THINKING GEOGRAPHICALLY

1. Review the major economic, social, and demographic characteristics that contribute to a country's level of development. Which indicators can vary significantly by gender within countries and between countries at various levels of development? Why?
2. Some geographers have been attracted to the concepts of Immanuel Wallerstein, who argued that the modern world consists of a single entity, the capitalist world economy, that is divided into three regions: the core, semi-periphery, and periphery. How have the boundaries among these three regions changed?
3. China has relied on self-sufficiency to promote development, whereas Hong Kong has been a prominent practitioner of international trade. Explain how these two approaches have been reconciled since Hong Kong became part of China in 1997.
4. Some LDCs claim that the requirements placed on them by lending organizations such as the World Bank impede rather than promote development. Should LDCs 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?
5. What obstacles do Eastern European countries face as they dismantle 40 years of communism and convert to market economies?

ON THE INTERNET

In our cyberspace exercises for Chapter 9 (**www.prenhall.com/rubenstein**), we ask you to compare and contrast the economic differences among capitalist countries that have interpreted capitalism differently. We explore the "new economy" and e-commerce successes and failures, as well as consider questions of leapfrogging infrastructure development using technology. You will examine growth poles, as well as compare and contrast recent economic growth among the United States, the European Union, and Japan, and explore why some highly developed economies flourish, whereas others wither, during favorable economic cycles. We also provide you with a very short and easy tutorial on how to conduct successful Boolean searches in our **GeoSearch** section, as well as Internet destinations that offer differing perspectives for your consideration.

The complete Human Development Index can be accessed through **www.undp.org**. Other measures of development are included in addition to the country-by-country rankings by HDI, GDI, and GEM. Manufacturing value added data can be found at another United Nations site, **www.unido.org**.

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CHAPTER 10

Growing wheat on farm in northern Montana.

Agriculture

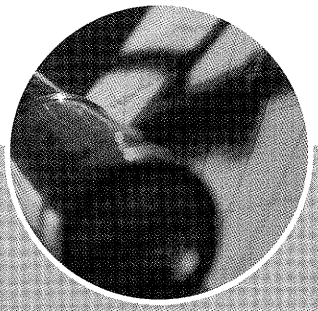
When you buy food in the supermarket, are you reminded of a farm? Not likely. The meat is carved into pieces that no longer resemble an animal and is wrapped in paper or plastic film. Often the vegetables are canned or frozen. The milk and eggs are in cartons.

Providing food in the United States and Canada is a vast industry. 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.

KEY ISSUES

1. **Where did agriculture originate?**
2. **Where are agricultural regions in less developed countries?**
3. **Where are agricultural regions in more developed countries?**
4. **Why do farmers face economic difficulties?**



CASE STUDY

Wheat Farmers in Kansas and Pakistan

The Iqbel family grows wheat on its 1–hectare (2.5–acre) plot of land in the Punjab province of Pakistan in a manner similar to that of their ancestors. They perform most tasks by hand or with the help of animals. To irrigate the land, for example, they lift water from a 20-meter (65-foot) well by pushing a water wheel. More prosperous farmers in Pakistan use bullocks to turn the wheel.

The farm produces about 1,500 kilograms (3,300 pounds) of wheat per year—enough to feed the Iqbel family. Some years they produce a small surplus, which they can sell. They can then use that money to buy other types of food or household items. In drought years, however, the crop yield is lower, and the Iqbel family must receive food from government and international relief organizations.

A world away, in Kansas, the McKinley's farm the prairie sod. Like the Iqbels, they grow wheat in a climate that receives little rain. Otherwise, the two farm families lead very different lives. The McKinley family's farm is 200 times as large—200 hectares (500 acres). The McKinleys derive several hundred times more income from the sale of wheat than do the Iqbels.

The wheat grown on the McKinley's farm is not consumed directly by them. Instead, it is sold to a processing company and ultimately turned into bread wrapped in plastic and sold in a supermarket hundreds of kilometers away. Most of the wheat from the Iqbels' farm is consumed in the village where it is grown.

More than 40 percent of the people in the world are farmers. The overwhelming majority of them are like the Iqbels, growing enough food to feed themselves, but little more. In most African and Asian countries more than one-half of the people are farmers. In contrast, fewer than 2 percent of the people in the United States and Canada are farmers. Yet the advanced technology used by these farmers allows them to produce enough food for people in the United States and Canada at a very high standard, plus food for many people elsewhere in the world.

The previous chapter divided economic activities into primary, secondary, and tertiary sectors. This chapter is concerned with the principal form of primary-sector economic activity—agriculture. The next two chapters look at the secondary and tertiary sectors.

Geographers study ***where*** agriculture is distributed across Earth. The most important distinction is what happens to farm products. In less developed ***regions***, the farm products are most often consumed on or near the farm where they are produced, whereas in more developed countries farmers sell what they produce.

Geographers observe a wide variety of agricultural practices. The reason ***why*** farming varies around the world relates to distribution across ***space*** of cultural and environmental factors. Elements of the physical environment, such as climate, soil, and topography, set broad limits on agricultural practices, and farmers make choices to modify the environment in a variety of ways.

Farming is an economic activity that still depends very much on ***local diversity*** of environmental and cultural conditions in each ***place***. Despite increased knowledge of alternatives, farmers practice distinctive agriculture in different regions and, in fact, on neighboring farms. Broad climate patterns influence the crops planted in a region, and local soil conditions influence the crops planted on an individual farm.

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.

Although individual farmers may make specific decisions on a very local ***scale***, agriculture is as caught up in the ***globalization*** of the economy as other industries. Agriculture is big business in MDCs and a major component of international trade ***connections*** in LDCs.

After examining the origins and diffusion of agriculture, we will consider the agricultural practices used in less developed and more developed regions. We also will examine the problems farmers face in each type of region. Although each farm has a unique set of physical conditions and choice of crops, geographers group farms into several types by their distinctive environmental and cultural characteristics.

KEY ISSUE 1

Where Did Agriculture Originate?

- Origins of agriculture
- Location of agricultural hearths
- Classifying agricultural regions

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 process of origin and diffusion of agriculture.

Origins of Agriculture

Determining the origin of agriculture first requires a definition of what it is—and agriculture is not easily defined. We will use this definition: **agriculture** is deliberate modification of Earth's surface through cultivation of plants and rearing of animals to obtain sustenance or economic gain. Agriculture thus 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.

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, with usually fewer than 50 persons, because a larger number would quickly exhaust the available resources within walking distance. They survived by collecting food often, perhaps daily. The food search might take only a short time or much of the day, depending on local conditions. 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.

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.

Contemporary Hunting and Gathering. 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. These people live in isolated locations, including the Arctic and the interior of Africa, Australia, and South America. Examples include African Bushmen of Namibia and Botswana and Aborigines in Australia.

Contemporary hunting and gathering societies are isolated groups living on the periphery of world settlement, but they provide insight into human customs that prevailed in prehistoric times, before the invention of agriculture.

Invention of Agriculture

Why did nomadic groups convert from hunting, gathering, and fishing to agriculture? 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.

Prehistoric people may have originally domesticated animals for noneconomic reasons, such as sacrifices and other religious ceremonies. Other animals probably were domesticated as household pets, surviving on the group's food scraps.

Two Types of Cultivation. The earliest form of plant cultivation, according to prominent cultural geographer Carl Sauer, was **vegetative planting**, which is the reproduction of plants by direct cloning from existing plants, such as cutting stems and dividing roots. Plants found growing wild were deliberately divided and transplanted.

Coming later, according to Sauer, was **seed agriculture**, which is the reproduction of plants through annual planting of seeds that result from sexual fertilization. Seed agriculture is practiced by most farmers today.

Location of Agricultural Hearths

Agriculture probably did not originate in one location, but began in multiple, independent hearths, or points of origin. From these hearths, agricultural practices diffused across Earth's surface.

Location of First Vegetative Planting

Sauer believes that vegetative planting probably originated in Southeast Asia (Figure 10–1). The region's diversity of climate and topography probably encouraged growth of a wide variety of plants suitable for dividing and transplanting. Also, the people obtained food primarily by fishing rather than by hunting and gathering, so they may have been more sedentary and therefore able to devote more attention to growing plants.

The first plants domesticated in Southeast Asia through vegetative planting probably included roots such as the taro and yam, and tree crops such as the banana and palm. Vegetative planting diffused from the Southeast Asian hearth northward and eastward to China and Japan, and westward through India to Southwest Asia, tropical Africa, and the Mediterranean lands. As for livestock, the dog, pig, and chicken probably were domesticated first in Southeast Asia.

Other early hearths of vegetative planting also may have emerged independently in West Africa and northwestern South America. It may have begun with the oil-palm tree and yam in West Africa and the manioc, sweet potato, and arrowroot in South America. The practice diffused from northwestern South America to Central America and eastern portions of South America.

Location of First Seed Agriculture

Seed agriculture also originated in more than one hearth. Sauer identified three hearths in the Eastern Hemisphere: western India, northern China, and Ethiopia (Figure 10–2). Seed agriculture diffused quickly from western India to Southwest Asia, where important early advances were made, including the domestication of wheat and barley, two grains that became particularly important thousands of years later in European and American civilizations.

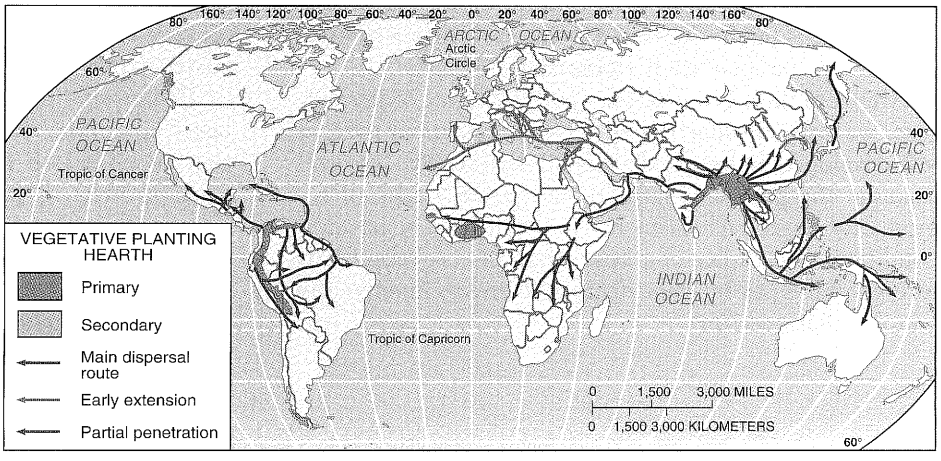


FIGURE 10–1 *Origin and diffusion of vegetative planting. Vegetative planting is the reproduction of plants by direct cloning from existing plants. The practice originated primarily in Southeast Asia, according to Carl Sauer. Two other early centers of vegetative planting were in West Africa and northwestern South America. From these hearths, the practice diffused to other regions.*

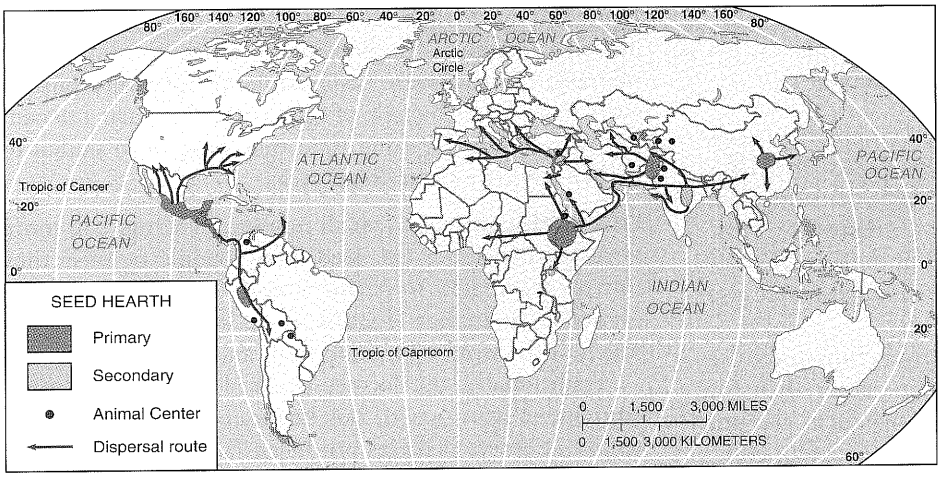


FIGURE 10–2 *Origin and diffusion of seed agriculture and livestock herding. Seed agriculture may have originated in several hearths, including western India, northern China, and Ethiopia. Southern Mexico and northwestern South America may have been other early hearths. Early advances were made in Southwest Asia.*

Apparently, inhabitants of Southwest Asia also were first to integrate seed agriculture with domestication of herd animals such as cattle, sheep, and goats. These animals were used to plow the land before planting seeds and, in turn, were fed part of the harvested crop. Other animal products, such as milk, meat, and skins, were first exploited at a later date, according to Sauer. This integration of plants and animals is a fundamental element of modern agriculture.

Diffusion of Seed Agriculture. Seed agriculture diffused from Southwest Asia across Europe and through North Africa. Greece, Crete, and Cyprus display the earliest evidence of seed agriculture in Europe. From these countries, agriculture may have diffused northwestward through the Danube River basin, eventually to the Baltic and North seas, and northeastward to Ukraine. Most of the plants and animals domesticated in Southwest Asia spread into Europe, although barley and cattle became more important farther north, perhaps because of cooler and moister climatic conditions.

Seed agriculture also diffused eastward from Southwest Asia to northwestern India and the Indus River plain. Again, various domesticated plants and animals were brought from Southwest Asia, although other plants, such as cotton and rice, arrived in India from different hearths.

From the northern China hearth, millet diffused to South Asia and Southeast Asia. Rice, which ultimately became the most important crop in much of Asia, has an unknown hearth, although some geographers consider Southeast Asia to be its most likely location. Sauer identified a third independent hearth in Ethiopia, where millet and sorghum were domesticated early. However, he argued that agricultural advances in Ethiopia did not diffuse widely to other locations. That Ethiopia is an ancient hearth for seed agriculture is ironic, because rapid population growth, devastating civil wars, and adverse environmental conditions have combined to make Ethiopia the site of widespread starvation.

Two independent seed agriculture hearths originated in the Western Hemisphere: southern Mexico and northern Peru. The hearth in southern Mexico, which extended into Guatemala and Honduras, was the point of origin for squash and maize (corn). Squash, beans, and cotton may have been domesticated in northern Peru. From these two hearths, agricultural practices diffused to other parts of the Western Hemisphere, although agriculture was not widely practiced until European colonists began to arrive some 500 years ago. The only domesticated animals were the llama, alpaca, and turkey; herd animals were unknown until European explorers brought them in the sixteenth century.

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 A.D. 1500, for example, were wheat, oats, and barley introduced to the Western Hemisphere, and maize to the Eastern Hemisphere.

Classifying Agricultural Regions

The most fundamental differences in agricultural practices are between those in LDCs and those in MDCs. Farmers in LDCs generally practice subsistence agriculture, whereas farmers in MDCs, including the United States, Canada, Western Europe, Australia, and New Zealand, practice commercial agriculture.

Differences Between Subsistence and Commercial Agriculture

Subsistence agriculture, found in LDCs, is the production of food primarily for consumption by the farmer's family. **Commercial agriculture**, found in more developed countries, is the production of food primarily for sale off the farm. Five principal features distinguish commercial agriculture from subsistence agriculture:

- Purpose of farming
- Percentage of farmers in the labor force

- Use of machinery
- Farm size
- Relationship of farming to other businesses

Purpose of Farming. Subsistence and commercial agriculture are undertaken for different purposes. In LDCs most people produce food for their own consumption. Some surplus may be sold to the government or to private firms, but the surplus product is not the farmer's primary purpose and may not even exist some years because of growing conditions.

In commercial farming, farmers grow crops and raise animals primarily for sale off the farm rather than for their own consumption. Agricultural products are not sold directly to consumers but to food-processing companies. Large processors, such as General Mills and Kraft, typically sign contracts with commercial farmers to buy their grain, chickens, cattle, and other output. Farmers may have contracts to sell sugar beets to sugar refineries, potatoes to distilleries, and oranges to manufacturers of concentrated juices.

Percentage of Farmers in the Labor Force. In MDCs less than 5 percent of the workers are engaged directly in farming, compared to 55 percent in LDCs. (Figure 10–3). The percentage of farmers is even lower in the United States and Canada, at only 2 percent. Yet the small percentage of farmers in the United States and Canada produces enough food not only for themselves and the rest of the region but also a surplus to feed people elsewhere.

The number of farmers declined dramatically in more developed societies during the twentieth century. The United States had about 6 million farms in 1940, 4 million in 1960, and 2 million in 2000. Both push and pull migration factors were responsible: people were pushed away from farms by lack of opportunity to earn a decent income, and at the same time they have been pulled to higher-paying jobs in urban areas.

Use of Machinery. A small number of farmers in more developed societies can feed many people because they rely on machinery to perform work, rather than relying on people or animals (Figure 10–4). In LDCs, 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 also aid 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

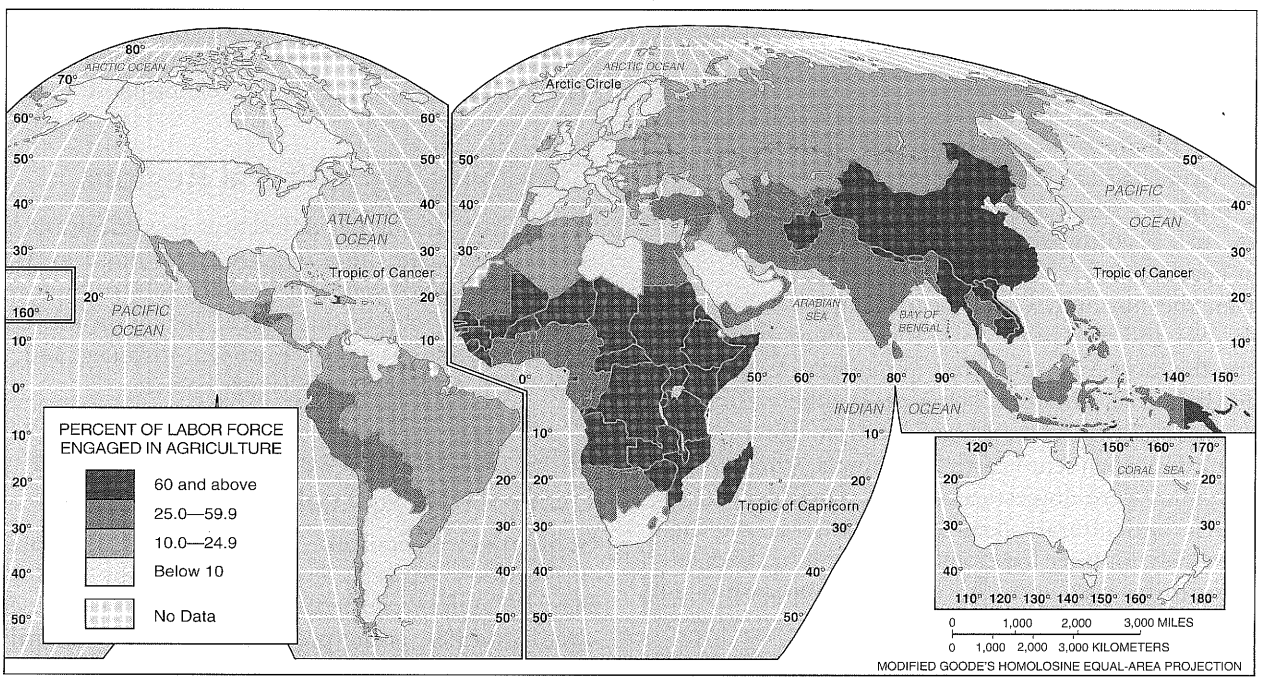


FIGURE 10–3 *Percent primary-sector workers. A priority for all people is to secure the food they need to survive. In LDCs most people work in agriculture to produce the food they and their families require. In MDCs few people are farmers, and most people buy food with money earned by working in factories, offices, or performing other services.*

