmers in developed countries practice commercial agriculture. **Subsistence agriculture**, found in developing countries, is the production of food primarily for consumption by the farmer's family. **Commercial agriculture**, found in developed countries, is the production of food primarily for sale off the farm. The main features that distinguish commercial agriculture from subsistence agriculture include the percentage of farmers in the labor force, the use of machinery, and farm size.

PERCENTAGE OF FARMERS IN THE LABOR FORCE

A priority for all people is to secure the food they need to survive. In developing countries most people are subsistence farmers who work in agriculture to produce the food they and their families require. In developed countries the relatively few people engaged in farming are commercial farmers, and most people buy food with money earned by working in factories or offices or by performing other services.

In developed countries, around 5 percent of workers are engaged directly in farming, compared to around 44 percent in developing countries (Figure 10-6). The percentage of farmers is even lower in North America—only around 2 percent. Yet the small percentage of farmers in the United States and Canada produces not only enough food for themselves and the rest of the region but also a surplus to feed people elsewhere.

The number of farmers declined dramatically in developed countries during the twentieth century. The United States had about 60 percent fewer farms and 85 percent fewer farmers in 2000 than in 1900. The number of farms in the United States declined from about 6 million in 1940 to 4 million in 1960 and 2 million in 1980. Both push and pull migration factors have been responsible for the decline: People were pushed away from farms by lack of opportunity to earn a decent income, and at the same time they were pulled to higher-paying jobs in urban areas. The number of U.S. farmers has stabilized since 1980 at around 2 million.

USE OF MACHINERY

In developed countries, a small number of commercial farmers can feed many people because they rely on machinery to perform work rather than on people or animals (Figure 10-7). In developing countries, subsistence farmers do much of the work with hand tools and animal power.

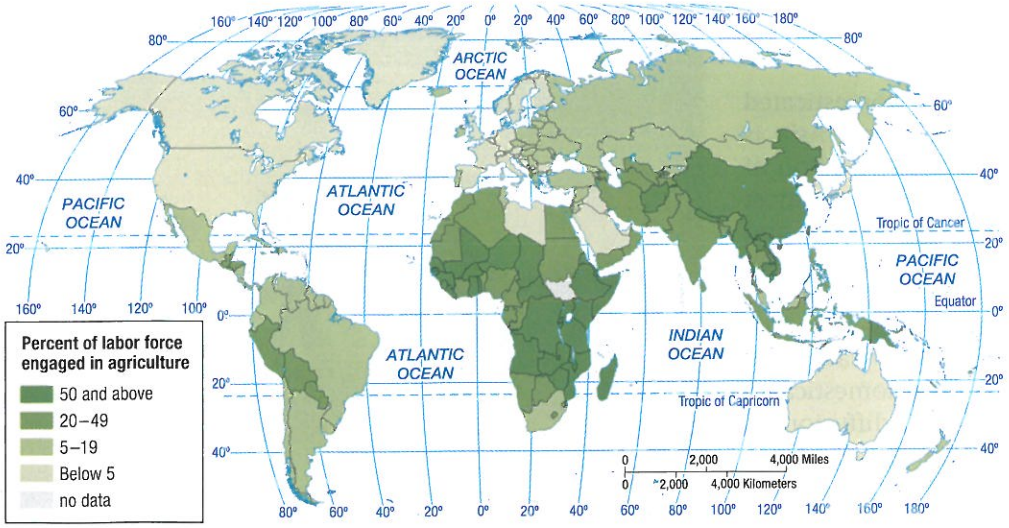
Traditionally, the farmer or local craftspeople made equipment from wood, but beginning in the late eighteenth century, factories produced farm machinery. The first all-iron plow was made in the 1770s and was followed in the nineteenth and twentieth centuries by inventions that made farming less dependent on human or animal power. Tractors, combines, corn pickers, planters, and other factory-made farm machines have replaced or supplemented manual labor.

