The Development of Agriculture

Twelve thousand years ago, everybody on earth was a hunter-gatherer; now almost all of us are farmers or else are fed by farmers. . . . Farming spread mainly through farmers’ outbreeding hunters, developing more potent technology, and then killing the hunters or driving them off of all lands suitable for agriculture.

—Jared Diamond, Guns, Germs, and Steel: The Fate of Human Societies

Essential Question: How has the development of agriculture affected the spatial distribution of people?

Hunting and gathering are the earliest known ways that people obtained food to eat. They relied on these methods until about 12,000 years ago, around 10,000 B.C.E., when they began to use agriculture, the process by which humans alter the landscape in order to raise crops and livestock for consumption and trade. The evolution of agriculture has been punctuated by three great leaps:

- The First (Neolithic) Agricultural Revolution was the origin of farming. It was marked by the first domestinations of plants and animals. Much of the farming that took place during this time was subsistence farming, which is when farmers consume the crops that they grow and raise, usually using simple tools and manual labor.

- The Second Agricultural Revolution, which began in the 1700s, used the advances of the Industrial Revolution to increase food supplies and support population growth. Both revolutions benefited from the seemingly continuous innovations in mechanization. In addition, agriculture benefited from improved knowledge of fertilizers, soils, and selective breeding practices for plants and animals.

- The Third Agricultural Revolution, which began in the 1960s, included the Green Revolution as well as an agribusiness model of companies controlling the development, planting, processing, and selling of food products to the consumer.
Centers of Plant and Animal Domestication

The First Agricultural Revolution began in five centers, or hearths. The first hearths were in Southwest Asia, East Asia, South Asia, Africa, and the Americas.

Agricultural Hearths

Geographer Carl Sauer, writing in the mid-20th century, was one of the first to argue that agricultural hearths were independently established at various times and locations. He thought that the first hearths were located in areas with high biodiversity on the edge of forests:

- **Animal domestication**, raising and caring for animals by humans for protection or food, probably began when Central Asian hunters domesticated dogs. Later, agriculturalists in Southwest Asia kept goats and sheep.

- **Plant domestication**, the growing of crops that people planted, raised, and harvested, probably began after animal domestication. Sauer believed that people first used vegetative planting, growing crops using parts of the stems or roots of existing plants. Later they began to plant seeds.

Eventually, people in these separate agricultural hearths began to trade with each other, thus creating an exchange of both crops and innovations.

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Location</th>
<th>Crops</th>
<th>Early Diffusion Pattern</th>
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<tbody>
<tr>
<td>10,000 to 12,000</td>
<td>Southwest Asia (Fertile</td>
<td>- Barley</td>
<td>North Africa</td>
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<tr>
<td>Years Ago</td>
<td>Crescent)</td>
<td>- Wheat</td>
<td>Southern Europe</td>
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<td>- Lentils</td>
<td>Central Asia</td>
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<td>- Olives</td>
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<td>- Rye</td>
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<tr>
<td>10,000 Years Ago</td>
<td>Southeast Asia</td>
<td>- Mango</td>
<td>Southeastern Asia</td>
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<td>- Taro</td>
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<td>- Coconut</td>
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<tr>
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<td>- Rice</td>
<td>North Central Asia</td>
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<td>- Soybean</td>
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<td>- Walnut</td>
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<td>- Yams</td>
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<td>- Sorghum</td>
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<td>North America</td>
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<td>- Peppers</td>
<td>South America</td>
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<td>- Maize (corn)</td>
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<td>- Potato</td>
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<td>- Sweet potato</td>
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<td></td>
<td></td>
<td>- Cassava</td>
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**Diffusion of the First Agricultural Revolution**

The major hearths of agriculture led to the first urban centers. These first settlements grew into the first civilizations, large societies with cities and powerful states. Civilization brought increased trade, larger empires, and conquest. As societies grew wealthier, people had time to specialize in their work and even develop new occupations and technologies. This led to the advent of the full-time metalworker, artist, soldier, weaver, and other specialized jobs.

Over thousands of years, agriculture spread widely and led to increased trade among cultures. The diffusion paths in the ancient world were somewhat expansive given the transportation technology of the time. For example, the great empire based in Rome that reached its peak around 200 C.E. carried on extensive trade in wheat and other agricultural products from present-day England to Africa and southwest Asia. On the Silk Roads, the routes connecting Rome with China, people traded silk, rice, and other goods.

One of the most dramatic shifts in agriculture came after the voyage of Christopher Columbus in 1492. The **Columbian Exchange** was the global movement of plants and animals between Afro-Eurasia and the Americas. Europeans brought hundreds of plants and animals west across the Atlantic Ocean to the Americas and took hundreds of plants and animals back east. Crops such as coffee (originally from eastern Africa) and bananas (originally from New Guinea) continue to thrive today in the tropical climates of the Americas. Temperate climate crops such as potatoes (originally from northwest South America) and maize (originally from southern Mexico) continue to thrive today in Europe, Asia, and Africa, as well as in the Americas.

**THE FIRST AGRICULTURAL HEARTHS**

![Map showing the first agricultural hearths around the world.](image-url)
Physical Geography and Agriculture

Physical geography features, such as climate, soil types, and landforms, influence how people farm in a region. As agriculture and technology have progressed and advanced throughout history, so too have attempts by humans to alter the natural environment. Irrigation, terrace farming, deforestation, desertification, and the drainage of wetlands have occurred as farmers try to increase production to feed an ever-growing human population.