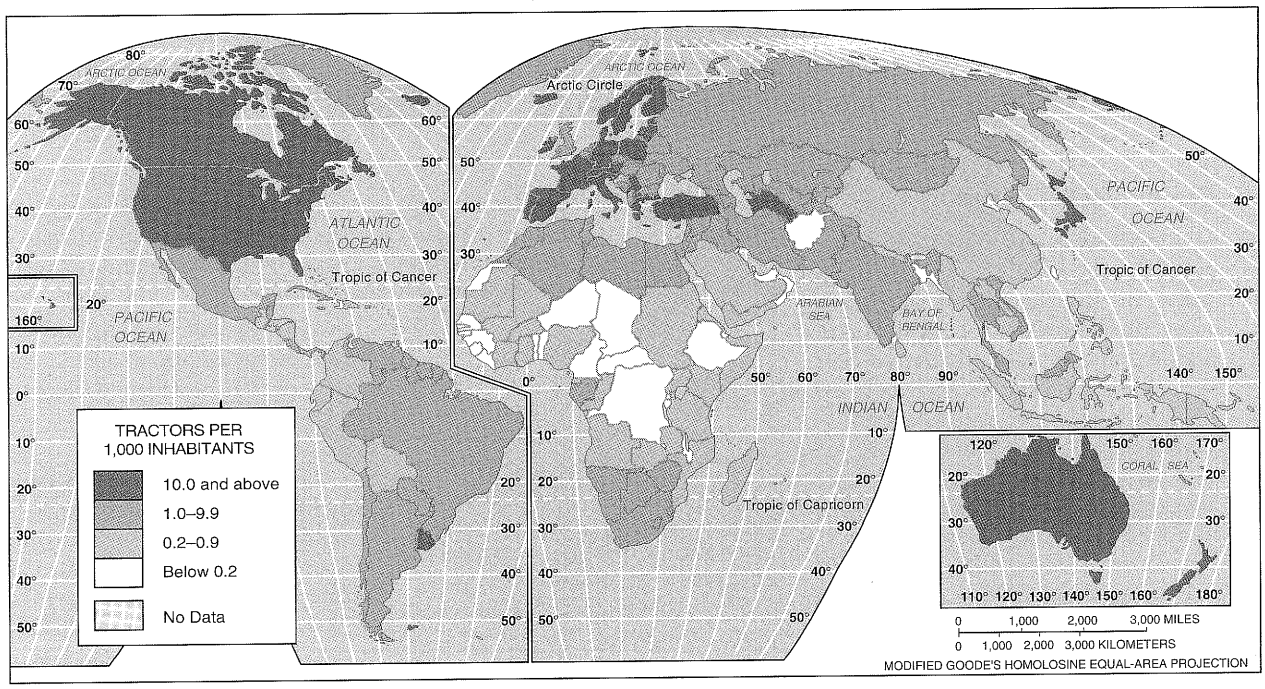
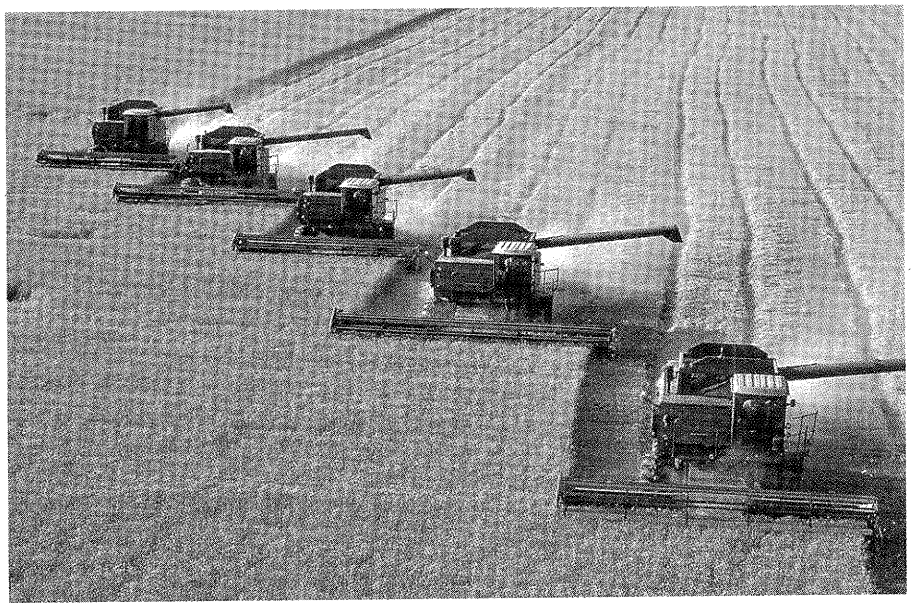


FIGURE 10–4 *Tractors per 1,000 inhabitants. Farmers in more developed countries possess more machinery, such as tractors, than do farmers in less developed ones. The machinery makes it possible for commercial farmers to farm extensive areas, a necessary practice to pay for the expensive machinery. These combine machines are reaping, threshing, and cleaning wheat in Sherman County, Kansas.*



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 aid commercial farmers. GPS units determine the precise coordinates for spreading different types and amounts of fertilizers. GPS is also used to monitor the location of cattle on large ranches. Satellite imagery monitors crop progress. Yield monitors attached to combines determine the precise number of bushels being harvested.

Farm Size. The average farm size is relatively large in commercial agriculture, especially in the United States and Canada. U.S. farms average about 175 hectares (435 acres). Despite their size, most commercial farms in developed countries are family owned and operated—98 percent in the United States. Commercial farmers frequently expand their holdings by renting nearby fields.

Commercial agriculture is increasingly dominated by a handful of large farms. In the United States the largest 4 percent of farms (those selling agricultural products with market value exceeding $500,000 per year) account for more than one-half of the country's total output. At the other extreme, one-half of U.S. farms generate less than $10,000 a year in sales.

Large size is partly a consequence of 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

CONTEMPORARY GEOGRAPHIC TOOLS

Protecting Farmland

Loss of farmland to urban growth is especially severe at the edge of the string of large metropolitan areas along the East Coast of the United States. Some of the most threatened agricultural land lies in Maryland, a small state where two major cities—Washington and Baltimore—have coalesced into a continuous built-up area (see Chapter 13). A geographic information system was used to identify which farms should be preserved.

Farmland preservation efforts traditionally identify "prime" agricultural areas on the basis of only one factor: soil quality. "Prime" farmland is typically flat and well-drained, qualities that also attract developers of new housing projects. Through GIS, the distribution of Maryland's most productive soils could be compared to the distribution of other factors.

Maps generated through GIS were essential in identifying agricultural land to protect, because the most appropriate farms to preserve were not necessarily those with the highest-quality soil. Why should the state and nonprofit organizations spend scarce funds to preserve "prime" farmland that is nowhere near the path of urban sprawl? Conversely, why purchase an expensive, isolated farm already totally surrounded by residential developments, when the same amount of money could buy several large contiguous farms that effectively blocked urban sprawl elsewhere?

To identify the "best" lands according to several economic and environmental factors, not just soil quality, GIS consultants produced a series of maps at the state and county levels. Environmental maps identified farmland in need of preservation because of water quality, flood control, species habitats, historic sites, or especially attractive scenery. Economic maps included the market value of the products grown or raised on the land and areas projected to have relatively high population growth if not prevented. The GIS maps showed that 63 percent of Maryland's farmland contained prime soils, 32 percent important environmental features, and 23 percent high population growth pressures.

The various soil quality, environmental, and economic maps were combined through the GIS to produce a single composite map of all three sets of important factors (Figure 10-1.1). The map shows that 4 percent of the state's farmland had prime soils, significant environmental features, and high projected population growth, and 25 percent had two of the three factors (such as prime soils and significant environmental features but not high population growth).

GIS can't rank the relative importance of the various physical, environmental, and economic features. Land with one important physical, environmental, or economic feature may be as important to preserve as land with three features. Still, Maryland officials are making use of the results of the GIS as part of an overall strategy to minimize sprawl and keep new developments as tightly packed around existing urban areas as possible. For example, state highway money is allocated to improving roads in existing built-up areas rather than extend new roads through rural areas.

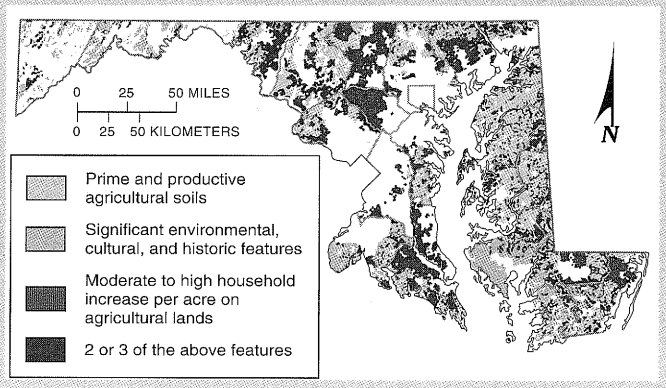


FIGURE 10-1.1 *Maryland soil quality, environmental conditions, and population growth.*

land and machinery before beginning operations. This money is frequently borrowed from a bank and repaid after the output is sold.

Although the United States currently has fewer farms and farmers than in 1900, the amount of land devoted to agriculture has increased. The United States has 60 percent fewer farms and 85 percent fewer farmers in 2000 than in 1900, but 13 percent more farmland, primarily through irrigation and reclamation.

However, the amount of U.S. farmland has declined from an all-time peak around 1960. The United States lost an annual average of about 1.5 million hectares (4 million acres) of its 400 million hectares (1 billion acres) of farmland during the 1990s, primarily because of expansion of urban areas. A more serious problem in the United States has been the loss of the most productive farmland, known as **prime agricultural land**, as urban areas sprawl into the surrounding countryside.

Relationship of Farming to Other Businesses. Commercial farming is closely tied to other businesses. The system of commercial farming found in the United States and other relatively developed countries has been called **agribusiness**, because the family farm is not an

isolated activity but is integrated into a large food-production industry. Commercial farmers make heavy use of modern communications and information technology to stay in touch and keep track of prices, yields, and expenditures.

Although farmers are less than 2 percent of the U.S. labor force, more than 20 percent of U.S. labor works in food production related to agribusiness: food processing, packaging, storing, distributing, and retailing. Agribusiness encompasses such diverse enterprises as tractor manufacturing, fertilizer production, and seed distribution. Although most farms are owned by individual families, many other aspects of agribusiness are controlled by large corporations.

Mapping Agricultural Regions

Several attempts have been made to outline the major types of subsistence and commercial agriculture currently practiced in the world, but few of these classifications include maps that show regional distributions. The most widely used map of world agricultural regions was prepared by geographer Derwent Whittlesey in 1936.

Whittlesey identified 11 main agricultural regions, plus an area where agriculture was nonexistent. Whittlesey's 11 regions are divided between five that are important in LDCs and six that are important in MDCs (Figure 10–5 bottom).

Within more developed and less developed regions, Whittlesey sorted out agricultural practices primarily by climate. Climate influences the crop that is grown, or whether animals are raised instead of growing any crop (Figure 10–5, top). Similarities between the two maps are striking. For example, pastoral nomadism is the predominant type of agriculture in the Middle East, which has a dry climate, whereas shifting cultivation is the predominant type of agriculture in central Africa, which has a tropical climate.

Note the division between southeastern China (warm midlatitude climate, intensive subsistence agriculture with wet rice dominant) and northeastern China (cold midlatitude climate, intensive subsistence agriculture with wet rice not dominant). In the United States much of the West is distinguished from the rest of the country according to climate (dry) and agriculture (livestock ranching). Thus, agriculture varies between the drylands and the tropics within LDCs—as well as between the drylands of less developed and more developed countries.

The correlation between agriculture and climate is by no means perfect, but clearly some relationship exists between climate and agriculture. Because of the problems with environmental determinism discussed in Chapter 1, geographers are wary of placing too much emphasis on the role of climate.

Cultural preferences, discussed in Chapter 4, explain some agricultural differences in areas of similar climate. Hog production is virtually nonexistent in predominantly Muslim regions, because of that religion's taboo against consuming pork products (refer to Figure 4–6). Wine production is relatively low in Africa and Asia, even where climate is favorable for growing grapes, because of alcohol avoidance in predominantly non-Christian countries (refer to Figure 4–13).

KEY ISSUE 2

Where Are Agricultural Regions in Less Developed Countries?

- Shifting cultivation
- Pastoral nomadism
- Intensive subsistence agriculture

This section considers four of the five agricultural types characteristic of LDCs: shifting cultivation, pastoral nomadism, and two types of intensive subsistence. The fifth type of LDC agriculture, plantation, is discussed in the third key issue along with agriculture in MDCs. Although located in LDCs, plantations are typically owned and operated by companies based in MDCs, and they produce principally for consumers located in MDCs.

Shifting Cultivation

Shifting cultivation is practiced in much of the world's Humid Low-Latitude, or A, climate regions, which have relatively high temperatures and abundant rainfall. It predominates in the Amazon area of South America, Central and West Africa, and Southeast Asia, including Indochina, Indonesia, and New Guinea.

Why is it called shifting cultivation rather than shifting agriculture? It is essentially a matter of scale. We use the term "cultivation" (as in "cultivate a garden") because "agriculture" implies greater use of tools and animals and more sophisticated modification of the landscape. Shifting cultivation bears little relation to the agriculture practiced in the more developed regions of Western Europe and North America, or even in other LDCs such as China.

Characteristics of Shifting Cultivation

Shifting cultivation has two distinguishing hallmarks:

- Farmers clear land for planting by slashing vegetation and burning the debris (**slash-and-burn agriculture**).
- Farmers grow crops on a cleared field for only a few years until soil nutrients are depleted and then leave it fallow (nothing planted) for many years so the soil can recover.

People who practice shifting cultivation generally live in small villages and grow food on the surrounding land, which the village controls. Well-recognized boundaries usually separate neighboring villages.

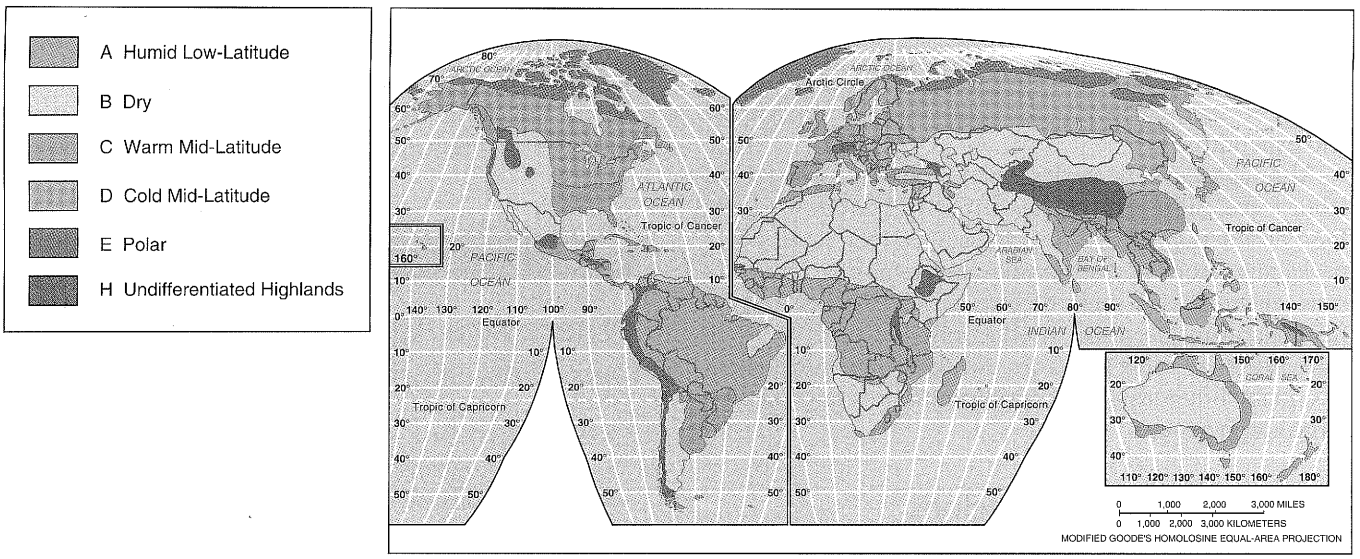


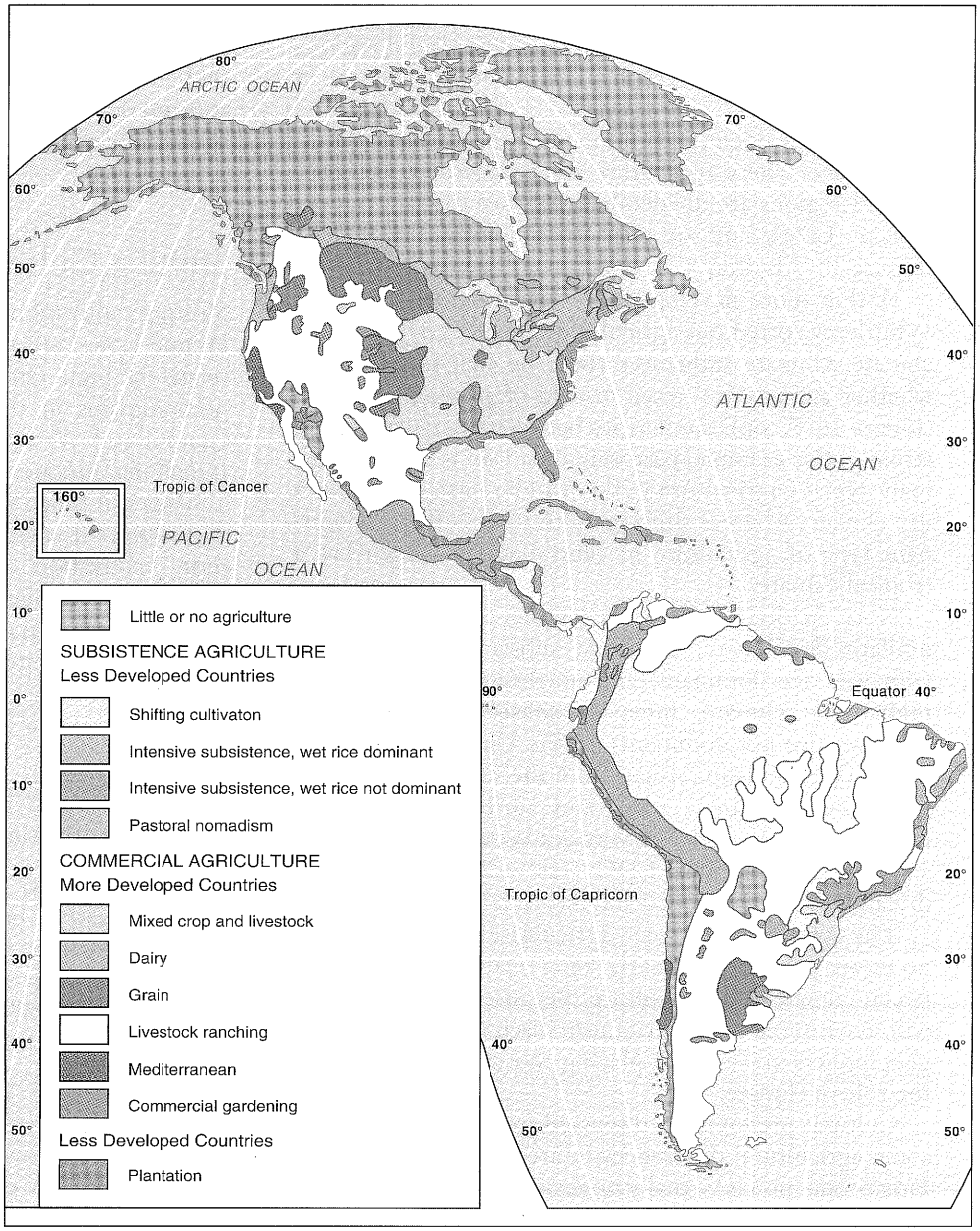
FIGURE 10–5 *(top) Simplified climate regions. Figure 2–2 shows more detail. Compare the broad distribution of the major climate regions with the distinctive types of agriculture in more developed and less developed countries. (bottom) Agricultural regions. The major agricultural practices of the world can be divided into subsistence and commercial regions.*