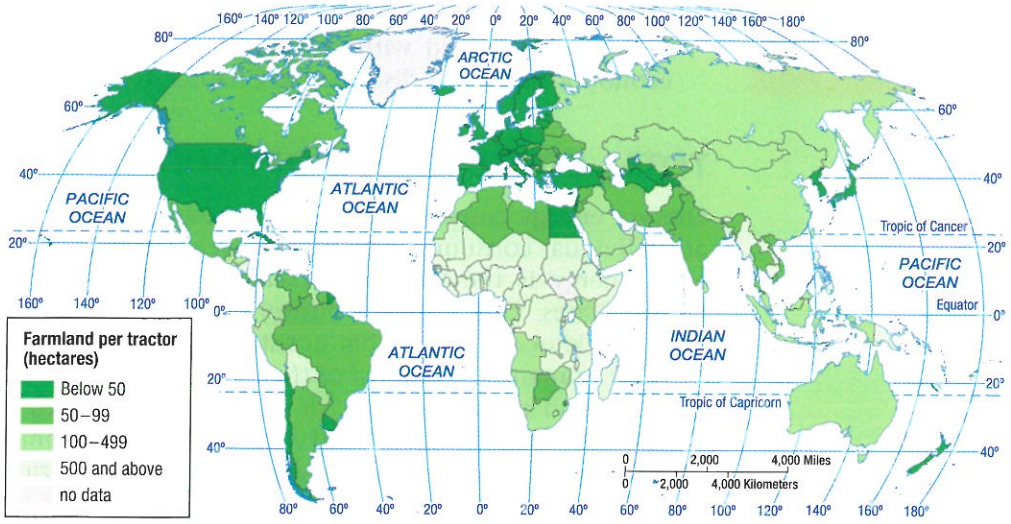
Transportation improvements have also aided commercial farmers. The building of railroads in the nineteenth century and highways and trucks in the twentieth century have enabled farmers to transport crops and livestock farther and faster. Cattle arrive at market heavier and in better condition when transported by truck or train than when driven on hoof. Crops reach markets without spoiling.

Commercial farmers use scientific advances to increase productivity. Experiments conducted in university laboratories, industry, and research organizations generate new fertilizers, herbicides, hybrid plants, animal breeds, and farming practices, which produce higher crop yields and healthier animals. Access to other scientific information has enabled farmers to make more intelligent decisions concerning proper agricultural practices. Some farmers conduct their own on-farm research.

Electronics also help commercial farmers. Farmers use Global Positioning System (GPS) devices to determine the precise coordinates for spreading different types and amounts of fertilizers. On large ranches, they also use GPS devices to monitor the location

▼ **FIGURE 10-6 AGRICULTURAL WORKERS** The percentage of the workforce engaged in agriculture is higher in developing countries than in developed countries.





▲ **FIGURE 10-7 AREA OF FARMLAND PER TRACTOR** Farmers in developing countries have more hectares or acres of land per tractor than do farmers in developed countries. The machinery makes it possible for commercial farmers to farm extensive areas, a practice necessary to pay for the expensive machinery.

of cattle. They ue satellite imagery to measure crop progress and yield monitors attached to combines to determine the precise number of bushels being harvested.

Pause and Reflect 10.1.2

What other electronics, in addition to GPS devices, might help a farmer on a very large farm?

FARM SIZE

The average farm is relatively large in commercial agriculture. Farms average 161 hectares (418 acres) in the United States, compared to about 1 hectare (2.5 acres) in China (Figure 10-8). Large size partly depends on mechanization. Combines, pickers, and other machinery perform most efficiently at very large scales, and their considerable expense cannot be justified on a small farm. As a result of the large size and the high level of mechanization, commercial agriculture is an expensive business. Farmers spend hundreds of thousands of dollars to buy or rent land and machinery before beginning operations. This money is frequently borrowed from a bank and repaid after output is sold.

Commercial agriculture is increasingly dominated by a handful of large farms. In the United States, the largest 5 percent of farms produce 75 percent of the country's total agriculture. Despite their size, most commercial farms in developed countries—90 percent in the United States—are family owned and operated. Commercial farmers frequently expand their holdings by renting nearby fields.