Wherever crops grow and animals live, they need water. Even cattle herders in the Sahel, a dry region on the southern edge of the Sahara, must have access to water. Nutrient levels in soils have influenced the type of agriculture that takes place in a particular area. For example, cotton needs nutrient-rich soil while sorghum can grow in nutrient-poor soils, in places such as tropical rainforests. Climatic differences influenced by latitude and physical geography can have a dramatic impact on what crops can be grown.

Landforms can also greatly influence the types of agricultural activity in a specific place. The flat land found in large, expansive valleys provides excellent landscapes for agriculture. In contrast, mountains, ridges, and hills limit agricultural activity and often require more human inputs in order to make the land more useful for agricultural production.

Humans Altering the Landscape for Agriculture

Ever since the first humans began to farm, they altered the landscape to their advantage. Things that people today consider natural—building earthworks, redirecting streams, or removing natural obstacles—were at one time innovations. Far from natural, these undertakings were fresh, creative solutions to challenges faced by the earliest agriculturalists.

Terracing

One of the earliest human alterations of the landscape was terrace farming, in which farmers build a series of steps into the side of a hill. This creates flat surfaces, which have several benefits over steeply graded hillsides:

- Planting, tending, and harvesting crops is physically easier for farmers.
- The land collects rainfall rather than allowing it to run down a sloped hillside. The water helps sustain crops.
- The reduction in water running down the hillside reduces soil erosion.

However, if terraces are not carefully maintained, a heavy rainfall can cause disastrous and deadly mudslides.

Terrace farming has long been used throughout the world. In East Asia, terrace farming is often used to grow rice. In northern Africa, people often grow fruit and olive trees on terraced land. In South America, potatoes and maize (corn) are the main crops.
Managing Water

Irrigation is the process of diverting water from its natural course or location to aid in the production of crops. Humans have used irrigation to increase food production and increase their standard of living for thousands of years. The earliest forms of irrigation probably involved people simply carrying containers of water from a river or lake to pour onto plants. But by about 6,000 B.C.E., civilizations in Mesopotamia and Egypt used organized strategies (digging canals and creating earthworks) to manage their water resources.

Following these humble beginnings, irrigation technologies became more concentrated and more effective. In the 19th and 20th centuries, the successful use of large-scale irrigation contributed greatly to feeding the rapidly growing population of the world.

However, creating irrigation systems can damage the local environment. When misused, irrigation can cause several problems:

- It can disrupt the natural drainage of water and reduce the normal regeneration of soils caused by natural flooding.
- It can result in the salinization—increasing the salt content—of soil, which can result in decreases in crop yield and soil fertility.
- It can pump so much groundwater to the surface that it causes land subsidence—the collapse of land resulting from the removal of underground water that supports the surface land.

Two regions of the United States use irrigation extensively. One is California, particularly the Central and Imperial Valleys. The other is a region roughly from Nebraska to northern Texas that uses an underground water supply called the Ogallala Aquifer.

People have also drained wetlands to provide more farmable land. In most cases, this recovered land is rich in nutrients. Increased farmland increases a region’s carrying capacity, which is the number of crops or people that an area can support. However, a major drawback to the draining of wetlands is the reduction of biodiversity in both plants and animals. In addition, wetlands often act as natural filters that protect and promote surface water and groundwater quality.

Clearing Trees and Other Vegetation

Deforestation, the removal of large tracts of forest, has occurred throughout human history. Northern and central Europe were once heavily forested. Now, the region is mostly farmland and urban areas. Today, deforestation occurs mostly in Southeast Asia, parts of Africa, and, most famously, in the rainforests of South America.

Cutting down trees can result in local problems, such as soil erosion, decrease in rainfall, and desertification (the transition of land from fertile to desert). In addition, it can cause devastating global environmental damage.
In particular, the rainforests absorb so much carbon dioxide that shrinking them leads to an increase in atmospheric carbon dioxide, which contributes to worldwide climate change.

**Slash-and-burn agriculture**, in which all vegetation in an area of forest is cut down and burned in place, is likely one of the earliest agricultural practices. The ash provides some soil nutrients, and the land can be farmed for a few years before the soil becomes depleted and the plot is abandoned. The plot then returns to a natural, if somewhat altered state, while the farmers move on to burn and plant in a new space. Because slash-and-burn agriculture requires people to move regularly, it is also known as shifting cultivation. On a small scale, this system is beneficial to humans, and the environment recovers quickly. However, slash-and-burn agriculture on a large scale might seriously damage the environment.

Rather than use fire, farmers usually remove vegetation by cutting it down, pulling it out, or killing it with herbicides. On the Great Plains and prairies of the United States, farmers removed the tall prairie grasses in order to plant wheat and other grains. These new crops lacked the extensive root systems of prairie grass. Without the anchor of strong roots, and with a lack of rain and some wind, the valuable topsoil can simply blow away. The worst period of this occurred in the 1930s, and is known as the Dust Bowl. This era of massive soil erosion was one of the worst ecological disasters in U.S. history.

**Recent Trends**

In the modern era, **commercial agriculture**, in which farmers focus on raising one specific crop to sell for profit, has increasingly replaced **subsistence farming**, in which farmers focus on raising food they need to live. Increasing numbers of farming operations evolved from small enterprises owned by a single family into large-scale, capital-intensive businesses. This shift put more stress on the alteration of the environment than ever before.