Subsistence *regions include*

- Shifting cultivation—*primarily the tropical regions of South America, Africa, and Southeast Asia.*
- Pastoral nomadism—*primarily the drylands of North Africa and Asia.*
- Intensive subsistence, wet rice dominant—*primarily the large population concentrations of East and South Asia.*
- Intensive subsistence, crops other than rice dominant—*primarily the large population concentrations of East and South Asia where growing rice is difficult.*

Commercial *regions include*

- Mixed crop and livestock—*primarily U.S. Midwest and central Europe.*
- Dairying—*primarily near population clusters in northeastern United States, southeastern Canada, and northwestern Europe.*
- Grain—*primarily north-central United States and Eastern Europe.*
- Ranching—*primarily the drylands of western United States, southeastern South America, Central Asia, southern Africa, and Australia.*
- Mediterranean—*primarily lands surrounding the Mediterranean Sea, western United States, and Chile.*
- Commercial gardening—*primarily southeastern United States and southeastern Australia.*
- Plantation—*primarily the tropical and subtropical regions of Latin America, Africa, and Asia.*



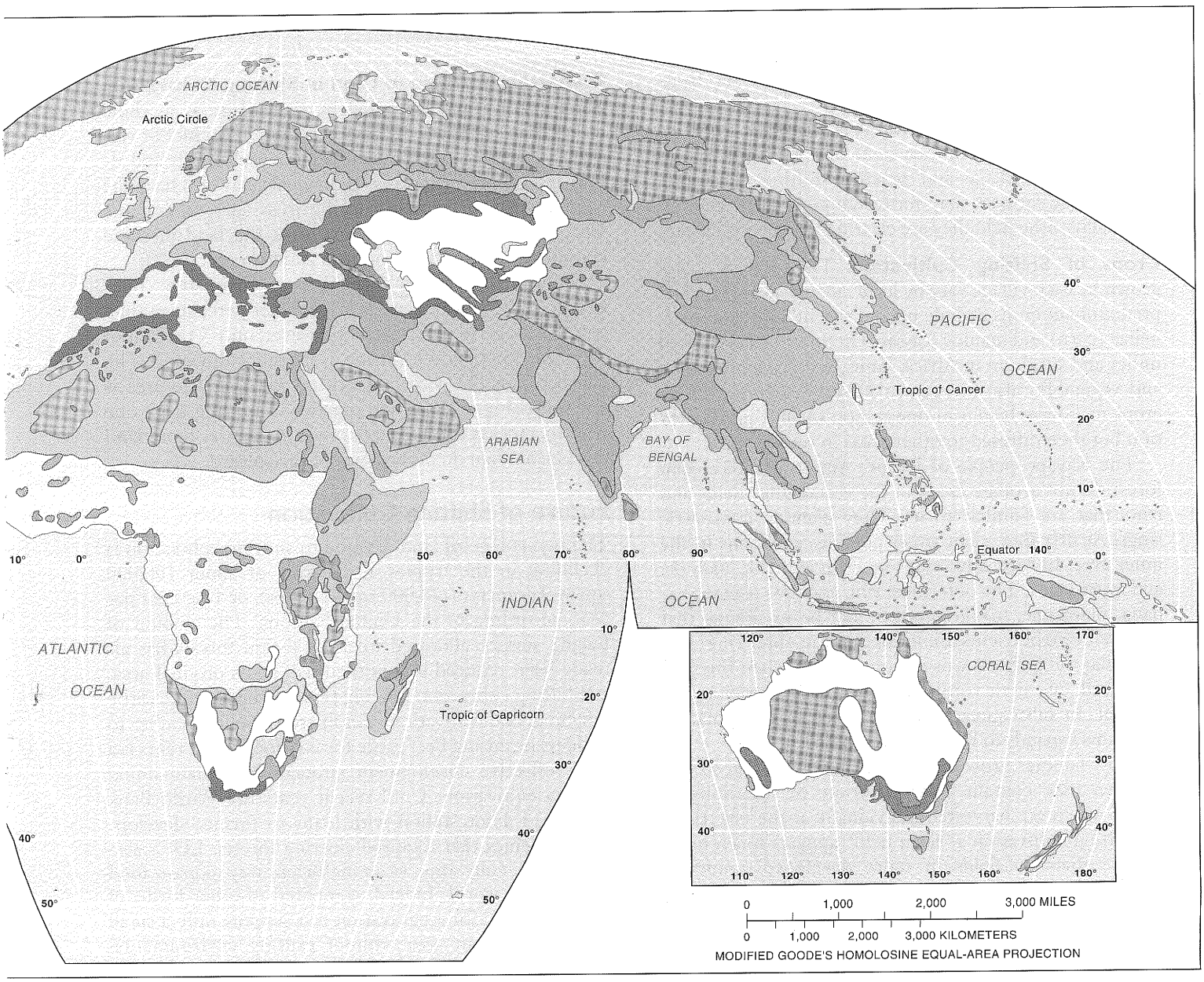
The Process of Shifting Cultivation. Each year villagers designate for planting an area surrounding the settlement. Before planting, they must remove the dense vegetation that typically covers tropical land. Using axes, they cut most of the trees, sparing only those that are economically useful. An efficient strategy they employ is to cut selected large trees, which bring down smaller trees that may have been weakened by notching.

The undergrowth is cleared away with a machete or other long knife. On a windless day the debris is burned under carefully controlled conditions. The rains wash the fresh ashes into the soil, providing needed nutrients. The cleared area is known by a variety of names in different regions, including **swidden**, *ladang*, *milpa*, *chena*, and *kaingin*.

Before planting, fields are prepared by hand, perhaps with the help of a simple implement such as a hoe; plows and animals are rarely used. The only fertilizer generally available is potash (potassium) from burning the debris when the site is cleared. Little weeding is done the first year that a cleared patch of land is farmed; weeds may be cleared with a hoe in subsequent years.

The cleared land can support crops only briefly, usually three years or less. In many regions the most productive harvest comes in the second year after burning. Thereafter, soil nutrients are rapidly depleted and the land becomes too infertile to nourish crops. Rapid weed growth also contributes to the abandonment of a swidden after a few years.

When the swidden is no longer fertile, villagers identify a new site and begin clearing it. They leave the old site uncropped for many years, allowing it to become overrun again by natural vegetation. The field is not actually abandoned; the villagers will return to the site someday, perhaps as few as six years or as many as 20 years later, to begin the process of clearing the land



Shifting cultivation. These shifting cultivation farmers in Peru are preparing fields for planting by slashing and burning the vegetation. The dense vegetation is chopped down, and the debris is burned in order to provide the soil with needed nutrients.

again. In the meantime, they may still care for fruit-bearing trees on the site.

If a cleared area outside a village is too small to provide food for the population, then some of the people may establish a new village and practice shifting cultivation there. Some farmers may move temporarily to another settlement if the field they are clearing that year is distant.

Crops of Shifting Cultivation. The precise crops grown by each village vary by local custom and taste. The predominant crops include upland rice in Southeast Asia, maize (corn) and manioc (cassava) in South America, and millet and sorghum in Africa. Yams, sugarcane, plantain, and vegetables also are grown in some regions. These crops may have begun in one region of shifting cultivation but then diffused to other areas in recent years.

The Kayapo people of Brazil's Amazon tropical rain forest do not arrange crops in the rectangular fields and rows that are familiar to us. They plant in concentric rings. At first they plant sweet potatoes and yams in the inner area. In successive rings go corn and rice, manioc, and more yams. The outermost ring contains papaya, banana, pineapple, mango, cotton, and beans. Plants that require more nutrients are located in the outer ring. It is here that the leafy crowns of cut trees fall when the field is cleared, and their rotting releases more nutrients into the soil. In subsequent years the inner area of potatoes and yams expands to replace corn and rice.

Most families grow only for their own needs, so one swidden may contain a large variety of intermingled crops, which are harvested individually at the best time. In shifting cultivation a "farm field" appears much more chaotic than do fields in more developed countries, where a single crop such as corn or wheat may grow over an extensive area. In some cases, families may specialize in a few crops and trade with villagers who have a surplus of others.

Ownership and Use of Land in Shifting Cultivation. Traditionally, land is owned by the village as a whole rather than separately by each resident. The chief or ruling council allocates a patch of land to each family and allows it to retain the output. Individuals may also have the right to own or protect specific trees surrounding the village. Private individuals now own the land in some communities, especially in Latin America.

Shifting cultivation occupies approximately one-fourth of the world's land area, a higher percentage than any other type of agriculture. However, only 5 percent of the world's population engage in shifting cultivation. The gap between the percentage of people and land area is not surprising, because the practice of moving from one field to another every couple of years requires more land per person than do other types of agriculture.

Future of Shifting Cultivation

The percentage of land devoted to shifting cultivation is declining in the tropics at the rate of about 100,000 square kilometers (40,000 square miles), or 1 percent per year, according to the United Nations. The amount of Earth's surface allocated to tropical rain forests has already been reduced to less than half of its original area.

Shifting cultivation is being replaced by logging, cattle ranching, and cultivation of cash crops. Selling timber to builders or raising beef cattle for fast-food restaurants is a more effective development strategy than maintaining shifting cultivation. Until recent years the World Bank supported deforestation with loans to finance development schemes that required clearing forests. LDCs also see shifting cultivation as an inefficient way to grow food in a hungry world. Indeed, compared to other forms of agriculture, shifting cultivation can support only a small population in an area without causing environmental damage.

To its critics, shifting cultivation is at best a preliminary step in economic development. Pioneers use shifting cultivation to clear forests in the tropics and to open land for development where permanent agriculture never existed. People unable to find agricultural land elsewhere can migrate to the tropical forests and initially practice shifting cultivation. Critics say it then should be replaced by more sophisticated agriculture that yields more per land area.

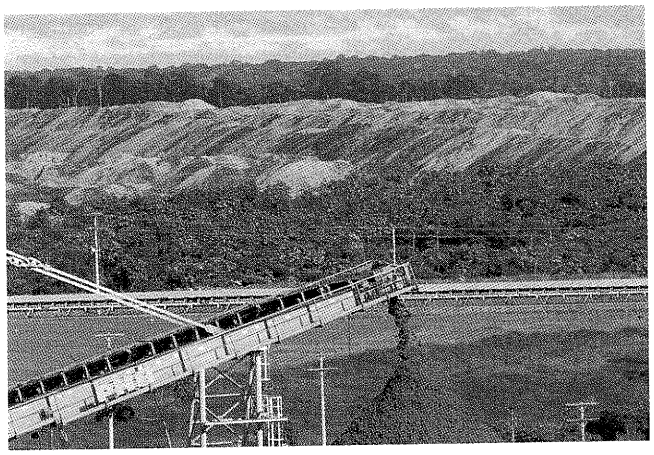
But defenders of shifting cultivation consider it the most environmentally sound approach for the tropics. Practices used in other forms of agriculture, such as using fertilizers and pesticides and permanently clearing fields, may damage the soil, cause severe erosion, and upset balanced ecosystems.

Large-scale destruction of the rain forests also may contribute to global warming. When large numbers of trees are cut, their burning and decay release large volumes of carbon dioxide. This gas can build up in the atmosphere, acting like the window glass in a greenhouse to trap solar energy in the atmosphere, resulting in the "greenhouse effect," discussed in Chapter 14.

Elimination of shifting cultivation could also upset the traditional local diversity of cultures in the tropics. The activities of shifting cultivation are intertwined with other social, religious, political, and various folk customs. A drastic change in the agricultural economy could disrupt other activities of daily life.

As the importance of tropical rain forests to the global environment has become recognized, LDCs have been pressured to restrict further destruction of them. In one innovative strategy, Bolivia agreed to set aside 1.5 million hectares (3.7 million acres) in a forest reserve in exchange for cancellation of $650,000,000 of its debt to developed countries.

In Brazil's Amazon rain forest, deforestation is increasing. From 21,000 square kilometers (6,000 square miles) per year during the 1980s, deforestation declined nearly half to 11,000 square kilometers (4,000 square miles) in 1991, but increased to 29,000 square kilometers (11,000 square miles) in 1995. A 1997 U.S. government study placed deforestation even higher, at 58,000 square kilometers (22,000 square miles) per year.



Deforestation and reforestation in the Amazon. Bare areas are where the forest has been cut by the Rio do Norte mining company near Trombetas, Brazil. Conveyor belt carries bauxite that will be spread to begin reforestation program in the foreground. Green area in the middle is a mined area that has already been reforested.

Pastoral Nomadism

Pastoral nomadism is a form of subsistence agriculture based on the herding of domesticated animals. The word *pastoral* refers to sheep herding. It is adapted to dry climates, where planting crops is impossible. Pastoral nomads live primarily in the large belt of arid and semiarid land that includes North Africa, the Middle East, and parts of Central Asia. The Bedouins of Saudi Arabia and North Africa and the Masai of East Africa are examples of nomadic groups. Only about 15 million people are pastoral nomads, but they sparsely occupy about 20 percent of Earth's land area.

Characteristics of Pastoral Nomadism

In contrast to other subsistence farmers, pastoral nomads depend primarily on animals rather than crops for survival. The animals provide milk, and their skins and hair are used for clothing and tents. Like other subsistence farmers, though, pastoral nomads consume mostly grain rather than meat. Their animals are commonly not slaughtered, although dead ones may be consumed. To nomads, the size of their herd is both an important measure of power and prestige and their main security during adverse environmental conditions.

Some pastoral nomads obtain grain from sedentary subsistence farmers in exchange for animal products. More often, part of a nomadic group—perhaps the women and children—may plant crops at a fixed location while the rest of the group wanders with the herd. Nomads might hire workers to practice sedentary agriculture in return for grain and protection. Other nomads might sow grain in recently flooded areas and return later in the year to harvest the crop. Yet another strategy is to remain in one place and cultivate the land when rainfall is abundant; then, during periods that are too dry to grow crops, the group can increase the size of the herd and migrate in search of food and water.

Choice of Animals. Nomads select the type and number of animals for the herd according to local cultural and physical characteristics. The choice depends on the relative prestige of animals and the ability of species to adapt to a particular climate and vegetation. The camel is most frequently desired in North Africa and the Middle East, followed by sheep and goats. In Central Asia the horse is particularly important.

The camel is well suited to arid climates because it can go long periods without water, carry heavy baggage, and move rapidly. However, the camel is particularly bothered by flies and sleeping sickness and has a relatively long period—12 months—from conception to birth. Goats need more water than do camels but are tough and agile and can survive on virtually any vegetation, no

Pastoral nomadism. Qashqai people use modern roads to practice pastoral nomadism in the drylands near Shiraz, Iran.

matter how poor. Sheep are relatively slow moving and are more affected by climatic changes. They require more water and are more selective in which plants they will eat. The minimum number of animals necessary to support each family adequately varies according to the particular group and animal. The typical nomadic family needs 25 to 60 goats or sheep or 10 to 25 camels.

Movements of Pastoral Nomads. Pastoral nomads do not wander randomly across the landscape but have a strong sense of territoriality. Every group controls a piece of territory and will invade another group's territory only in an emergency or if war is declared. The goal of each group is to control a territory large enough to contain the forage and water needed for survival. The actual amount of land a group controls depends on its wealth and power.

The precise migration patterns evolve from intimate knowledge of the area's physical and cultural characteristics. Groups frequently divide into herding units of five or six families and choose routes based on the most likely water sources during the various seasons of the year. The selection of routes varies in unusually wet or dry years and is influenced by the condition of their animals and the area's political stability.

Some pastoral nomads practice **transhumance**, which is seasonal migration of livestock between mountains and lowland pasture areas. **Pasture** is grass or other plants grown for feeding grazing animals, as well as land used for grazing. Sheep or other animals may pasture in alpine meadows in the summer and be herded back down into valleys for winter pasture.

The Future of Pastoral Nomadism

Agricultural experts once regarded pastoral nomadism as a stage in the evolution of agriculture—between the hunters and gatherers who migrated across Earth's surface in search of food, and sedentary farmers who cultivate grain in one place. Because they had domesticated animals but not plants, pastoral nomads were considered more advanced than hunters and gatherers but less advanced than settled farmers.

Pastoral nomadism is now generally recognized as an offshoot of sedentary agriculture, not as a primitive precursor of it. It is simply a practical way of surviving on land that receives too little rain for cultivation of crops. The domestication of animals—the basis for pastoral nomadism—probably was achieved originally by sedentary farmers, not by nomadic hunters. Pastoral nomads therefore had to be familiar with sedentary farming, and in many cases practiced it.

Today pastoral nomadism is a declining form of agriculture, partly a victim of modern technology. Before recent transportation and communications inventions, pastoral nomads played an important role as carriers of goods and information across the sparsely inhabited drylands. Nomads used to be the most powerful inhabitants of the drylands, but now, with modern weapons, national governments can control the nomadic population more effectively.

Government efforts to resettle nomads have been particularly vigorous in China, Kazakhstan, and several Middle Eastern countries, including Egypt, Israel, Saudi Arabia, and Syria. Nomads are reluctant to cooperate, so these countries have experienced difficulty in trying to force settlement in collectives and cooperatives. Governments force groups to give up pastoral nomadism because they want the land for other uses. Land that can be irrigated is converted from nomadic to sedentary agriculture. In some instances the mining and petroleum industries now operate in drylands formerly occupied by pastoral nomads.

Some nomads are encouraged to try sedentary agriculture or to work for mining or petroleum companies. Others are still allowed to move about, but only within ranches of fixed boundaries. In the future, pastoral nomadism will be increasingly confined to areas that cannot be irrigated or that lack valuable raw materials.

Intensive Subsistence Agriculture

Shifting cultivation and pastoral nomadism are forms of subsistence agriculture found in regions of low density.

But three-fourths of the world's people live in LDCs, and another form of subsistence agriculture is needed to feed most of them: **intensive subsistence agriculture**. The term *intensive* implies that farmers must work more intensively to subsist on a parcel of land.

In densely populated East, South, and Southeast Asia, most farmers practice intensive subsistence agriculture. The typical farm in Asia's intensive subsistence agriculture regions is much smaller than elsewhere in the world. Many Asian farmers own several fragmented plots, frequently a result of dividing individual holdings among several children over several centuries.

Because the agricultural density—the ratio of farmers to arable land—is so high in parts of East and South Asia, families must produce enough food for their survival from a very small area of land. They do this through careful agricultural practices, refined over thousands of years in response to local environmental and cultural patterns. Most of the work is done by hand or with animals rather than with machines, in part due to abundant labor, but largely from lack of funds to buy equipment.

To maximize food production, intensive subsistence farmers waste virtually no land. Corners of fields and irregularly shaped pieces of land are planted rather than left idle. Paths and roads are kept as narrow as possible to minimize the loss of arable land. Livestock are rarely permitted to graze on land that could be used to plant crops, and little grain is grown to feed the animals.

Intensive Subsistence with Wet Rice Dominant

The intensive agriculture region of Asia can be divided between areas where wet rice dominates and areas where it does not (refer to Figure 10–5). The term **wet rice** refers to the practice of planting rice on dry land in a nursery and then moving the seedlings to a flooded field to promote growth. Wet rice occupies a relatively small percentage of Asia's agricultural land but is the region's most important source of food. Intensive wet-rice farming is the dominant type of agriculture in Southeast China, East India, and much of Southeast Asia (Figure 10–6).