Although the United States had fewer farms and farmers in 2000 than in 1900, the amount of land devoted to agriculture increased by 13 percent, primarily due to irrigation and reclamation. However, in the twenty-first century, the United States has been losing 1.2 million hectares (3 million acres) per year of its 400 million hectares (1 billion acres) of farmland, primarily because of the expansion of urban areas.

CHECK-IN: KEY ISSUE 1

Where Did Agriculture Originate?

- ✓ **Before the invention of agriculture, most humans were hunters and gatherers.**
- ✓ **Agriculture was invented in multiple hearths beginning approximately 10,000 years ago.**
- ✓ **Modern agriculture is divided between subsistence agriculture in developing countries and commercial agriculture in developed countries. They differ according to the percentage of farmers, use of machinery, and farm size.**

▼ **FIGURE 10-8 FARM SIZE** The average size of a family farm in China is much smaller than in the United States. (left) Family farm in Anhui Province, China. (right) Family farm in West Brooklyn, Illinois.

(a)

(b)

KEY ISSUE 2

Why Do People Consume Different Foods?

- Diet
- Nutrition and Hunger

Learning Outcome 10.2.1

Explain differences between developed and developing countries in food consumption.

When you buy food in a supermarket, are you reminded of a farm? Not likely. The meat is carved into pieces that no longer resemble an animal and is wrapped in paper or plastic film. Often the vegetables are canned or frozen. The milk and eggs are in cartons.

The food industry in the United States and Canada is vast, but only a few people are full-time farmers, and they may be more familiar with the operation of computers and advanced machinery than the typical factory or office worker. The mechanized, highly productive American or Canadian farm contrasts with the subsistence farm found in much of the world. The most "typical" human—if there is such a person—is an Asian farmer who grows enough food to survive, with little surplus. This sharp contrast in agricultural practices constitutes one of the most fundamental differences between the more developed and less developed countries of the world.

Diet

Everyone needs food to survive. Consumption of food varies around the world, both in total amount and source of nutrients. The variation results from a combination of:

- **Level of development.** People in developed countries tend to consume more food and from different sources than do people in developing countries.
- **Physical conditions.** Climate is important in influencing what can be most easily grown and therefore consumed in developing countries. In developed countries, though, food is shipped long distances to locations with different climates.
- **Cultural preferences.** Some food preferences and avoidances are expressed without regard for physical and economic factors, as discussed in Chapter 4.

TOTAL CONSUMPTION OF FOOD

Dietary energy consumption is the amount of food that an individual consumes. The unit of measurement of dietary energy is the kilocalorie (kcal), or Calorie in the United States. One gram (or ounce) of each food source delivers a kilocalorie level that nutritionists can measure.

Most humans derive most of their kilocalories through consumption of **cereal grain**, or simply **cereal**, which is a grass that yields grain for food. **Grain** is the seed from a cereal grass. The three leading cereal grains—wheat, rice, and maize (corn in North America)—together account for nearly 90 percent of all grain production and more than 40 percent of all dietary energy consumed worldwide:

- **Wheat.** The principal cereal grain consumed in the developed regions of Europe and North America is wheat, which is consumed in bread, pasta, cake, and many other forms. It is also the most consumed grain in the developing regions of Central and Southwest Asia, where relatively dry conditions are more suitable for growing wheat than other grains (Figure 10-9).
- **Rice.** The principal cereal grain consumed in the developing regions of East, South, and Southeast Asia is rice. It is the most suitable crop for production in tropical climates.
- **Maize.** The leading crop in the world is maize (called corn in North America), though much of it is grown for purposes other than direct human consumption, especially as animal feed. It is the leading crop in some countries of sub-Saharan Africa.
- **Other crops.** A handful of countries obtain the largest share of dietary energy from other crops, especially in sub-Saharan Africa (Figure 10-10). These include cassava, sorghum, millet, plantains, sweet potatoes, and

▼ **FIGURE 10-9 DIETARY ENERGY BY SOURCE** Wheat, rice, and maize are the three main sources of kilocalories.