**Impact of the Second Agricultural Revolution**

The **Second Agricultural Revolution**, which accompanied the Industrial Revolution that began in Great Britain in the 18th century, involved the mechanization of agricultural production, advances in transportation, development of large-scale irrigation, and changes to consumption patterns of agricultural goods. Innovations such as the steel plough and mechanized harvesting greatly increased food production.

**The Effects of Technology**

Advances in food production technology in the mid-19th century through the early half of the 20th century led to better diets, longer life spans, and an increase in population. As population increased, so too did the pool for workers in industry. Since most of these industrial jobs existed in cities and new factory
towns, mass migration to urban areas began to unfold. Urbanization, a process that is continuing today, changed the cultural landscape and population distributions throughout the world.

**Land Usage and Farming Advances**

Paralleling changes in technology were changes in the law. The *Enclosure Acts* were a series of laws enacted by the British government that enabled landowners to purchase and enclose land for their own use that had previously been common land used by peasant farmers. Similar enclosure movements occurred throughout Europe. Farms became larger, production became more efficient, producers raised crops to sell for profit rather than simply for their own consumption, and people were forced off the land, which created a workforce for the growing factories.

However, the enclosures were not popular with everyone. People who lost their traditional way of life suffered greatly.

Several advancements in sowing (planting) and reaping (harvesting), storage, irrigation, and transportation were made in agriculture throughout the 19th century. Some of these are listed in the chart below.

<table>
<thead>
<tr>
<th><strong>EARLY ADVANCES IN MODERN AGRICULTURE</strong></th>
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<tbody>
<tr>
<td><strong>Advancement</strong></td>
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| Iron/Steel Plough | 1819 | • Reduced human labor  
 • Could break through harder soils  
 • Increased amount of crops grown per acre  
 • Increased size of farms |
| Mechanized Seed Drilling | 18th century | • Planted and covered each seed quickly  
 • Resulted in increased yield per acre |
| McCormick Reaper/ Harvester | 1831 | • Increased harvest  
 • Reduced human labor  
 • Reduced amount of crops that perished in the field before harvest |
| Grain Elevator | 1849 | • Increased storage space and food supply  
 • Protected harvested food from animals and the elements |
| Barbed Wire | 1870s | • Provided inexpensive fencing to keep livestock in grazing areas |
| Mixed Nitrogen and Nitric Acid Fertilizer | 1903 | • Increased crop yields per acre |
Agricultural Changes and Shifting Demographics

The Second Agricultural Revolution resulted in fewer, larger, and much more productive farms, caused a decrease in the number of farm owners and an even greater drop-off in the need for agricultural laborers. By the late 19th century, an increased number of displaced farm laborers led to farmers and other rural residents migrating to urban centers in Europe and the United States. The 1920 U.S. Census showed for the first time in the country’s history that more people lived in urban areas than in rural areas. Only 30 percent of the labor force worked in agriculture, less than half what it was in 1840.

The Third Agricultural Revolution

Starting in the mid-20th century, science, research, and technology generated a Third Agricultural Revolution. It involved the development and dissemination of better and more efficient farming equipment and practices, particularly in the area of vastly improved varieties of grain.

The Green Revolution

The advances in plant biology that began in the mid-20th century are known as the Green Revolution, the development of higher-yielding, disease-resistant, faster-growing varieties of grains. The biggest advances were in growing rice, corn, and wheat. The Green Revolution allowed more farmers to double crop (grow more than one crop in a year) and increased use of fertilizer and pesticides in developing countries in Asia and the Americas. Countries such as India developed large-scale irrigation projects in order to make the most efficient use of their water resources.

INCREASE IN GRAIN PRODUCTION BY REGION

**Hybrids** Seed hybridization is the process of breeding together two plants that have desirable characteristics. For hundreds of years, humans have been creating plant hybrids from local varieties available to them. However, the Green Revolution scientists focused their attention on grains. Further, living in an increasingly globalized world, they had a much wider range of plants from which to crossbreed than did local farmers.

One example of hybridization is that in the 1960s scientists created a new strain of rice. They used the long-grain Indonesian rice and the denser-grain Taiwan dwarf rice to produce a rice grain that was both longer and denser. The hybridization of these two strains of rice was introduced to rice-growing countries in East and Southeast Asia.

The chief architect of the Green Revolution was Norman Borlaug, a microbiologist born in Iowa and educated at the University of Minnesota. His research was successful in turning Mexico from a wheat-importing country to one that was self-sufficient and even had a wheat surplus. This transfer of agricultural technology during the 1930s from the United States to Mexico would serve as a model for the Green Revolution that would occur after the Second World War. This period of advancements in seed hybridization, chemical fertilizers, and mechanization was the beginning of the Third Agricultural Revolution.

**GMOs** Hybridization differs from the production of a genetically modified organism (GMO), a process by which humans use engineering techniques to change the DNA of a seed. These techniques were first used in the 1970s. GMO crops started becoming widely used in the 1990s. Today, most corn, soybeans, and cotton grown in the United States are GMO varieties. They have been developed to increase yield, or to resist diseases or the chemicals used to kill weeds or pests. While GMOs seem to offer benefits, many people remain cautious about their use, arguing that potential problems have not been adequately studied.