Successful production of large yields of rice is an elaborate process, time-consuming and done mostly by hand. The consumers of the rice also perform the work, and all family members, including children, contribute to the effort.

Growing rice involves several steps. First, a farmer prepares the field for planting, using a plow drawn by water buffalo or oxen. The use of a plow and animal power is one characteristic that distinguishes subsistence agriculture from shifting cultivation.

Then the plowed land is flooded with water. The water is collected from rainfall, river overflow, or irrigation. Too much or too little can damage the crop—a particular problem for farmers in South Asia who depend on monsoon rains, which do not always arrive at the same time each summer. Before planting, dikes and canals are repaired to ensure the right quantity of water in the field. The flooded field is called a **sawah** in the Austronesian language widely spoken in Indonesia, including Java. Europeans and North Americans frequently, but incorrectly, call it a **paddy**, the Malay word for wet rice.

The customary way to plant rice is by growing seedlings on dry land in a nursery and then transplanting the seedlings into the flooded field. Typically, one-tenth of a sawah is devoted to cultivation of seedlings. After about a month they are transferred to the rest of the field. Rice plants grow submerged in water for approximately three-fourths of the growing period. Another method of planting rice is to broadcast dry seeds by scattering them through the field, a method used to some extent in South Asia.

Rice plants are harvested by hand, usually with knives. To separate the husks, known as **chaff**, from the seeds, the heads are **threshed** by beating them on the ground or treading on them barefoot. The threshed rice is placed in a tray, and the lighter chaff is **winnowed**—that is, allowed to be blown away by the wind. If the rice is to be consumed directly by the farmer, the **hull**, or outer covering, is removed by mortar and pestle. Rice that is sold commercially is frequently whitened and polished, a process that removes some nutrients but leaves rice more pleasing in appearance and taste to many consumers.

Wet rice is most easily grown on flat land, because the plants are submerged in water much of the time. Thus most wet-rice cultivation is located in river valleys and deltas. But the pressure of population growth in parts of East Asia has forced expansion of areas under rice cultivation. One method of developing additional land suitable for growing rice is to terrace the hillsides of river valleys.

Land is used even more intensively in parts of Asia by obtaining two harvests per year from one field, a process known as **double cropping**. Double cropping is common in places having warm winters, such as South China and Taiwan, but is relatively rare in India, where most areas have dry winters. Normally, double cropping involves alternating between wet rice, grown in the summer when precipitation is higher, and wheat, barley, or another dry crop, grown in the drier winter season. Crops other than rice may be grown in the wet-rice region in the summer on nonirrigated land.

Intensive Subsistence with Wet Rice Not Dominant

Climate prevents farmers from growing wet rice in portions of Asia, especially where summer precipitation levels are too low and winters are too harsh (refer to Figure 10–4). Agriculture in much of interior India and northeast China is devoted to crops other than wet rice.

Aside from what is grown, this region shares most of the characteristics of intensive subsistence agriculture with the wet-rice region. Land is used intensively and worked primarily by human power with the assistance of some hand implements and animals. Wheat is the most important crop, followed by barley. Various other grains

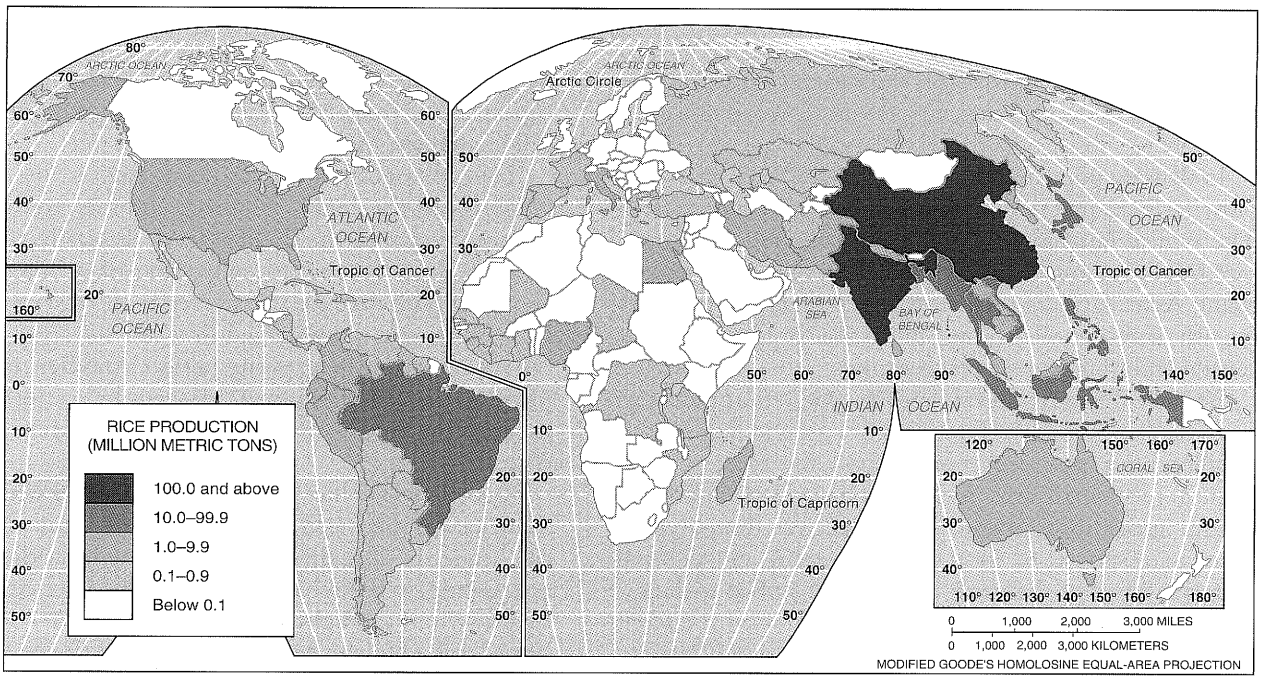


FIGURE 10–6 *Rice production. Rice is the most important crop in the large population concentrations of East, South, and Southeast Asia. Asian farmers grow more than 90 percent of the world's rice, and two countries—China and India—account for more than half of world production. Growing rice is a labor-intensive operation, done mostly by hand. In Yunnan Province, China, rice seedlings grown in a nursery are transplanted to the field.*

and legumes are grown for household consumption, including millet, oats, corn, kaoliang, sorghum, and soybeans. Also grown are some crops sold for cash, such as cotton, flax, hemp, and tobacco.

In milder parts of the region where wet rice does not dominate, more than one harvest can be obtained some years through skilled use of **crop rotation**, which is the practice of rotating use of different fields from crop to crop each year to avoid exhausting the soil. In colder climates, wheat or another crop is planted in the spring and harvested in the fall, but no crops can be sown through the winter.

Since the Communist Revolution in 1949, private individuals have owned little agricultural land in China. Instead, the Communist government organized agricultural producer communes, which typically consisted of several villages of several hundred people. By combining several small fields into a single large unit, the government hoped to promote agricultural efficiency, because scarce equipment and animals could be shared,

Wet rice terraces, Indonesia. Because wet rice needs to be grown on flat land, hillsides are terraced to increase the area of rice production.

and larger improvement projects, such as flood control, water storage, and terracing, could be completed. In reality productivity did not increase as much as the government had expected, because people worked less efficiently for the commune than when working for themselves.

China has dismantled the agricultural communes. The communes still hold legal title to agricultural land, but villagers sign contracts entitling them to farm portions of the land as private individuals. Chinese farmers may sell to others the right to use the land and to pass on the right to their children. Reorganization has been difficult because irrigation systems, equipment, and other infrastructure were developed to serve large communal farms rather than small individually managed ones, which cannot afford to operate and maintain the machinery. But production has increased greatly.

KEY ISSUE 3

Where Are Agricultural Regions in More Developed Countries?

- Mixed crop and livestock farming
- Dairy farming
- Grain farming
- Livestock ranching
- Mediterranean agriculture
- Commercial gardening and fruit farming
- Plantation farming

Commercial agriculture in MDCs can be divided into six main types: mixed crops and livestock, dairying, grain farming, livestock ranching, Mediterranean agriculture, and gardening and fruit culture. Each type is predominant in distinctive regions within MDCs, depending largely on climate. The end of this section examines plantation farming, a form of commercial agriculture in LDCs.

Mixed Crop and Livestock Farming

Mixed crop and livestock farming is the most common form of commercial agriculture in the United States west of the Appalachians and east of 98° west longitude and in much of Europe from France to Russia (refer to Figure 10–5).

Characteristics of Mixed Crop and Livestock Farming

The most distinctive characteristic of mixed crop and livestock farming is its integration of crops and livestock. Most of the crops are fed to animals rather than consumed directly by humans. In turn, the livestock supply manure to improve soil fertility to grow more crops. A typical mixed commercial farm devotes nearly all land area to growing crops but derives more than three-fourths of its income from the sale of animal products, such as beef, milk, and eggs. In the United States pigs are often bred directly on the farms, whereas cattle may be brought in to be fattened on corn.

Mixed crop and livestock farming permits farmers to distribute the workload more evenly through the year. Fields require less attention in the winter than in the spring, when crops are planted, and in the fall, when they are harvested. Livestock, on the other hand, require year-long attention. A mix of crops and livestock also reduces seasonal variations in income; most income from crops comes during the harvest season, but livestock products can be sold throughout the year.

Crop Rotation Systems. Mixed crop and livestock farming typically involves crop rotation. The farm is divided into a number of fields, and each field is planted on a planned cycle, often of several years. The crop planted changes from one year to the next, typically going through a cycle of two or more crops and a year of fallow before the cycle is repeated. Crop rotation helps maintain the fertility of a field, because various crops deplete the soil of certain nutrients but restore others.

Crop rotation contrasts with shifting cultivation, in which nutrients depleted from a field are restored only by leaving the field fallow (uncropped) for many years. In any given year, crops cannot be planted in most of an area's fields, so overall production in shifting cultivation is much lower than in mixed commercial farming.

A two-field crop-rotation system was developed in Northern Europe as early as the fifth century A.D. A **cereal grain**, such as oats, wheat, rye, or barley, was planted in Field A one year, while Field B was left fallow. The following year Field B was planted but A left fallow, and so forth. Beginning in the eighth century, a three-field system was introduced. The first field was planted with a winter cereal, the second with a spring cereal, and the third was left fallow. As a result, each field yielded four harvests every six years, compared to three every six years under the two-field system.

A four-field system was used in Northwest Europe by the eighteenth century. The first year, the farmer could

plant a root crop (such as turnips) in Field A, a cereal in Field B, a "rest" crop (such as clover, which helps restore the field) in Field C, and a cereal in Field D. The second year, the farmer might select a cereal for Field A, a rest crop for Field B, a cereal for Field C, and a root for Field D. The rotation would continue for two more years before the cycle would start again. Each field thus passed through a cycle of four crops: root, cereal, rest crop, and another cereal.

Cereals such as wheat and barley were sold for flour and beer production, and straw, which is the stalks that remain after the heads of wheat are threshed, was retained for animal bedding. Root crops such as turnips were fed to the animals during the winter. Clover and other "rest" crops were used for cattle grazing and restoration of nitrogen to the soil.

Choice of Crops

In the United States, mixed crop and livestock farmers select corn most frequently because of higher yields per area than other crops. Some of the corn is consumed by people either directly or as oil, margarine, and other food products, but most is fed to pigs and cattle (Figure 10–7). The most important mixed crop and livestock farming region in the United States—extending from Ohio to the Dakotas, with its center in Iowa—is frequently called the Corn Belt, because approximately half of the crop land is planted in corn (maize).

Soybeans have become the second most important crop in the U.S. mixed commercial farming region. Like corn, soybeans are sometimes used to make products consumed directly by people, but mostly to make animal feed. Tofu (made from soybean milk) is a major food source, especially for people in China and Japan. Soybean oil is widely used in U.S. foods but as a hidden ingredient.

Dairy Farming

Dairy farming is the most important type of commercial agriculture practiced on farms near the large urban areas of the Northeast United States, Southeast Canada, and Northwest Europe. It accounts for approximately 20 percent of the total value of agricultural output throughout Western Europe and North America. Russia, Australia, and New Zealand also have extensive areas devoted to dairy farming. Nearly 60 percent of the world's supply of milk is produced and consumed in these developed regions (Figure 10–8).

Traditionally, fresh milk was rarely consumed except directly on the farm or in nearby villages. With the rapid growth of cities in relatively developed countries during the nineteenth century, demand for the sale of milk to urban residents increased. Rising incomes permitted urban residents to buy milk products, which were once considered luxuries. Average weekly consumption of milk per person in England, for example, rose from 0.8 liters (0.2 U.S. gallons) in the 1870s to 2.8 liters (0.7 U.S. gallons) by the 1950s.

Why Dairy Farms Locate Near Urban Areas

Dairying has become the most important type of commercial agriculture in the first ring outside large cities because of transportation factors. Dairy farms must be closer to their market than other products because milk is

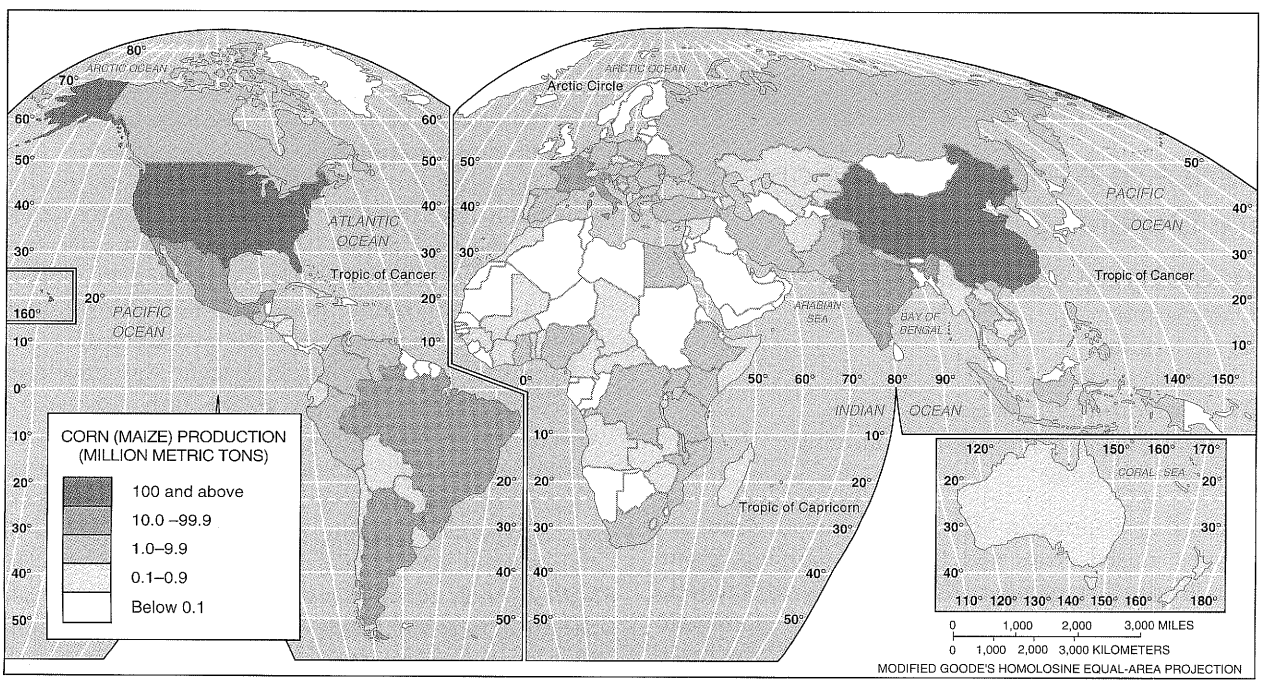


FIGURE 10–7 *Corn (maize) production. The United States accounts for about 40 percent of the world's corn production. China is the second leading producer. Outside North America, corn is called maize.*

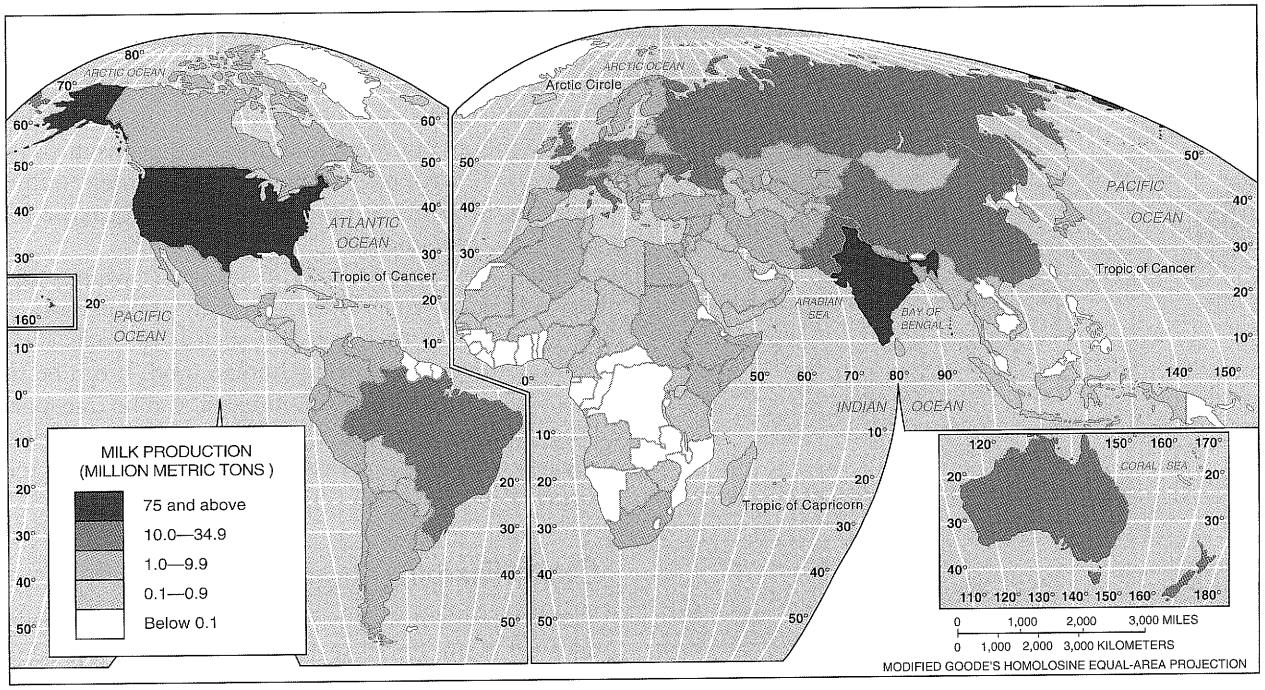


FIGURE 10–8 *Milk production. The distribution of milk production closely matches the division of the world into more and less developed regions. Consumers in MDCs have the income to pay for milk products, and farmers in these countries can afford the high cost of establishing dairy farms. Two very populous countries—Brazil and India—rank among the world leaders in total milk production, but not in production per capita.*

highly perishable. The ring surrounding a city from which milk can be supplied without spoiling is known as the **milkshed**.

Improvements in transportation have permitted dairying to be undertaken farther from the market. Until the 1840s, when railroads were first used for transporting dairy products, milksheds rarely had a radius beyond 50 kilometers (30 miles). Today refrigerated rail cars and trucks enable farmers to ship milk more than 500 kilometers (300 miles). As a result, nearly every farm in the U.S. Northeast and Northwest Europe is within the milkshed of at least one urban area.

Some dairy farms specialize in products other than milk. Originally, butter and cheese were made directly on the farm, primarily from the excess milk produced in the summer, before modern agricultural methods evened the flow of milk through the year. In the twentieth century, dairy farmers have generally chosen to specialize either in fresh milk production or other products, such as butter and cheese.

Regional Differences in Dairy Products

The choice of product varies within the U.S. dairy region, depending on whether the farms are within the milkshed of a large urban area. In general, the farther the farm is from large urban concentrations, the smaller is the percentage of output devoted to fresh milk. Farms located farther from consumers are more likely to sell their output to processors who make butter, cheese, or dried, evaporated, and condensed milk. The reason is that these products keep longer than does milk and therefore can be safely shipped from remote farms.

In the East, virtually all milk is sold to consumers living in New York, Philadelphia, Boston, and the other large urban areas. Farther west, most milk is processed into cheese and butter. Virtually all of the milk in Wisconsin is processed, for example, compared to only 5 percent in Pennsylvania. The proximity of northeastern farmers to several large markets accounts for these regional differences (Figure 10–9).

Countries likewise tend to specialize in certain products. New Zealand, the world's largest producer of dairy products, devotes about 5 percent to liquid milk, compared to more than 50 percent in the United Kingdom. New Zealand farmers do not sell much liquid milk, because the country is too far from North America and Northwest Europe, the two largest relatively wealthy population concentrations.

Dairy farmers, like other commercial farmers, usually do not sell their products directly to consumers. Instead, they generally sell milk to wholesalers, who distribute it in turn to retailers. Retailers then sell milk to consumers in shops or at home. Farmers also sell milk to butter and cheese manufacturers.

Problems for Dairy Farmers

Like other commercial farmers, dairy farmers face economic problems because of declining revenues and rising costs. Distinctive features of dairy farming have exacerbated the economic difficulties. First, dairy farming is labor-intensive, because the cows must be milked twice a day, every day. Although the actual milking can be done by machines, dairy farming nonetheless requires constant attention throughout the year.

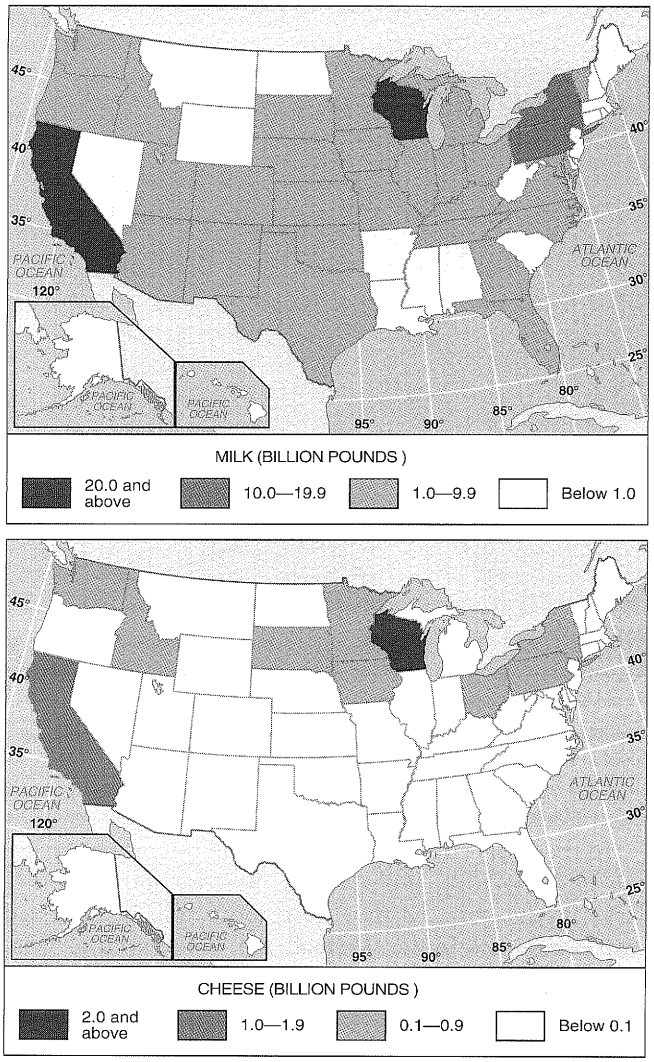


FIGURE 10–9 *Dairy production. The production of highly perishable dairy products, such as milk, is dispersed around the United States, whereas just two states—Wisconsin and California—are responsible for production of nearly one-half of the country's cheese.*

Dairy farmers also face the expense of feeding the cows in the winter, when they may be unable to graze on grass. In Northwest Europe and New England, farmers generally purchase hay or grain for winter feed. In the western part of the U.S. dairy region, crops are more likely to be grown in the summer and stored for winter feed on the same farm.

The number of farms with milk cows declined in the United States by two-thirds between 1980 and 2000. Departing dairy farmers most often cite lack of profitability and excessive workload as reasons for leaving. However, the number of dairy cows declined by only one-eighth, and production actually increased by one-fourth—yields per cow increased substantially.

Grain Farming

Grain is the seed from various grasses, like wheat, corn, oats, barley, rice, millet, and others. Some form of grain is the major crop on most farms. Commercial grain agriculture is distinguished from mixed crop and livestock farming because crops on a grain farm are grown primarily for consumption by humans rather than by livestock. Farms in LDCs also grow crops for human consumption, but the output is directly consumed by the farmers. Commercial grain farms sell their output to manufacturers of food products, such as breakfast cereals and snack-food makers.

The most important crop grown is wheat, used to make bread flour. Wheat generally can be sold for a higher price than other grains, such as rye, oats, and barley, and it has more uses as human food. It can be stored relatively easily without spoiling and can be transported a long distance. Because wheat has a relatively high value per unit weight, it can be shipped profitably from remote farms to markets.

Grain-Farming Regions

The United States is by far the largest commercial producer of grain. Large-scale commercial grain production is found in only a few other countries, including Canada, Argentina, Australia, France, and the United Kingdom. Commercial grain farms are generally located in regions that are too dry for mixed crop and livestock agriculture (Figure 10–10).

Within North America, large-scale grain production is concentrated in three areas. The first is the winter wheat belt that extends through Kansas, Colorado, and Oklahoma. In the **winter wheat** area, the crop is planted in the autumn and develops a strong root system before growth stops for the winter. The wheat survives the winter, especially if it is insulated beneath a snow blanket, and is ripe by the beginning of summer.

The second important grain-producing region in North America is the **spring wheat** belt of the Dakotas, Montana, and southern Saskatchewan in Canada. Because winters are usually too severe for winter wheat in this region, spring wheat is planted in the spring and harvested in the late summer. Approximately two-thirds of the wheat grown in the United States comes either from the winter or the spring wheat belt. A third important grain-growing region is the Palouse region of Washington State.

Large-scale grain production, like other commercial farming ventures in MDCs, is heavily mechanized, conducted on large farms, and oriented to consumer preferences. The McCormick **reaper** (a machine that cuts grain standing in the field), invented in the 1830s, first permitted large-scale wheat production. Today the **combine** machine performs in one operation the three tasks of reaping, threshing, and cleaning.

Unlike work on a mixed crop and livestock farm, the effort required to grow wheat is not uniform throughout the year. Some individuals or firms may therefore have two sets of fields—one in the spring-wheat belt and one in the winter-wheat belt. Because the planting and harvesting in the two regions occur at different times of the year, the workload can be distributed throughout the

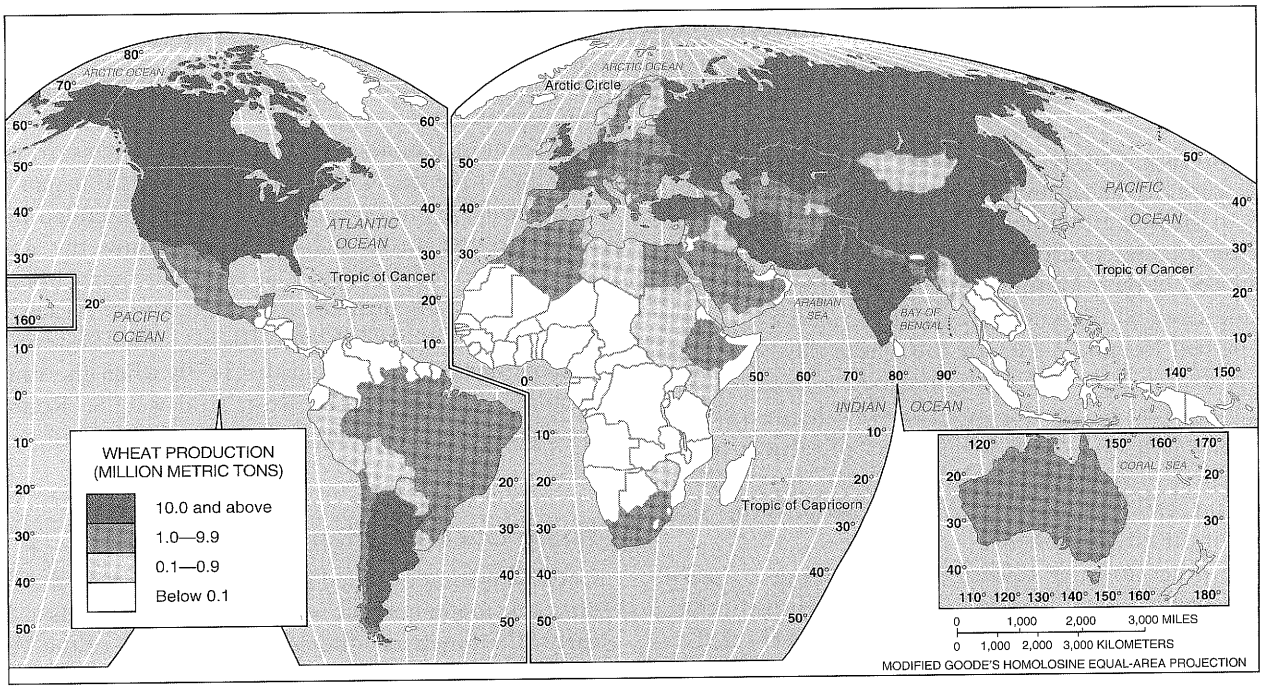


FIGURE 10–10 *Wheat production. The United States is by far the world's leading producer of wheat for sale off the farm. China is the world's leading wheat producer, and India is a major producer, but wheat grown in the Asian countries is used principally to feed the local population. A large percentage of the wheat grown commercially in North America is exported to other countries.*

year. In addition, the same machinery can be used in the two regions, thus spreading the cost of the expensive equipment. Combine companies start working in Oklahoma in early summer and work their way northward.

Importance of Wheat

Wheat's significance extends beyond the amount of land or number of people involved in growing it. Unlike other agricultural products, wheat is grown to a considerable extent for international trade and is the world's leading export crop. As the United States and Canada account for about half of the world's wheat exports, the North American prairies are accurately labeled the world's "breadbasket." The ability to provide food for many people elsewhere in the world is a major source of economic and political strength for the United States and Canada.

Livestock Ranching

Ranching is the commercial grazing of livestock over an extensive area. This form of agriculture is adapted to semiarid or arid land. It is practiced in MDCs, where the vegetation is too sparse and the soil too poor to support crops.

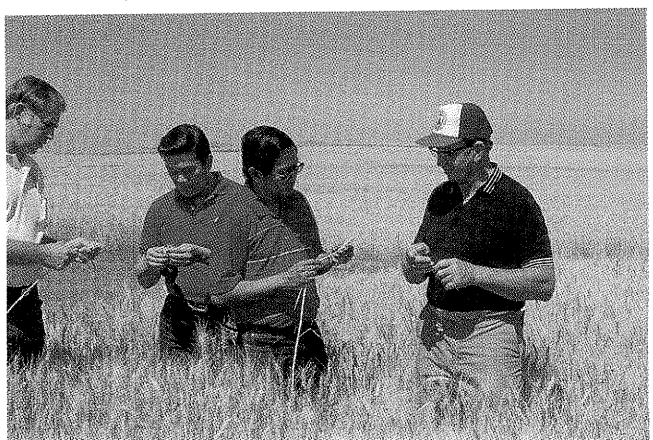
Cattle Ranching in U.S. Popular Culture

The importance of ranching in the United States extends beyond the number of people who choose this form of commercial farming because of its prominence in popular culture, especially in Hollywood films and television. Cattle ranching in Texas, though, as glamorized in popular culture, actually dominated commercial agriculture for a short period—from 1867 to 1885.

Beginning of U.S. Cattle Ranching. Cattle were first brought to the Americas by Columbus on his second voyage, because they were sufficiently hardy to survive the ocean crossing. Living in the wild, the cattle multiplied and thrived on abundant grazing lands on the frontiers of North and South America. Immigrants from Spain and Portugal—the only European countries with a tradition of cattle ranching—began ranching in the Americas. They taught the practice to settlers from Northern Europe and the Eastern United States who moved to Texas and other frontier territories in the nineteenth century.

Cattle ranching in the United States expanded because of demand for beef in the East Coast cities during the 1860s. The challenge for ranchers was to transport the cattle from Texas to eastern markets. Ranchers who could get their cattle to Chicago were paid $30 to $40 per

Exporting U.S. wheat. Much of the wheat grown in the United States and Canada is exported. This Idaho farmer is selling wheat to Asian buyers.



head, compared to only $3 or $4 per head in Texas. Once in Chicago, the cattle could be slaughtered and processed by meat-packing companies and sold to consumers in the East.

Transporting Cattle to Market. To reach Chicago, cattle were driven on hoof by cowboys over trails from Texas to the nearest railhead. Distances were several hundred kilometers. There they were driven into cattle cars for the rest of their journey. The western terminus of the rail line reached Abilene, Kansas, in 1867. That year, a man named Joseph G. McCoy (on whom the expression "the real McCoy" was based) launched a massive construction effort to provide Abilene with homes, shops, and stockyards. As a result, the number of cattle brought into Abilene increased from 1,000 in 1867 to 35,000 in 1868 and 150,000 in 1869. McCoy became the first mayor of the city of Abilene.

Like other frontier towns, Abilene became a haven where cowboys let off steam. Gunfights, prostitution, gambling, and alcoholism were rampant until McCoy hired James B. "Wild Bill" Hickock as sheriff to clean up the town. After a few years the terminus of the railroad moved farther west. Wichita, Caldwell, Dodge City, and other towns in Kansas took their turn as the main destination for cattle driven north on trails from Texas. Abilene became a ghost town for a while. Eventually, though, use of the surrounding land changed from cattle grazing to crop growing, and Abilene became a prosperous market center.

The most famous route from Texas northward to the rail line was the Chisholm Trail, which began near Brownsville at the Mexican border and extended northward through Texas, Indian Territory (now the state of Oklahoma), and Kansas. The trail had many branches, but the main line extended through Austin, Waco, Fort Worth, and Caldwell (Figure 10–11). The Western Trail became more important in the 1870s when the railroad terminus moved farther west. Today U.S. Route 81 roughly follows the course of the Chisholm Trail.

Fixed Location Ranching

Cattle ranching declined in importance during the 1880s after it came in conflict with sedentary agriculture. Most early U.S. ranchers adhered to "The Code of the West," although the system had no official legal status. Under the code, ranchers had range rights—that is, their cattle could graze on any open land and had access to scarce water sources and grasslands. The early cattle ranchers in the West owned little land, only cattle.

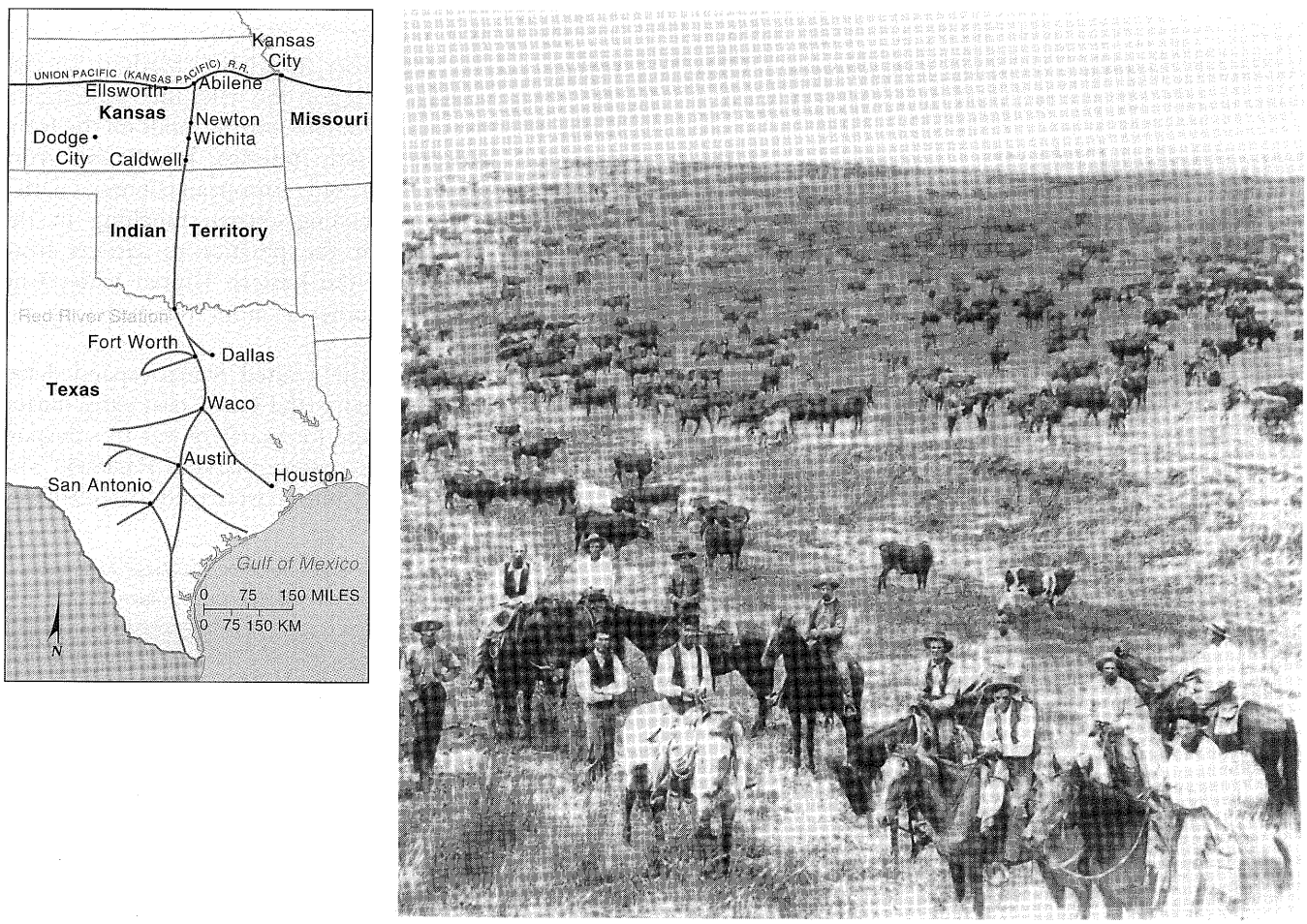
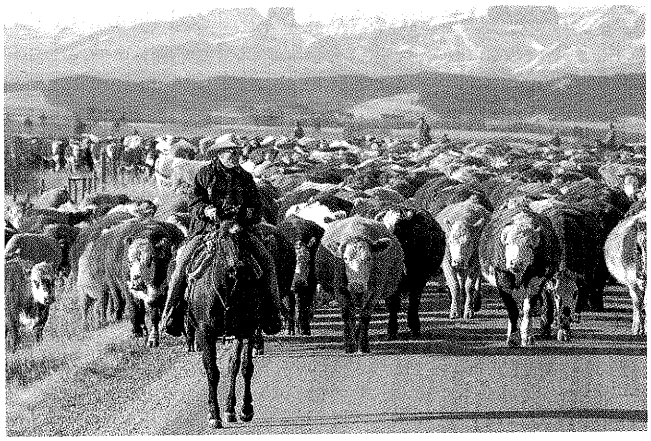


FIGURE 10–11 *The Chisholm Trail. Although actively used for only a few years, the Chisholm Trail became famous in American folklore as the main route for cattle drives, from Texas ranches to Kansas railheads.*



Cattle ranching. It took sixteen herders five hours to move 800 head of cattle 14 kilometers to the Rocky Butte Ranch, west of Calgary, Alberta, for winter pasture.