**Machinery** In addition to using hybrids, chemical fertilizers, and pesticides, proponents of the Green Revolution encouraged the transfer of mechanical technology, as well. Machinery such as tractors, tillers, broadcast seeders, and grain carts were introduced to the beneficiaries of the Green Revolution in the developing world. The introduction of these agricultural technologies assisted in production and challenged traditional labor-intensive farming practices that had been in place for thousands of years.

**Positive Impacts of the Green Revolution**

During the Green Revolution, global food production increased dramatically. The introduction of new seed technology, mechanization, pesticides, chemical (human-made) fertilizers, and irrigation led to increased yields. More food led to reduced hunger, lower death rates, and a growing population in many parts of the developing world.
Higher Yields

Increased food production in the developing world was believed to have prevented a devastating famine in the early 1960s. By the mid-1950s, crop yields had increased without cultivating more land. The increased yields have kept up with global population growth, but experts debate whether agricultural production increases or population increases will be faster in the future.

The Green Revolution was most successful in Latin America, South Asia, East Asia, and Southeast Asia. Similar to what occurred in Mexico, India went from being an importer of wheat to harvesting a surplus of wheat within a few decades after the end of World War II. India's increased wheat output curbed hunger in the country.

The result was higher yields on relatively the same plots of land. Despite rapid population growth in these regions during the mid- to late 20th century, the increased crop output helped to stave off hunger and famine. By the second decade of the 21st century, The World Bank estimated that 80 percent of the developing world's population had an adequate diet. The UN Food and Agriculture Organization (FAO) in Rome, Italy, reported the following yield increases from 1960 to 2000:

- wheat: 208%
- corn: 157%
- rice: 109%
- potatoes: 78%

Money for Research and Business

The Green Revolution helped to create high rates of investment in both the public and private sectors. Using grant money from the government, universities in the United States and other developed countries undertook the basic research on seed hybridization, fertilizers, and pesticides that were the basis for the Green Revolution. This research was then used by for-profit corporations to create and market the products that farmers used. So, while the Green Revolution benefited hungry people in poor regions, it also financially benefited universities and corporations in more prosperous regions.

Food Prices

Higher yields and increased production led to falling real (adjusted for inflation) food prices. The supply of certain crops, mainly wheat, corn, and rice, became abundant through the mid- to late 20th century and, as a result, led to lower prices. More food at affordable prices helped to ease the economic stress of hunger and famine on governments and economic systems in the developing world. However, starting in 2005, global food prices began rising. This might explain some of the political turmoil in the Middle East and North Africa.
Negative Consequences of the Green Revolution

Like all large and rapid changes, the Green Revolution had some negative consequences. Some of these were environmental damage, lack of sustained investment, and a disregard for local needs.

Much of the success of the Green Revolution hinged on human-manufactured products such as hybrid seeds, chemical fertilizers, pesticides, and fossil-fueled equipment. While crop yields increased, they often did so at the expense of the natural environment. Critics of the Green Revolution argued that it was not a sustainable system.

Increased yields and the application of human-made fertilizers put a strain on the land. This intensive use of land (double cropping) coupled with more aggressive irrigation led to soil erosion.

In addition, intense land use and irrigation drained the land of its natural nutrients, which had to be supplemented with more human-made fertilizers. This made farmers more dependent on more artificial products. The introduction of these chemicals to the environment resulted in potentially hazardous runoff into streams, rivers, and lakes, which posed serious consequences to the local ecosystems, habitats, and communities. Hazards included polluted drinking water, species extinction, and health issues for the population.

The transfer of technology from the developed countries to the developing countries included machinery such as tractors, tillers, and harvesters. These new technologies required vast amounts of fossil-based fuels. These petroleum-fueled machines increased air, water, and sound pollution. Therefore, in order for the Green Revolution to succeed, it needed mechanization to keep up with crop production, thus resulting in further environmental stress.

The Green Revolution’s Impact on Gender Roles

Many countries in the developing world that participated in the Green Revolution had traditional economies. In a traditional economy, subsistence farming is the cornerstone of economic activity. Even though much of the farming labor is performed by women, men usually dominate societies based on a traditional economy socially, politically, and economically.

When the Green Revolution and its technologies were introduced to these countries, it was the men who usually benefited and who were given decision-making powers. Men operated machinery and were educated on newer methods of farming. Women were often excluded from learning the new methods. This further marginalized the role of women within many societies.

Economic Changes

Initial successes of the Green Revolution were a mixture of private and public investments. The transfer of farming technology heavily relied on private investment by corporations and public support by governments. As research
and production increased, so too did the cost of production. Machinery, seeds, fertilizers, and pesticides became more expensive and the cost was passed on to farmers in the developing world and the organizations that helped to support these farmers. As profit margins decreased, many corporations began to curtail further investments in the Green Revolution. Without a clear financial incentive, their motivation waned.

In addition, the labor markets of less developed countries began to change. As with the Second Agricultural Revolution, the Green Revolution allowed—or pushed—people from rural areas to move to urban areas in search of industrial and service sector jobs. The available and relatively cheap labor also attracted many multinational corporations who moved manufacturing facilities to countries like Vietnam, China, and India.

Demographers predict that migration from rural to urban in the developing world will continue. In the future, the percentage of people living in cities will dwarf the rural population.