Range Wars. The U.S. government, which owned most of the land used for open grazing, began to sell it to farmers to grow crops, leaving cattle ranchers with no legal claim to it. For a few years the ranchers tried to drive out the farmers by cutting fences and then illegally erecting their own fences on public land, and "range wars" flared.

The farmers' most potent weapon proved to be barbed wire, first commercially produced in 1873. The farmers eventually won the battle, and ranchers were compelled to buy or lease land to accommodate their cattle. Large cattle ranches were established, primarily on land that was too dry to support crops. Ironically, 60 percent of cattle grazing today is on land leased from the U.S. government.

Changes in Cattle Breeding. Ranchers were also induced to switch from cattle drives to fixed-location ranching by a change in the predominant breed of cattle. Longhorns, the first cattle used by ranchers, were hardy animals, able to survive the long-distance drive along the trails with little weight loss. But longhorns were susceptible to cattle ticks, parasitic insects that carried a fever and were difficult to remove, and the meat of longhorns was of poor quality.

New cattle breeds introduced from Europe, such as the Hereford, offered superior meat but were not adapted to the old ranching system. The new breeds could not survive the winter by open grazing, as could the longhorns. Instead, crops had to be grown or feed purchased for them. The cattle could not be driven long distances, and they required more water. However, these breeds thrived once open grazing was replaced by fixed ranching, and long-distance trail drives and rail journeys to Chicago gave way to short rail or truck trips to nearby meat packers.

With the spread of irrigation techniques and hardier crops, land in the United States has been converted from ranching to crop growing. Ranching generates lower income per area of land, although it has lower operating costs. Cattle are still raised on ranches but are frequently sent for fattening to farms or to local feed lots along major railroad and highway routes rather than directly to meat processors. The average size of a ranch is large, because the capacity of the land to support cattle is low in much of the semiarid West. Large ranches may be owned by meat-processing companies rather than individuals.

Ranching Outside the United States

Commercial ranching is conducted in other more developed regions of the world (Figure 10–12). Ranching is

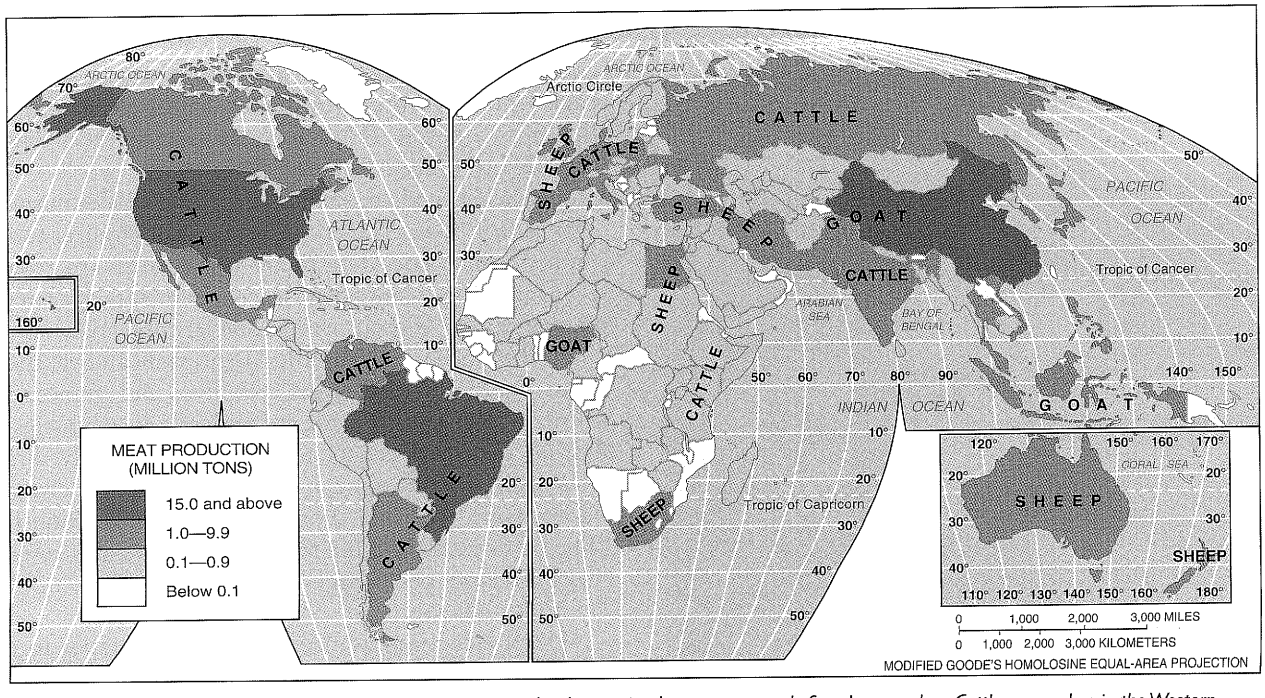


FIGURE 10–12 *Meat production. Cattle, sheep, and goats are the three animals most commonly found on ranches. Cattle on ranches in the Western Hemisphere, sheep in Australia, and goats in Central Asia.*

rare in Europe, except in Spain and Portugal. In South America a large portion of the pampas of Argentina, southern Brazil, and Uruguay are devoted to grazing cattle and sheep. The cattle industry grew rapidly in Argentina in part because the land devoted to ranching was relatively accessible to the ocean, and meat could be transported to overseas markets.

The relatively humid climate on the pampas provides more shoots and shrubs on a given area of land than in the U.S. West. This growth of ranching in South America was stimulated because more cattle could graze on a given area of land in the pampas than in the U.S. West. Land was divided into large holdings in the nineteenth century, in contrast to the U.S. practice of permitting common grazing on public land. Ranching has declined in Argentina, as in the United States, because growing crops is more profitable except on very dry lands.

The interior of Australia was opened for grazing in the nineteenth century, although sheep are more common than cattle. Ranches in the Middle East, New Zealand, and South Africa are also more likely to have sheep. Like the U.S. West, Australia's drylands went through several land-use changes. Until the 1860s, shepherding was practiced on the open range. Then large ranches with fixed boundaries were established, stock was improved, and water facilities were expanded. Eventually, ranching was confined to drier lands, and wheat—which yielded greater profits per hectare than ranching—was planted where precipitation levels permitted.

Thus ranching has followed similar stages around the world. First was the herding of animals over open ranges, in a seminomadic style. Then ranching was transformed into fixed farming by dividing the open land into ranches. Many of the farms converted to growing crops, and ranching was confined to the drier lands. To survive, the remaining ranches experimented with new methods of breeding and sources of water and feed. Ranching became part of the meat-processing industry rather than an economic activity carried out on isolated farms. In this way, commercial ranching differs from pastoral nomadism, the form of animal herding practiced in less developed regions.

Countries with Mediterranean climate account for most of the world's grape production. Workers harvest first grapes in Bourgogne (Burgundy), one of France's most famous wine-making regions.

Mediterranean Agriculture

Mediterranean agriculture exists primarily in the lands that border the Mediterranean Sea in Southern Europe, North Africa, and western Asia. Farmers in California, central Chile, the southwestern part of South Africa, and southwestern Australia practice Mediterranean agriculture as well.

These Mediterranean areas share a similar physical environment (refer to Figure 10–5). Every Mediterranean area borders a sea. Mediterranean areas are on west coasts of continents (except for some lands surrounding the Mediterranean Sea). Prevailing sea winds provide moisture and moderate the winter temperatures. Summers are hot and dry, but sea breezes provide some relief. The land is very hilly, and mountains frequently plunge directly to the sea, leaving very narrow strips of flat land along the coast.

Farmers derive a smaller percentage of income from animal products in the Mediterranean region than in the mixed crop and livestock region. Livestock production is hindered during the summer by the lack of water and good grazing land. Some farmers living along the Mediterranean Sea traditionally used transhumance to raise animals, although the practice is now less common. Under transhumance, animals—primarily sheep and goats—are kept on the coastal plains in the winter and transferred to the hills in the summer.

Mediterranean Crops

Most crops in Mediterranean lands are grown for human consumption rather than for animal feed. **Horticulture**—which is the growing of fruits, vegetables, and flowers—and tree crops form the commercial base of the Mediterranean farming. Most of the world's olives, grapes, fruits, and vegetables are grown in Mediterranean agriculture areas. A combination of local physical and cultural characteristics determines which crops are grown in each area. The hilly landscape encourages farmers to plant a variety of crops within one farming area.

In the lands bordering the Mediterranean Sea, the two most important cash crops are olives and grapes. Two-thirds of the world's wine is produced in countries that border the Mediterranean Sea, especially Italy, France, and Spain. Mediterranean agricultural regions elsewhere in the world produce most of the remaining one-third. The lands near the Mediterranean Sea are also responsible for a large percentage of the world's supply of olives, an important source of cooking oil.

Despite the importance of olives and grapes to commercial farms bordering the Mediterranean Sea, approximately half of the land is devoted to growing cereals, especially wheat for pasta and bread. As in the U.S.

winter-wheat belt, the seeds are sown in the fall and harvested in early summer. After cultivation, cash crops are planted on some of the land, whereas the remainder is left fallow for a year or two to conserve moisture in the soil.

Cereals occupy a much lower percentage of the cultivated land in California than in other Mediterranean climates. Instead, much of California farmland is devoted to fruit and vegetable horticulture. California supplies much of the citrus fruits, tree nuts, and deciduous fruits consumed in the United States. Horticulture is practiced in other Mediterranean climates, but not to the extent found in California.

The rapid growth of urban areas in California, especially Los Angeles, has converted high-quality agricultural land into housing developments. Thus far, the loss of farmland has been offset by expansion of agriculture into arid lands. However, farming in drylands requires massive irrigation to provide water. In the future, agriculture may face stiffer competition to divert the Southwest's increasingly scarce water supply.

Commercial Gardening and Fruit Farming

Commercial gardening and fruit farming is the predominant type of agriculture in the U.S. Southeast. The region has a long growing season and humid climate and is accessible to the large markets of New York, Philadelphia, Washington, and the other eastern U.S. urban areas. The type of agriculture practiced in this region is frequently called **truck farming**, because "truck" was a Middle English word meaning bartering or the exchange of commodities.

Truck farms grow many of the fruits and vegetables that consumers demand in more developed societies, such as apples, asparagus, cherries, lettuce, mushrooms, and tomatoes. Some of these fruits and vegetables are sold fresh to consumers, but most are sold to large processors for canning or freezing.

Truck farms are highly efficient large-scale operations that take full advantage of machines at every stage of the growing process. Truck farmers are willing to experiment with new varieties, seeds, fertilizers, and other inputs to maximize efficiency. Labor costs are kept down by hiring migrant farm workers, some of whom are undocumented immigrants from Mexico who work for very low wages. Farms tend to specialize in a few crops, and a handful of farms may dominate national output of some fruits and vegetables.

A form of truck farming called *specialty farming* has spread to New England. Farmers are profitably growing crops that have limited but increasing demand among affluent consumers, such as asparagus, peppers, mushrooms, strawberries, and nursery plants. Specialty farming represents a profitable alternative for New England farmers, at a time when dairy farming is declining because of relatively high operating costs and low milk prices.

Plantation Farming

The plantation is a form of commercial agriculture found in the tropics and subtropics, especially in Latin America, Africa, and Asia. Although generally situated in LDCs, plantations are often owned or operated by Europeans or North Americans and grow crops for sale primarily in MDCs.

A **plantation** is a large farm that specializes in one or two crops. Among the most important crops grown on plantations are cotton, sugarcane, coffee, rubber, and tobacco. Also produced in large quantities are cocoa, jute, bananas, tea, coconuts, and palm oil. Latin American plantations are more likely to grow coffee, sugarcane, and bananas, whereas Asian plantations may provide rubber and palm oil.

Because plantations are usually situated in sparsely settled locations, they must import workers and provide them with food, housing, and social services. Plantation managers try to spread the work as evenly as possible throughout the year to make full use of the large labor force. Where the climate permits, more than one crop is planted and harvested during the year. Rubber-tree plantations try to spread the task of tapping the trees through the year.

Crops such as tobacco, cotton, and sugarcane, which can be planted only once a year, are less likely to be grown on large plantations today than in the past. Crops are normally processed at the plantation before shipping, because processed goods are less bulky and therefore cheaper to ship long distances to the North American and European markets.

Until the Civil War, plantations were important in the U.S. South, where the principal crop was cotton, followed by tobacco and sugarcane. Demand for cotton increased dramatically after the establishment of textile factories in England at the start of the Industrial Revolution in the late eighteenth century. Cotton production was stimulated by the improvement of the cotton gin by Eli Whitney in 1793 and the development of new varieties of cotton that were hardier and easier to pick. Slaves brought from Africa performed most of the labor until the abolition of slavery and the defeat of the South in the Civil War. Thereafter, plantations declined in the United States; they were subdivided and either sold to individual farmers or worked by tenant farmers.

KEY ISSUE 4

Why Do Farmers Face Economic Difficulties?

- Issues for commercial farmers
- Issues for subsistence farmers
- Strategies to increase food supply

Issues for Commercial Farmers

Two economic factors influence the choice of crops (or livestock) by commercial farmers: access to markets and overproduction.

Access to Markets

Because the purpose of commercial farming is to sell produce off the farm, the distance from the farm to the market influences the farmer's choice of crop to plant. The clearest example of the importance of proximity to the market is dairy farming, because milk spoils quickly. Crops that can be shipped long distances without spoiling are grown farther from the market. Geographers use the von Thünen model to help explain the importance of proximity to market in the choice of crops on commercial farms.

Von Thünen's Model. The von Thünen model was first proposed in 1826 by Johann Heinrich von Thünen, a farmer in northern Germany, in a book titled *The Isolated State*. According to the model, which was later modified by geographers, a commercial farmer initially considers which crops to cultivate and which animals to raise based on market location.

In choosing an enterprise, a commercial farmer compares two costs: the cost of the land versus the cost of transporting products to market. First, a farmer identifies a crop that can be sold for more than the land cost. Assume that a farmer's land costs $100 per hectare per year. The farmer would consider planting wheat if the output from 1 hectare could be marketed for more than $100 that year. Another crop, such as corn, will also be considered if the yield from 1 hectare can sell for more than $100.

A farmer will not necessarily plant the crop that sells for the highest price per hectare. The choice further depends on the distance of the farmer's land from the central market city. Distance to market is critical because the cost of transporting each product is different.

Example of Von Thünen's Model. The following example illustrates the influence of transportation cost on the profitability of growing wheat:

1. Gross profit from sale of wheat grown on 1 hectare of land *not* including transportation costs:
   a. Wheat can be grown for $0.25 per kilogram
   b. Yield per hectare of wheat is 1,000 kilograms
   c. Gross profit is $250 per hectare ($0.25 per kilogram × 1,000 kilograms per hectare)
2. Net profit from sale of wheat grown on 1 hectare of land *including* transportation costs:
   a. Cost of transporting 1,000 kilograms of wheat to the market is $62.50 per kilometer
   b. Net profit from sale of 1,000 kilograms of wheat grown on a farm located 1 kilometer from the market is $187.50 ($250 gross profit − $62.50 per kilometer transport costs)
   c. Net profit from sale of 1,000 kilograms of wheat grown on a farm located 4 kilometers from the market is $0 ($250 gross profit − $62.50 per kilometer × 4 kilometers)

The example shows that a farmer would make a profit growing wheat on land located less than 4 kilometers from the market. Beyond 4 kilometers, wheat is not profitable, because the cost of transporting it exceeds the gross profit.

The von Thünen model shows that a commercial farmer must combine two sets of monetary values to determine the most profitable crop:

- the value of the yield per hectare
- the cost of transporting the yield per hectare

These calculations demonstrate that farms located closer to the market tend to select crops with higher transportation costs per hectare of output, whereas more distant farms are more likely to select crops that can be transported less expensively.

Application of Von Thünen's Model. Von Thünen based his general model of the spatial arrangement of different crops on his experiences as owner of a large estate in northern Germany during the early nineteenth century (Figure 10–13). He found that specific crops were grown in different rings around the cities in the area. Market-oriented gardens and milk producers were located in the first ring out from the cities. These products are expensive to deliver and must reach the market quickly because they are perishable.

The next ring out from the cities contained wood lots, where timber was cut for construction and fuel; closeness to market is important for this commodity because of its weight. The next rings were used for various crops and for pasture; the specific commodity was rotated from one year to the next. The outermost ring was devoted exclusively to animal grazing, which requires lots of space.

Von Thünen did not consider site or human factors in his model. The model assumed that all land in a study area had similar site characteristics and was of uniform quality, although he recognized that the model could vary according to topography and other distinctive physical conditions. For example, a river might modify the shape of the rings because transportation costs change when products are shipped by water routes rather than over roads. The model also failed to understand that social customs and government policies influence the attractiveness of plants and animals for a commercial farmer.

Although von Thünen developed the model for a small region with a single market center, it also applies to a national or global scale. Farmers in relatively remote locations who wish to sell their output in the major markets of Western Europe and North America, for example, are less likely to grow highly perishable and bulky products.

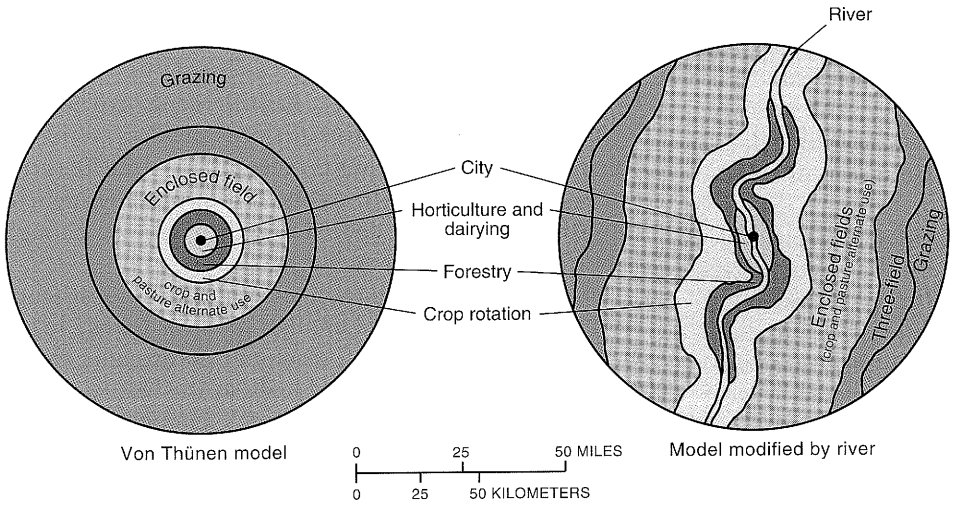


FIGURE 10–13 *(left) Von Thünen model of role of situation factors in choice of crop. According to the von Thünen model, in the absence of topographic factors, different types of farming are conducted at different distances from a city, depending on the cost of transportation and the value of the product. (right) Von Thünen recognized that his model would be modified by site factors, such as a river in this sketch, which changes the accessibility of different land parcels to the market center. Agricultural uses that seek highly accessible locations need to locate nearer the river.*

Overproduction in Commercial Farming

Commercial farmers suffer from low incomes because they produce too much food rather than too little. A surplus of food has been produced in part because of widespread adoption of efficient agricultural practices. New seeds, fertilizers, pesticides, mechanical equipment, and management practices have enabled farmers to obtain greatly increased yields per area of land.

Commercial farmers have dramatically increased the capacity of the land to produce food. For example, during the 1960s about 20 million dairy cows produced 57 million metric tons (63 million tons) of milk a year in the United States. The number of dairy cows in the United States declined to 10 million during the 1990s, but they produced 68 million metric tons (75 million tons).