**The Green Revolution’s Poor Success in Africa**

Unlike Latin America and Asia, Africa saw few successes from the Green Revolution. Reasons the Green Revolution failed throughout the continent of Africa are both environmental and cultural:

- Africa has a greater diversity of climate and soils than other places. Hence, developing the right fertilizers proved to be very expensive.
- Africa has many regions with harsh environmental conditions. Insects, plants, and viral strains proved to be extremely challenging to the Green Revolution technologies and researchers.
- Africa is so large, and so lacking of sufficient transportation infrastructure, that the costs of investment in research and development and transportation were very high.
- Africa’s staple crops such as sorghum, millet, cassava, yams, cowpeas, and peanuts were not always included in research seed hybridization programs.

During the period known as the Green Revolution, the world’s population more than doubled. Most of this growth was in poor countries on the periphery of the global economy. From the mid-20th century to the 21st century, the continent with the highest population growth rate was Africa. Since that was the region where the Green Revolution had the least impact, hunger remained a greater problem there than elsewhere. Today, nearly 30 percent of Africa’s population has been affected by food insecurity.

In response to the ongoing food problems in Africa, private foundations and governments are working together. They hope to develop a new Green Revolution there, using updated technology.
GEOGRAPHIC PERSPECTIVES: FOOD PRODUCTION AND POPULATION DENSITY

An old saying among historians is that the first law of human history is that a person must eat. Geographers focus on how the need to eat has shaped where people live and how they govern their societies.

Higher Density Settlements
Before humans developed agriculture, they had existed as hunters and gatherers for tens of thousands of years. They lived in small, mobile groups—maybe 30 to 50 people who could move easily in search of food. Larger groups would surpass the carrying capacity of their respective regions. People survived by living in low density regions.

The development of agriculture allowed people to live in permanent, higher-density communities. These communities were usually along rivers, which provided a source of water. But rivers such as the Nile had another benefit. They flooded regularly, which spread nutrients across the land that contributed to soil fertility. Since this made agriculture more productive, farmers could support denser settlements, and it freed more people to specialize in tasks other than growing food. People could dedicate themselves to building structures, providing protection (military), and innovating new ideas and products.

Centralization of Political Power
Increased job specialization began to reshape the spatial distribution of political power. Traditional hunting and gathering societies were usually tight-knit communities in which people shared responsibilities. This meant political power was decentralized. But as the roles in societies became more diverse and specialized, and as the population increased, divisions among social class became sharper and people desired new forms of governments. As a result, political power became more centralized.

<table>
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<th>KEY TERMS</th>
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<td>agriculture</td>
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<td>commercial agriculture</td>
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<td>subsistence agriculture</td>
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<td>plant domestication</td>
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<td>animal domestication</td>
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<tr>
<td>First Agricultural Revolution</td>
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Agricultural Regions

Without agriculture it is not possible to have a city, stock market, banks, university, church or army. Agriculture is the foundation of civilization and any stable economy.

—Allan Savory, biologist and farmer, Zimbabwe

**Essential Question:** Why does agriculture vary so greatly around the world?

Two driving forces have always shaped agriculture. One is physical geography. Climate and landforms determine what crops can be grown and what animals can be raised in each region of the world. For example, coffee grows well only in low latitudes. And in North America, blueberries do well in Michigan, Washington, and Oregon—places just east of large bodies of water that also have periods of cold weather.

The other force is economics, the workings of supply and demand that influence the competing use of the land. Whether consumers want to purchase peaches or plums influences what farmers will decide to grow.

**Climate and Agriculture**

Plant and animal production are directly linked to the climate in which they exist. Despite human intervention, climate, soil types, and levels of precipitation still govern what types of crops will be grown and what types of animals will be raised.

**Climate Conditions and Agricultural Production**

Climate always has and will continue to play a major role in determining what types of agriculture will take place throughout the world. Most of the earth’s land surface supports some type of agricultural activity. The few exceptions are in the high latitudes—around the north and south poles—and the high altitudes—the tops of mountains.

The following chart summarizes the types of agriculture most commonly found in each type of climate region. American geographer Derwent Whittlesey identified these eleven main agricultural regions in 1936.
<table>
<thead>
<tr>
<th>Agricultural Practice</th>
<th>Climate</th>
<th>Locations</th>
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<tbody>
<tr>
<td>Pastoral Nomadism</td>
<td>Drylands</td>
<td>• Southwest, Central, and East Asia</td>
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<td>• North Africa</td>
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<td>Shifting Cultivation</td>
<td>Tropical</td>
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<td>• Sub-Saharan Africa</td>
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<td>• Southeast Asia</td>
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<td>Plantation</td>
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<td>• Latin America</td>
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<td>• Sub-Saharan Africa</td>
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<td></td>
<td>• South and Southeast Asia</td>
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<tr>
<td>Mixed Crop/Livestock</td>
<td>Cold and Warm Mid-Latitude</td>
<td>• Midwestern United States and Canada</td>
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<td>• Central Europe</td>
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<td>Grain</td>
<td>Cold Mid-Latitude</td>
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<td>• South Central Canada</td>
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<td>• Eastern Europe</td>
</tr>
<tr>
<td>Commercial Gardening</td>
<td>Warm Mid-Latitude</td>
<td>• Southeastern United States</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Southeastern Australia</td>
</tr>
<tr>
<td>Dairy</td>
<td>Cold and Warm Mid-Latitude</td>
<td>• Northeastern United States</td>
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<td></td>
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<td>• Southeastern Canada</td>
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<tr>
<td></td>
<td></td>
<td>• Northwestern Europe</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>Warm Mid-Latitude</td>
<td>• Southern coast of Europe</td>
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<tr>
<td></td>
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<td>• Northern coast of Africa</td>
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<tr>
<td></td>
<td></td>
<td>• Pacific coast of the United States</td>
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<tr>
<td></td>
<td></td>
<td>• Southern tip of Africa</td>
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<tr>
<td></td>
<td></td>
<td>• Chile</td>
</tr>
<tr>
<td>Livestock Ranching</td>
<td>Drylands</td>
<td>• Western North America</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Southeastern South America</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Central Asia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Southern Africa</td>
</tr>
<tr>
<td>Intensive Subsistence</td>
<td>Warm Mid-Latitude</td>
<td>• South, Southeast, and East Asia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Near large populations</td>
</tr>
<tr>
<td>None</td>
<td>Polar</td>
<td>• Arctic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Antarctica</td>
</tr>
</tbody>
</table>
Climate influences what agricultural activities will take place. For example, animal herding takes place in drier climates such as the western United States, North Africa, and Southwest Asia. However, animal herding can vary greatly depending on economic factors. In pastoral nomadism, a form of subsistence agriculture practiced in the developing world, people travel from place to place with their herds of domesticated animals. In contrast, in ranching, a form of commercial agriculture found in the developed world, livestock graze over large areas while the owners remain in the same place.

However, technology can overcome climate. In the chilly climates of Iceland and Greenland, farmers can grow crops in greenhouses. The tomato market, once dominated by sunny states such as Florida and California, now includes the products of large Canadian indoor growing facilities.

Cultural preferences also shape economic activity. Consider food preferences. The climate of southwest Asia is fine for raising hogs. However, in a region dominated by Muslims and Jews, most people have religious objections to eating or raising hogs, so farmers choose to raise other animals.

**Agricultural Regions Associated with Bioclimatic Zones**

Crops and livestock thrive best in specific types of bioclimates. So, each bioclimatic zone is home to different types of agriculture.

**Pastoral Nomadism** As previously stated, pastoral nomadism is practiced in arid and semi-arid climates throughout the world. Nomads rely on the animals for survival. Animals such as cattle, camels, reindeer, goats, yaks, sheep, and horses provide meat and sometimes milk for food and hides for clothing and shelter. Pastoral nomads move their herds to different pastures within their territory and often trade meat for crops with nearby subsistence crop farmers. Nomads in different regions rely upon different animals, depending on their culture and the climate in which they live:

- in south central Asia and east Africa: cattle, because they adapt to the hot climate
- in desert regions of the Middle East: camels, because they can survive without water for long periods
- in northern Siberia: reindeer, because they can thrive in cold weather

**Shifting Cultivation** Subsistence agriculture in which farmers, usually in tropical climate regions, move from one field to another is called shifting cultivation. It is also known as slash-and-burn agriculture and as swidden agriculture because farmers sometimes clear the land by burning vegetation, a process that enriches nutrient-poor soil by adding nitrogen to it. On the cleared land, they plant and harvest crops until the soil becomes less fertile. Then, the people move to another area of dense, wild vegetation and repeat the process.
Unlike crop rotation, in which farmers change which crops are grown within a field, shifting cultivation involves using entirely new fields.

Farmers using shifting cultivation grow crops such as rice in South East Asia, maize (corn) in South America, and millet and sorghum in sub-Saharan Africa. Most families grow food for their own consumption, so one field will yield a variety of crops. Ownership of the land usually belongs to the community or village as a whole.

**Plantation Agriculture** One of the legacies of colonialism was the replacement of subsistence farming with commercial agriculture in many less developed regions. A plantation is a large commercial farm that specializes in one crop, usually found in the low latitudes (tropics), and in hot, humid climates with substantial precipitation. Plantations are typically labor intensive and often exploit the cheap labor available in nearby villages and towns. In order to reduce the cost of transporting bulky crops, some of the processing occurs near the plantation. The valuable portion of the crop is then transported to global markets. Common plantation crops include coffee, cocoa, rubber, sugarcane, bananas, tobacco, tea, coconuts, and cotton.

**Mixed Crop/Livestock Farming** Mixed crop and livestock farming is an integrated system common in developed regions, such as the Midwestern United States, northern Europe, and Canada, but it has also diffused to many parts of the developing world. On these farms, the majority of the crops raised are fed directly to livestock. The livestock is fattened on these grains for eventual slaughter, or the grains are fed to dairy cows. The animals' manure
is in turn used to help fertilize the crops. The owners of the land and livestock may be different people, but what is important is the interrelationship among them. The most common grains used for these purposes in the United States are corn and soybeans. Each can be used for animal feed, processed into oil, or used to make other products.

**Grain Farming** In regions too dry for mixed crop agriculture, farmers often raise wheat. Consumed mostly by people, wheat is produced in the prairies and plains. China, India, and Russia are the world's top wheat producers, with the United States fourth. The type of wheat grown reflects the climate:

- **Spring wheat** is planted in early spring and harvested in early autumn. It is grown in a colder region that includes North Dakota, South Dakota, Montana, and the prairie provinces of Canada.