Although the food supply has increased in MDCs, demand has remained constant, because the market for most products is already saturated. In MDCs consumption of a particular commodity may not change significantly if the price changes. Americans, for example, do not switch from wheat to corn products if the price of corn falls more rapidly than wheat. Demand is also stagnant for most agricultural products in MDCs because of low population growth.

U.S. Government Policies. Agricultural production is also increasing in the United States because of government programs. The U.S. government has three policies to attack the problem of excess productive capacity. First, farmers are encouraged to avoid producing crops that are in excess supply. Because soil erosion is a constant threat, the government encourages planting fallow crops, such as clover, to restore nutrients to the soil and to help hold the soil in place. These crops can be used for hay, forage for pigs, or producing seeds for sale.

Second, the government pays farmers when certain commodity prices are low. The government sets a target price for the commodity and pays farmers the difference between the price they receive in the market and a target price set by the government as a fair level for the commodity. The target prices are calculated to give the farmers the same price for the commodity today as in the past, when compared to other consumer goods and services.

Third, the government buys surplus production and sells or donates it to foreign governments. In addition, low-income Americans receive food stamps in part to stimulate their purchase of additional food.

The United States spends about $10 billion a year on farm subsidies, including an average of $6 billion for feed grains, such as corn and soybeans, $2 billion for wheat, and $2 billion for dairy products. Annual spending varies considerably from one year to the next: subsidy payments are lower in years when market prices rise and production is down, typically as a result of poor weather conditions in the United States or political problems in other countries.

Government policies point out a fundamental irony in worldwide agricultural patterns. In an MDC such as the United States, farmers are encouraged to grow less food, whereas LDCs struggle to increase food production to match the rate of the growth in population.

Sustainable Agriculture

Some commercial farmers are converting their operations to **sustainable agriculture**, an agricultural practice that preserves and enhances environmental quality. Farmers practicing sustainable agriculture typically generate lower revenues than do conventional farmers, but they also have lower costs. Two principal practices distinguish sustainable agriculture from conventional agriculture:

- More sensitive land management
- Better integration of crops and livestock

Sensitive Land Management. Sustainable agriculture protects soil in part through ridge tillage and limited use of chemicals. **Ridge tillage** is a system of planting crops on ridge tops. Crops are planted on 4- to 8-inch ridges that are formed during cultivation or after harvest. The crop is planted on the same ridges, in the same rows, year after year. Ridge tillage is attractive for two main reasons: lower production costs and greater soil conservation.

Production costs are lower with ridge tillage in part because it requires less investment in tractors and other

machinery than conventional planting. An area that would be prepared for planting under conventional farming with three to five tractors can be prepared for ridge tillage with only one or two tractors. The primary tillage tool is a row-crop cultivator that can form ridges. There is no need for a plow, or field cultivator, or a 300-horsepower four-wheel drive tractor.

Ridge tillage features a minimum of soil disturbance from harvest to the next planting. A compaction-free zone is created under each ridge and in some row middles. Keeping the trafficked area separate from the crop-growing area improves soil properties. Over several years the soil will tend to have increased organic matter, greater water holding capacity and more earthworms. The channels left by earthworms and decaying roots enhance drainage.

Sustainable agriculture involves application of limited if any herbicides to control weeds. Seeds used in conventional agriculture are often genetically modified to survive when herbicides and insecticides are sprayed on the fields to kill weeds and insects. These are known as "Roundup-Ready" seeds, because Monsanto Corp., the herbicide creator and market leader, sells it under the brand name "Roundup." "Roundup-Ready" seeds were planted in 80 percent of all soybean acreage, 54 percent of all cotton acreage, and 12 percent of all corn acreage in the United States in 2003.

Aside from adverse impacts on soil and water quality, widespread use of "Roundup-Ready" seeds is causing some weeds to become resistant to the herbicide. Under sustainable agriculture, farmers control weeds with cultivation and minimal use of herbicides. Ridge tilling promotes decreased use of chemicals, because they can be applied only to the ridges rather than the entire field.

Integrated Crop and Livestock. Sustainable agriculture attempts to integrate the growing of crops and the raising of livestock as much as possible at the level of the individual farm. Animals consume crops grown on the farm and are not confined to small pens.

In conventional farming, integration between crops and livestock generally takes place through intermediaries rather than inside an individual farm. In other words, conventional farmers purchase feed for their animals and sell their crops off the farm. This is a result of a trend toward separation and specialization of crop and animal production systems, as farmers choose to only grow crops or only raise animals.

Issues for Subsistence Farmers

Two issues discussed in earlier chapters influence the choice of crops planted by subsistence farmers. First, because of rapid population growth in LDCs (discussed in Chapter 2), subsistence farmers must feed an increasing number of people. Second, because of adopting the international trade approach to development (discussed in Chapter 9), subsistence farmers must grow food for export instead of for direct consumption.

Subsistence Farming and Population Growth

Ester Boserup, an economist, has offered an explanation for why population growth influences the distribution of types of subsistence farming. According to the Boserup thesis, population growth compels subsistence farmers to consider new farming approaches that produce enough food to take care of the additional people.

For hundreds if not thousands of years, subsistence farming in LDCs yielded enough food for people living in rural villages to survive, assuming no drought, flood, or other natural disaster. Suddenly in the late twentieth century, the LDCs needed to provide enough food for a rapidly increasing population, as well as for the growing number of urban residents who cannot grow their own food.

According to the Boserup thesis, subsistence farmers increase the supply of food through intensification of production, achieved in two ways. First, land is left fallow for shorter periods, resulting in an expansion in the amount of land area devoted to growing crops at any given time. Boserup identified five basic stages in the intensification of farmland:

- **Forest Fallow**. Fields are cleared and utilized for up to two years and left fallow for more than 20 years, long enough for the forest to grow back.
- **Bush Fallow**. Fields are cleared and utilized for up to eight years and left fallow for up to 10 years, long enough for small trees and bushes to grow back.
- **Short Fallow**. Fields are cleared and utilized for perhaps two years (Boserup was uncertain) and left fallow for up to two years, long enough for wild grasses to grow back.
- **Annual Cropping**. Fields are used every year and left fallow for a few months by planting legumes and roots.
- **Multicropping**. Fields are used several times a year and never left fallow.

Contrast shifting cultivation, practiced in regions of low population density, such as central Africa, with intensive subsistence agriculture, practiced in regions of high population density, such as East Asia. Under shifting cultivation, cleared fields are utilized for a couple of years, then left fallow for 20 years or more. This type of agriculture supports a small population living at low density. As the number of people living in an area increases (that is, the population density increases) and more food must be grown, fields will be left fallow for shorter periods of time. Eventually, farmers achieve the very intensive use of farmland characteristic of areas of high population density.

The second way that subsistence farmers intensify production, according to the Boserup thesis, is through adopting new farming methods. Ploughs replace axes and sticks. More weeding is done, more manure applied, more terraces carved out of hillsides, more irrigation ditches dug. The additional labor needed to perform

these operations comes from the population growth. The farmland yields more food per area of land, but with the growing population, output per person remains about the same.

Subsistence Farming and International Trade

To expand production, subsistence farmers need higher-yield seeds, fertilizer, pesticides, and machinery. Some needed supplies can be secured through trading food with urban dwellers. For many African and Asian countries, though, the main source of agricultural supplies is importing from other countries. These countries lack the money to buy agricultural equipment and materials from MDCs.

To generate the funds they need to buy agricultural supplies, LDCs must produce something they can sell in MDCs. The LDCs sell some manufactured goods (see Chapter 11), but most raise funds through the sale of crops in MDCs. Consumers in MDCs are willing to pay high prices for fruits and vegetables that would otherwise be out of season, or for crops such as coffee and tea that cannot be grown there because of the climate.

In an LDC such as Kenya, families may divide by gender between traditional subsistence agriculture and contributing to international trade. Women practice most of the subsistence agriculture—that is, growing food for their families to consume—in addition to the tasks of cooking, cleaning, and carrying water from wells. Men may work for wages, either growing crops for export or in jobs in distant cities. Because men in Kenya frequently do not share the wages with their families, many women try to generate income for the household by making clothes, jewelry, baked goods, and other objects for sale in local markets.

The sale of export crops brings an LDC foreign currency, a portion of which can be used to buy agricultural supplies. But governments in LDCs face a dilemma: the more land that is devoted to growing export crops, the less that is available to grow crops for domestic consumption. Rather than helping to increase productivity, the funds generated through the sale of export crops may be needed to feed the people who switched from subsistence farming to growing export crops.

Drug Crops. The export crops chosen in some LDCs, especially in Latin America and Asia, are those that can be converted to drugs. Various drugs, such as coca leaf, marijuana, opium, and hashish, have distinctive geographic distributions.

Coca leaf is grown principally in northwestern South America, especially Colombia, Peru, and Bolivia. Most of the processing of cocaine, as well as its distribution to the United States and other MDCs, is based in Colombia. Mexico grows the overwhelming majority of the marijuana that reaches the United States. Most opium originates in Asia, especially Afghanistan, Myanmar, and Laos. Thailand serves as the transportation hub for distribution to MDCs.

Strategies to Increase Food Supply

Four strategies can increase the food supply:

- Expand the land area used for agriculture.
- Increase the productivity of land now used for agriculture.
- Identify new food sources.
- Increase exports from other countries.

We will now examine each alternative.

Increase Food Supply by Expanding Agricultural Land. Historically, world food production increased primarily by expanding the amount of land devoted to agriculture. When the world's population began to increase more rapidly in the late eighteenth and early nineteenth centuries, during the Industrial Revolution, pioneers could migrate to uninhabited territory and cultivate the land. Sparsely inhabited land suitable for agriculture was available in western North America, central Russia, and Argentina's pampas.

Two centuries ago people believed that good agricultural land would always be available for willing pioneers. Today few scientists believe that further expansion of agricultural land can feed the growing world population. Beginning about 1950, the human population has increased faster than the expansion of agricultural land.

At first glance, new agricultural land appears to be available, because only 11 percent of the world's land area is currently cultivated. In fact, growth is possible in North America, where some arable land is not cultivated for economic reasons, and the tropics of Africa and South America offer some hope for new agricultural land in LDCs. However, prospects for expanding the percentage of cultivated land are poor in much of Europe, Asia, and Africa.

In some regions, farmland is abandoned for lack of water. Especially in semiarid regions, human actions are causing land to deteriorate to a desertlike condition, a process called **desertification** (more precisely, semiarid land degradation). Semiarid lands that can support only a handful of pastoral nomads are overused because of rapid population growth. Excessive crop planting, animal grazing, and tree cutting exhaust the soil's nutrients and preclude agriculture. The United Nations estimates that desertification removes 27 million hectares (104,000 square miles) of land from agricultural production each year, an area roughly equivalent to Colorado (Figure 10–14).

Excessive water threatens other agricultural areas, especially drier lands that receive water from human-built irrigation systems. If the irrigated land has inadequate drainage, the underground water level rises to the point where roots become waterlogged. The United Nations estimates that 10 percent of all irrigated land is waterlogged, mostly in Asia and South America. If the water is salty, it can damage plants. The ancient civilization of Mesopotamia may have collapsed in part because of waterlogging and excessive salinity in their agricultural lands near the Tigris and Euphrates rivers.

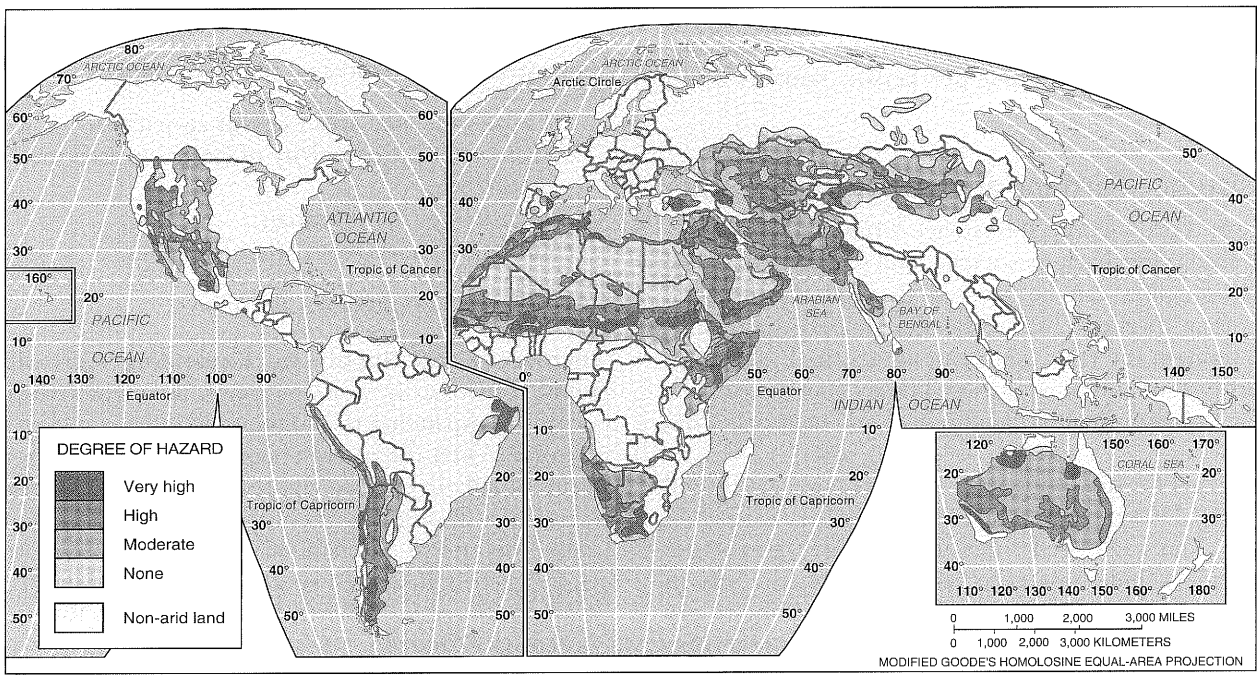


FIGURE 10–14 *Desertification (semiarid land degradation). The most severe problems are in northern Africa, central Australia, and the southwestern parts of Africa, Asia, North America, and South America.*

Urbanization can also contribute to reducing agricultural land. As urban areas grow in population and land area, farms on the periphery are replaced by homes, roads, shops, and other urban land uses. In North America, farms outside urban areas are left idle until the speculators who own them can sell them at a profit to builders and developers, who convert the land to urban uses.

Increase Food Supply Through Higher Productivity. Population began to grow faster than agricultural land expanded during the 1960s, especially in LDCs. At the time, many experts forecast massive global famine within a decade. However, these dire predictions did not come true, because new agricultural practices have permitted farmers worldwide to achieve much greater yields from the same amount of land.

The invention and rapid diffusion of more productive agricultural techniques during the 1970s and 1980s is called the **green revolution**. The green revolution involves two main practices: the introduction of new higher-yield seeds and the expanded use of fertilizers. Because of the green revolution, agricultural productivity at a global scale has increased faster than population growth.

Scientists began an intensive series of experiments during the 1950s to develop a higher-yield form of wheat. A decade later, the "miracle wheat seed" was ready. Shorter and stiffer than traditional breeds, the new wheat was less sensitive to variation in day length, responded better to fertilizers, and matured faster. The Rockefeller and Ford foundations sponsored many of the studies, and the program's director, Dr. Norman Borlaug, won the Nobel Peace Prize in 1970.

The International Rice Research Institute, established in the Philippines by the Rockefeller and Ford foundations, worked to create a miracle rice seed. During the 1960s, their scientists introduced a hybrid of Indonesian rice and Taiwan dwarf rice that was hardier and that increased yields. More recently, scientists have developed new high-yield maize (corn).

The new miracle seeds were diffused rapidly around the world. India's wheat production, for example, more than doubled in five years. After importing 10 million tons of wheat annually in the mid-1960s, India by 1971 had a surplus of several million tons. Other Asian and Latin American countries recorded similar productivity increases.

To take full advantage of the new miracle seeds, farmers must use more fertilizer and machinery. Farmers have known for thousands of years that application of manure, bones, and ashes somehow increases, or at least maintains, the fertility of the land. Not until the nineteenth century did scientists identify nitrogen, phosphorus, and potassium (potash) as the critical elements in these substances that improved fertility. Today these three elements form the basis for fertilizers—products that farmers apply on their fields to enrich the soil by restoring lost nutrients.

Nitrogen, the most important fertilizer, is a ubiquitous substance. Europeans most commonly produce a fertilizer known as urea, which contains 46 percent nitrogen. In North America, nitrogen is available as ammonia gas, which is 82 percent nitrogen but more awkward than urea to transport and store.

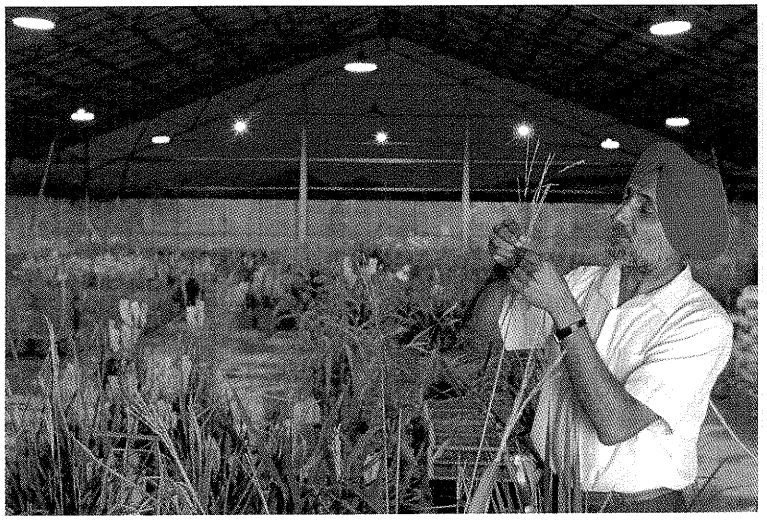
Both urea and ammonia gas combine nitrogen and hydrogen. The problem is that the cheapest way to produce both types of nitrogen-based fertilizers is to obtain hydrogen from natural gas or petroleum. As fossil-fuel

prices increase, so do the prices for nitrogen-based fertilizers, which then become too expensive for many farmers in LDCs.

In contrast with nitrogen, phosphorus and potash reserves are not distributed uniformly across Earth's surface. Two-thirds of the world's proven phosphate rock reserves are clustered in Morocco and the United States. Proven potash reserves are concentrated in Canada, Germany, Russia, and Ukraine.

Farmers need tractors, irrigation pumps, and other machinery to make the most effective use of the new miracle seeds. In LDCs, farmers cannot afford such equipment, nor, in view of high energy costs, can they buy fuel to operate the equipment. To maintain the green revolution, governments in LDCs must allocate scarce funds for subsidizing the cost of seeds, fertilizers, and machinery.

The green revolution did not stop with miracle seeds. Scientists have continued to create higher-yield hybrids that are adapted to environmental conditions in specific regions. Thanks to the green revolution, Dutch scientists calculate that the maximum annual crop yield currently has reached 6,000 kilograms of grain per hectare (5,000 pounds per acre) in parts of Asia and Latin America. This, however, still is far lower than the maximum possible yields of 15,000 kilograms per hectare (13,000 pounds per acre) in Asia and 20,000 kilograms per hectare (18,000 pounds per acre) in Latin America. The green revolution was largely responsible for preventing a food crisis in these regions during the 1970s and 1980s, but will these scientific breakthroughs continue in the twenty-first century?



The Green revolution of the 1970s and 1980s produced "miracle" high-yield seeds through laboratory experiments at the International Rice Research Institute (IRRI). An IRRI employee inspects the end of a rice plant in one of the institute's greenhouses.

Increase Food Supply by Identifying New Food Sources. The third alternative for increasing the world's food supply is to develop new food sources. Three strategies being considered are to cultivate the oceans, to develop higher-protein cereals, and to improve palatability of rarely consumed foods.