- **Winter wheat** is planted in the fall and harvested in early summer. It is grown in a warmer region that includes Kansas, Oklahoma, and Colorado.

**Commercial Gardening** In the United States, commercial gardening and fruit farming, known as market gardening, is found mostly in California and the Southeast in order to take advantage of long growing seasons. This type of farming is also referred to as truck farming because the products were traditionally driven to urban markets and sold. However, today most of the products are sold to companies for canning or freezing. Fruits and vegetables grown in the United States that are the result of truck farming include lettuce, broccoli, apples, oranges, and tomatoes.

**Dairy Farming** Traditionally, dairies and creameries were local farms and businesses supplying dairy products to customers in a small geographic area. This pattern still exists in many less developed regions of the world.

However, during the latter part of the twentieth century, improvements in refrigeration and transportation expanded the milk shed, the geographic distance that milk is delivered. Large corporate dairy operations replaced smaller family-owned farms, which has resulted in a decrease in the number of farms but an increase in dairy production. Most commercial dairy farms are located in the United States, Canada, Europe, and other highly developed countries near urban centers and transportation corridors.

In a few countries demand for dairy products increased faster than the pressure for consolidation. So, in Argentina and Brazil, as the economy developed and average incomes increased, the number of dairy farms also went up.

**Mediterranean Agriculture** Mediterranean agriculture is practiced in regions with hot-dry summers, mild winters, narrow valleys, and often some type of irrigation system. Some of these regions are southern Europe, northern Africa, southwestern Africa, southwestern Asia, southwestern Australia, California, and central Chile. Common crops grown in Mediterranean
agriculture include figs, dates, olives, and grapes. Herders in these regions often practice transhumance, the seasonal herding of animals from higher elevations in the summer to lower elevations and valleys in the winter. Because the regions have rugged terrain, goats and sheep are the principal livestock.

**Livestock Ranching**  
Livestock ranching is a commercial grazing of animals confined to a specific area. Similar to pastoral nomadism, livestock ranching is found in areas that are too dry for growing crops in large quantities. Ranching is a prevalent agricultural activity in the western United States; the pampas of Argentina, southern Brazil, and Uruguay; parts of Spain and Portugal; China; and central Australia.

**Economic Forces that Influence Agriculture**

Among the many factors that influence the decisions farmers make about how to farm are the relative costs of land, labor, and capital. Because of these different costs, farmers balance the use of these resources differently. If land is plentiful and costs little, they use it extensively. If land is scarce or expensive, they use it intensely.

**Extensive Land Use**  
Agriculture that uses fewer inputs of capital and paid labor relative to the amount of space being used is **extensive farming**. It includes practices such as shifting cultivation, nomadic herding, and ranching.

**Intensive Land Use**  
Agriculture that involves greater inputs of capital and paid labor relative to the space being used is **intensive farming**. Intensive practices are used in various regions and conditions:

- Paddy rice farming in south, southeast, and east Asia is very labor intensive. However, the nature of the fields, often on terraces, can make using machinery difficult.
- Market gardening in California, Texas, and Florida, and near large cities is sometimes capital intensive, but it is nearly always labor intensive. Many vegetable and fruit farms use large numbers of migrant workers to tend and harvest crops. These workers are traditionally paid low wages.
- The largest scale of intensive agriculture occurs on plantations in low latitudes.

One technique to maximize output on a small amount of land is **double cropping**, the planting and harvesting on the same parcel of land twice per year. Another technique, **intercropping**, also known as multicropping, is when farmers grow two or more crops simultaneously on the same field. For example, a farmer might plant a legume crop alongside a cereal crop in order to add nitrogen to the soil and guard against soil erosion.

**Extensive and intensive farming methods can be used for either subsistence or commercial purpose. The following chart shows how these methods and purposes can mix.**

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**HUMAN GEOGRAPHY: AP® EDITION**
<table>
<thead>
<tr>
<th>Land Use Methods</th>
<th>Commercial</th>
<th>Subsistence</th>
</tr>
</thead>
</table>
| **Intensive**    | *Location*: usually near urban centers or transportation hubs  
|                  | *Examples*: truck farming and dairy farming  
|                  | *Inputs*: large amounts of labor and machinery, often on large amounts of land  
|                  | *Location*: usually near densely populated areas with access to local markets  
|                  | *Examples*: farmers who grow wide variety of crops such as corn, cassava, millet, or yams and raise some livestock  
|                  | *Inputs*: often labor-intensive production on small plots  
| **Extensive**    | *Location*: usually near transportation centers with access to processing centers  
|                  | *Examples*: livestock ranching; some grain farming  
|                  | *Inputs*: minimal amount of labor and machinery on a large expanse of land  
|                  | *Location*: usually in sparsely populated areas with access to local markets  
|                  | *Examples*: pastoral nomadism and shifting cultivation  
|                  | *Inputs*: minimal amount of machinery, but sometimes labor-intensive work on a large plot of land that might be owned communally  

**Increasing Intensity** Regions of the world that traditionally relied on extensive agricultural techniques are under pressure from local increases in demand, regional population growth, and global competition to use land more intensely. These demographic and economic forces place more stress on the land because they push farmers to use land continually, rather than letting it fallow and recover. Those who rely on shifting cultivation find it more difficult to practice these methods as global demand for tropical cash crops such as coffee, tea, and cacao compete for more land use. The timber industry has also put an economic strain on shifting cultivation. For subsistence farmers, the competition for space to grow timber, rubber, or products that are not eaten, coupled with increasing population, have resulted in food security issues, most noticeably on the continent of Africa.