1. Cultivate Oceans. At first glance, increased use of food from the sea is attractive. Oceans are vast, covering nearly three-fourths of Earth's surface and lying near most population concentrations. But historically the sea has provided only a small percentage of world food supply. About two-thirds of the fish caught from the ocean is consumed directly, whereas the remainder is converted to fish meal and fed to poultry and hogs.

   Hope grew during the 1950s and 1960s that increased fish consumption could meet the needs of a rapidly growing global population. Indeed, the world's annual fish catch increased about five times, from 22 million tons in 1954 to more than 100 million tons in 1991. However, the population of some fish species has declined because they have been harvested faster than they can reproduce. Overfishing has been particularly acute in the North Atlantic and Pacific oceans. The U.S. National Marine Fisheries Service estimates that 65 of 153 species of fish that it monitors off the Atlantic and Pacific coasts are overfished. The population of large predatory fish, such as tuna and swordfish, has declined by 90 percent in the past half-century because of overfishing.

   To protect fishing areas, many countries have claimed control of the oceans within 200 nautical miles of the coast. These countries have the right to seize foreign fishing vessels that venture into the so-called exclusive economic zone.

   Peru has been especially sensitive to the overfishing problem after the country's catch of anchovies, its most important fish, declined by more than 75 percent between 1970 and 1973. To prevent further overfishing, the government nationalized its fish meal production industry, but the Peruvian experience demonstrates that the ocean is not a limitless source of fish.
2. Higher-Protein Cereals. A second possible new food source is higher-protein cereal grains. People in MDCs obtain protein by consuming meat, but people in LDCs generally rely on wheat, corn, and rice, which lack certain proteins. Scientists are experimenting with hybrids of the world's major cereals that have higher protein content.

   People can also obtain needed nutrition by consuming foods that are fortified during processing with vitamins, minerals, and protein-carrying amino acids. This approach achieves better nutrition without changing food-consumption habits. However, fortification has limited application in LDCs, where most people grow their own food rather than buy processed food.
3. Improve Palatability of Rarely Consumed Foods. To fulfill basic nutritional needs, people consume types of food adapted to their community's climate, soil, and other physical characteristics. People also select foods on the basis of religious values, taboos,

and other social customs that are unrelated to nutritional or environmental factors. A third way to make more effective use of existing global resources is to encourage consumption of foods that are avoided for social reasons.

A prominent example of an underused food resource in North America is the soybean. Although the soybean is one of the region's leading crops, most of the output is processed into animal feed, in part because many North Americans avoid consuming tofu, sprouts, and other recognizable soybean products. However, burgers, franks, oils, and other products that do not look like soybeans are more widely accepted in North America. New food products have been created in LDCs as well. In Asia, for example, high-protein beverages made from seeds resemble popular soft drinks.

Krill (a term for a group of small crustaceans) could be an important source of food from the oceans. The krill population has increased rapidly in recent years, because overhunting has reduced the number of whales that eat krill. About 1 million tons of krill are currently harvested, most of which goes to Russia and Eastern Europe to feed chickens and livestock. The harvest could be substantially increased for human food with new processing methods, because krill deteriorates rapidly. But krill does not taste very good.

Increase Food Supply by Increasing Exports from Other Countries. The fourth alternative for increasing the world's food supply is to export more food from countries that produce surpluses. The three top export grains are wheat, maize (corn), and rice. Few countries are major exporters of food, but increased production in these countries could cover the gap elsewhere.

Before World War II, Western Europe was the only major grain-importing region. Prior to their independence, colonies of Western European countries supplied food to their parent states. Asia became a net grain importer in the 1950s, Africa and Eastern Europe in the 1960s, and Latin America in the 1970s. Population increases in these regions largely accounted for the need to import grain. By 1980 North America was the only major exporting region in the world.

In response to the increasing global demand for food imports, the United States passed Public Law 480, the Agricultural, Trade, and Assistance Act of 1954 (frequently referred to as "P.L.-480"). Title I of the act provided for the sale of grain at low interest rates, and Title II gave grants to needy groups of people.

The largest beneficiary of U.S. food aid has been India. Sixty million Indians were fed entirely by U.S. grain in 1966 and 1967, when the monsoon rains failed. At the height of the rescue, 600 ships filled with grain sailed to India, the largest maritime maneuver since the Allied invasion of Normandy on D-Day, June 6, 1944. During those years, the United States allocated 20 percent of its wheat crop to feed India's population.

The United States remains by far the largest grain exporter, accounting for one-half of global corn exports and one-fourth of wheat. However, the United States has decreased its grain exports in the past quarter century, whereas other countries have increased theirs. Thailand has replaced the United States as the leading rice exporter, and other Asian countries, such as Vietnam, India,

Global Forces, Local Impacts

Genetically Modified Foods and Sub-Saharan Africa

Sub-Saharan African countries have been urged by the United States to increase their food supply in part through increased use of genetically modified (GM) crops and livestock. Africans are divided on whether to accept GM organisms.

Farmers have been manipulating crops and livestock for thousands of years: the very nature of agriculture is to deliberately manipulate nature. Humans have controlled selective reproduction of plants and animals in order to produce a larger number of stronger, hardier survivors. The science of genetics beginning in the nineteenth century expanded understanding of how to manipulate plants and animals to secure dominance of the most favorable traits.

GM, which became widespread in the late twentieth century, marks a sharp break with the agricultural practices of the past several thousand years. Whereas traditional selective breeding of plants and animals has involved increasing understanding of genetic traits, GM for the first time has involved modification of those traits. Under GM the genetic composition of an organism is not merely studied, it is actually altered. GM involves mixing of genetic material among two or more species that would not otherwise mix in nature.

GM is widespread in the United States, especially in the processed food that Americans consume in restaurants and at home heated in microwave ovens. Africans face arguments both for and against adoption of GM. In favor of GM are higher yields, increased nutrition, and more resistance to pests. GM foods are better tasting, at least to some palates.

Opposition to GM in Africa stems in part from practical economics: Europeans—the main customers for Africa's agricultural exports—are strongly opposed to GM, because they believe the food is less healthy than from traditionally bred crops and livestock. GM may cause safety problems, such as lowered resistance to antiobiotics and destroying long-standing ecological balances.

Africans are also uneasy with GM because it increases dependence on several multinational corporations responsible for manufacturing most of the GM seeds. If agriculture is regarded as a way of life, not just a food production business, GM represents for many Africans an unhealthy level of dependency on MDCs.

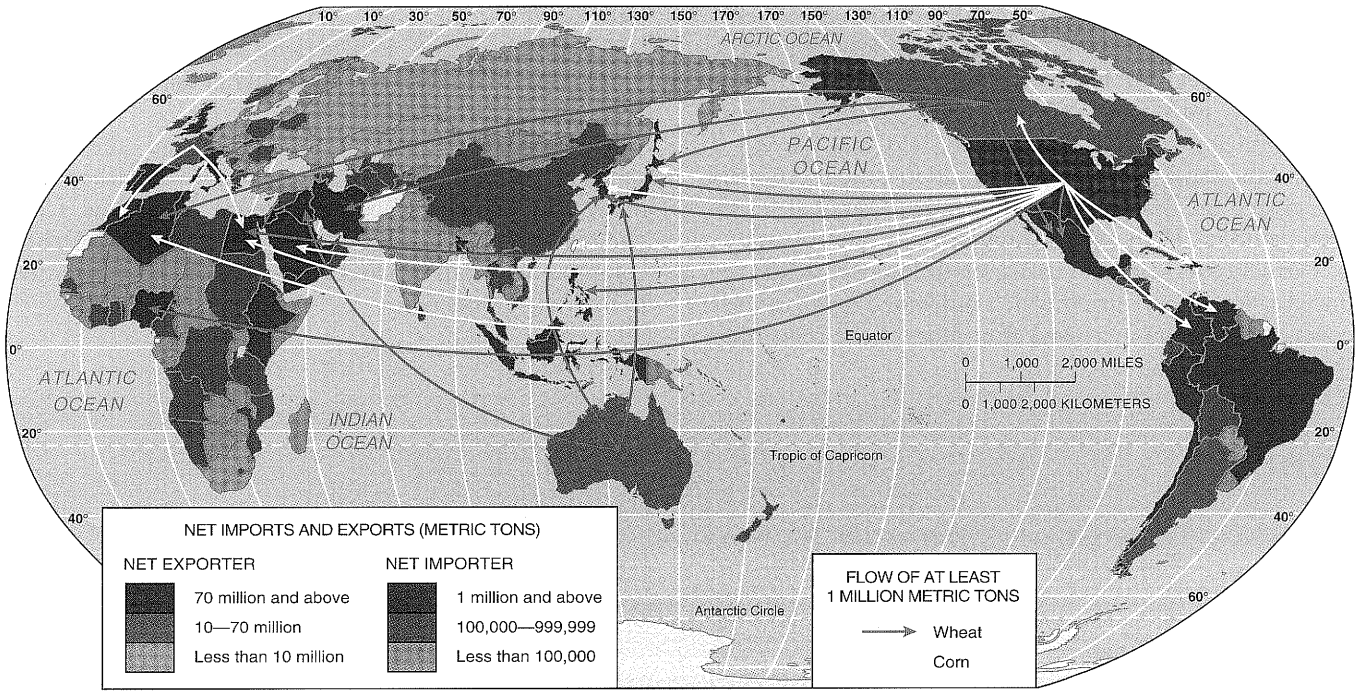


FIGURE 10–15 *Grain imports and exports. Most countries must import more food than they export. The United States has by far the largest excess of food exports compared to imports. Argentina, Australia, Canada, and France are the other leading food exporters.*

and China, account for most of the remaining rice exports. Argentina, Australia, and France have joined the United States and Canada as major wheat exporters (Figure 10–15).

Japan is by far the world's leading grain importer, especially of corn and wheat. South Korea and Mexico are major importers of corn, Egypt and Italy of wheat. World volume of trade in rice is much lower, with Bangladesh, Iran, and the Philippines the leading importers.

Africa's Food-Supply Crisis

Some countries that previously depended on imported grain have become self-sufficient in recent years. Higher productivity generated by the green revolution is primarily responsible for reducing dependency on imports, especially in Asia. India no longer ranks as a major wheat importer, and China no longer imports rice. As long as population growth continues to decline and agricultural productivity continues to increase, the large population concentrations of Asia can maintain the delicate balance between population and resources.

In contrast, sub-Saharan Africa is losing the race to keep food production ahead of population growth. The U N Food and Agricultural Organization estimates that 70 percent of Africans have too little to eat. Forty million Africans face famine, according to the World Food Program, including 14 million in Ethiopia, 7 million in Zimbabwe, and at least 1 million in eight other countries. By all estimates, the problems will grow worse.

Production of most food crops is lower today in Africa than in the 1960s. At the same time, population is increasing more rapidly than in any other world region. As a result, food production per person declined during the 1970s, 1980s, and 1990s in all but a handful of the region's countries, in several cases by more than 20 percent. Agriculture in sub-Saharan Africa can feed little more than half of the region's population.

The problem is particularly severe in the Horn of Africa, including Somalia, Ethiopia, and Sudan. Also facing severe food shortages are countries in the Sahel region, a 400- to 550-kilometer (250- to 350-mile) belt in West Africa that marks the southern border of the Sahara (Figure 10–16). The most severely affected countries in the Sahel are Gambia, Senegal, Mali, Mauritania, Burkina Faso, Niger, and Chad.

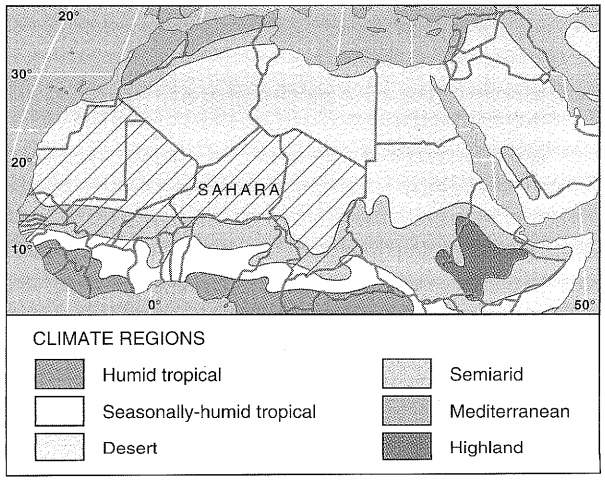


FIGURE 10–16 *The Sahel. The Sahel, which lies south of the drylands of the Sahara, faces severe food-supply problems, as does the Horn of Africa.*

Traditionally, this region supported limited agriculture. Pastoral nomads moved their herds frequently, permitting vegetation to regenerate. Farmers grew groundnuts for export and used the receipts to import rice. With rapid population growth, herd size increased beyond the capacity of the land to support them. Animals overgrazed the limited vegetation and clustered at scarce water sources. Many died of hunger.

Farmers overplanted, exhausting soil nutrients, and reduced fallow time, during which unplanted fields can recover. Soil erosion increased after most of the remaining trees were cut for wood and charcoal, used for urban cooking and heating. Productivity declined further, following several unusual drought years in the 1970s, 1980s, and 1990s.

Government policies have aggravated the food-shortage crisis. To make food affordable for urban residents, governments keep agricultural prices low. Constrained by price controls, farmers are unable to sell their commodities at a profit and therefore have little incentive to increase productivity.

SUMMARY

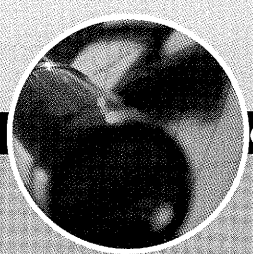
A country's agricultural system remains one of the best measures of its level of development and standard of material comfort. Despite major changes, agriculture in LDCs still employs the majority of the population, and producing food for local survival is still paramount.

Farming in MDCs directly employs few people, but when manufacturers of food products, supermarkets, restaurants, and other businesses that handle food are considered, then the food industry is actually the largest employer. The production and distribution of food are not primary-sector or agricultural activities, though; they are part of the industrial and service sectors of the economies in MDCs.

Even farming itself may one day no longer be considered a distinct primary-sector activity in MDCs. True, farmers still deliberately modify the land by planting seeds or grazing animals, but they spend more time sitting at computers, operating sophisticated machinery, and reviewing finances and devising marketing strategies.

Here again are the key questions concerning agricultural geography:

1. **Where did agriculture originate?** Prior to the development of agriculture, people survived by hunting animals, gathering wild vegetation, or fishing. Agriculture was not simply invented but was the product of thousands of years of experiments and accidents. Current agricultural practices vary between more developed and less developed countries.
2. **Where are agricultural regions in less developed countries?** Most people in the world, especially those in LDCs, are subsistence farmers, growing crops primarily to feed themselves. Important types of subsistence agriculture include shifting cultivation, pastoral nomadism, and intensive farming. Regions where subsistence agriculture is practiced are characterized by a large percentage of the labor force engaged in agriculture, with few mechanical aids.
3. **Where are agricultural regions in more developed countries?** The most common type of farm found in MDCs is mixed crop and livestock. Where mixed crop and livestock farming is not suitable, commercial farmers practice a variety of other types of agriculture, including dairying, commercial grain, and ranching.
4. **Why do farmers face economic difficulties?** Agriculture in LDCs faces distinctive economic problems resulting from rapid population growth and pressure to adopt international trade strategies to promote development. Agriculture in MDCs faces problems resulting from access to markets and overproduction.



CASE STUDY REVISITED

Uncertain Future for Farming

The future is uncertain for both subsistence farmers in LDCs such as Pakistan and commercial farmers in MDCs such as the United States. In one respect, the uncertainty stems from a similar problem: farming in neither location produces sufficient income to support the standard of living farm families desire. However, the underlying cause of low incomes differs significantly between more developed and less developed countries.

In LDCs people migrate from the farms to the cities in search of higher-paying jobs and a better life. Given the high natural increase rate and pressure to produce more for international trade, the migrants are not missed on the farms. The need for more food will not be met by adding more workers on the farms, but from more intensive use of existing farms and purchase of food from abroad.

In MDCs people also migrate from the farms to the cities in search of higher-paying jobs. However, these migrants are missed. Small farming communities in the United States are dying, and their death causes a loss of rural-based culture and values.

In many ways, the current migration from the farms in MDCs is simply the continuation of long-term trends. With farms becoming ever larger and more mechanized, the number of

farmworkers continually declines. Farm communities are suffering because most of the emigrants are young. But this has always been the case, as well: nearly a century ago, World War I veterans returning to the United States from Europe sang, "How ya gonna keep 'em down on the farm after they've seen Paree (Paris)."

The current decline in the farm population in MDCs has an especially strong impact on the rural landscape because, with so few farmers left, each further loss registers a large decline in percentage terms. Farming is the backbone of many small-town economies. Without farmers, banks and shops lose their main sources of income. For every five people that give up farming, one business closes in a small town. People still live on farms but work in factories, offices, or businesses in the nearest big city. And they shop at the big-city Wal-Mart instead of the small-town Main Street.

KEY TERMS

Agribusiness (p. 338)
Agriculture (p. 333)
Cereal grain (p. 347)
Chaff (p. 345)
Combine (p. 350)
Commercial agriculture (p. 335)
Crop (p. 333)
Crop rotation (p. 346)
Desertification (p. 359)
Double cropping (p. 345)
Grain (p. 350)
Green revolution (p. 360)
Horticulture (p. 354)
Hull (p. 345)
Intensive subsistence agriculture (p. 345)
Milkshed (p. 349)
Paddy (p. 345)
Pastoral nomadism (p. 343)
Pasture (p. 344)
Plantation (p. 355)
Prime agricultural land (p. 338)
Ranching (p. 351)
Reaper (p. 350)
Ridge tillage (p. 357)
Sawah (p. 345)
Seed agriculture (p. 334)
Slash-and-burn agriculture (p. 339)
Shifting cultivation (p. 339)
Spring wheat (p. 350)
Subsistence agriculture (p. 335)
Sustainable agriculture (p. 357)
Swidden (p. 341)
Thresh (p. 345)
Transhumance (p. 344)
Truck farming (p. 355)
Vegetative planting (p. 334)
Wet rice (p. 345)
Winnow (p. 345)
Winter wheat (p. 350)

THINKING GEOGRAPHICALLY

1. Assume that the United States constitutes one agricultural market, centered around New York City, the largest metropolitan area. To what extent can the major agricultural regions of the United States be viewed as irregularly shaped rings around the market center, as von Thünen applied to southern Germany?
2. New Zealand once sold nearly all its dairy products to the British, but since the United Kingdom joined the European Union in 1973, New Zealand has been forced to find other markets. What are some other examples of countries that have restructured their agricultural production in the face of increased global interdependence and regional cooperation?
3. Review the concept of overpopulation (the number of people in an area exceeds the capacity of the environment to support life at a decent standard of living). What agricultural regions have relatively limited capacities to support intensive food production? Which of these regions face rapid population growth?
4. Compare world distributions of corn, wheat, and rice production. To what extent do differences derive from environmental conditions and to what extent from food preferences and other social customs?
5. How might the loss of farmland on the edge of rapidly growing cities alter the choice of crops that other farmers make in a commercial agricultural society?

ON THE INTERNET

Our Internet exercises for Chapter 10 (**www.prenhall.com/rubenstein**) focus on agricultural issues in less developed countries, such as water policies and their effect on agriculture or soil degradation and desertification. With the aid of GIS we survey chronic undernutrition, increases in food production, and the role of agricultural trade. We also take a backward look (thanks to the Internet) at the successes and failures of the green revolution. Finally, we examine biotechnology in agriculture and the public's changing attitude about genetically engineered agricultural products. We have also provided useful **GeoSearch** and **Destinations** materials that will be helpful in these exercises. Agricultural statistics can be found on the Internet at the United Nations's Food and Agriculture Organization's web site, **www.fao.org**. The FAO maintains a data base known as FAOSTAT, with information on crops, food, and land use. Information about sustainable agriculture can be found through the Sustainable Agriculture Research and Education web site **www.sare.org**.

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