**The Beef Industry** Some agricultural products combine extensive and intensive phases. Raising cattle in Wyoming is an example of extensive farming. The cattle roam and feed on grass in large ranches that average nearly six square miles in size. As the cattle reach maturity, the intensive phase begins. Farmers transport the cattle to feedlots, known as concentrated animal feeding operations (CAFOs) in northern Colorado. The density of
animals is high, and the cattle are fed corn and water in order to fatten them up before being processed into meat for the market.

The global expansion of fast-food operations along with increased demand for meat has led to larger ranching operations not only in the United States but in South America as well. In the United States, the competition for space, animal size, and raising time have led to the creation of feed lots, which are confined spaces in which cattle and hogs have limited movement. Because of their reduced movement, animals gain weight faster and require less room.

The economic structure of livestock raising has changed in the past few decades. The increased demand for beef, poultry, and pork has created factory farms and processing centers. Cattle are less likely to graze on large expanses of land, but instead are raised in feedlots or CAFOs. The animals can grow bigger in a shorter period of time. This new practice maximizes the use of space and prepares the animal for slaughter quickly, thus maximizing profit.

![Commercial Agriculture and Agribusiness](image)

**Commercial Agriculture and Agribusiness**

Agribusiness is the integration of various steps of production in the food-processing industry. It not only includes large-scale commercial agriculture, but also the steps of processing and production, transportation, marketing, retail, and research and development. Given the enormity of this system, agribusiness operations are performed by transnational corporations. These large-scale operations are commercial, highly mechanized, and much of the raising of crops and animals involve chemicals and biotechnology. The following chart compares farming at the scale of a homeowner and an agribusiness.
### VEGE TABLE FARMING ON TWO SCALES

<table>
<thead>
<tr>
<th>Activity</th>
<th>Homeowner Scale</th>
<th>Agribusiness Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growing Food</td>
<td>Raising vegetables in a backyard garden</td>
<td>Owning farms of thousands of acres that are worked by large staffs of employees</td>
</tr>
<tr>
<td>Processing Food</td>
<td>Eating fresh, homo-grown vegetables for dinner and preserving vegetables for</td>
<td>Canning and freezing products in factories that are often located near the fields</td>
</tr>
<tr>
<td></td>
<td>future use</td>
<td></td>
</tr>
<tr>
<td>Selling Food</td>
<td>Selling vegetables at a local market</td>
<td>Selling to wholesale distributors who sell to supermarkets and restaurants</td>
</tr>
<tr>
<td>Financing the Food</td>
<td>Giving some vegetables to a neighbor in exchange for using some of their land</td>
<td>Borrowing money from banks and selling stock to raise money for operating expenses</td>
</tr>
<tr>
<td>Industry</td>
<td>for a garden</td>
<td></td>
</tr>
<tr>
<td>Researching Food</td>
<td>Growing different varieties of tomatoes to see which grow best</td>
<td>Investing in research and development of new seeds, fertilizers, and pesticides</td>
</tr>
<tr>
<td>Options</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Impact of Large-Scale Farms

Globalization has accelerated the growth of agribusiness during the latter half of the 20th century. Competition in agricultural products and services has encouraged large-scale farming operations, thus eliminating many small-scale operations. Even “family-owned and operated farms” are corporations far larger than the farms of the past.

This system of resources, producer transportation, communication, information, and consumers is referred to as a supply chain, or a commodity chain. Often these supply-chain businesses are owned by one corporation. Vertical integration is when a company owns several smaller businesses involved in different steps in developing a product. A vertically integrated agribusiness might include one company that contracts with farmers to raise the crop, a trucking firm that transports the crop, a factory that processes it, and a wholesaler that distributes it to stores. This gives the company control over most of the product development process.

### Large-Scale Replacing Small-Scale Farms

Large-scale farming usually practices monoculture, which is the raising of a single cash crop on large plots of land. Family farmers in developed countries and subsistence farmers in developing countries cannot compete with large-scale farming operations because large-scale farming produces food at a cheaper per unit cost. Many projects funded by the World Bank
have encouraged agribusiness ventures in the developing world, often at the expense of subsistence farmers. As a consequence of globalization and the Green Revolution, many subsistence farmers have lost available land and now work for agribusiness enterprises. A suitcase farm is one in which no one lives on the farm and the harvesting and planting is performed by farmers who live nearby or by migratory labor. These are common in the Midwest and Great Plains in the United States.

**Commodity Chains and Consumption**

The transformation of agriculture into a large-scale agribusiness entity has resulted in a complex system of connecting producers and consumers at a global scale. This complex and enormous system enables someone who lives in a small American town to consume bananas from Ecuador, coffee from Brazil, chocolate from Switzerland, and apples from Honduras. This transformation may be attributed to advancements in biotechnology, mechanization, transportation, and food preservation.

A commodity chain is a process used by corporations to gather resources and transform them into goods and then transport them to consumers. The visual below illustrates a simplified commodity chain for corn.

![Commodity Chain for Corn](image)

Because of improvements in agricultural technology, advances in transportation, and an increasingly globalized economy, farmers can raise crops and animals far from their final market, and consumers can still purchase the final products at low prices. Corn has numerous uses, such as livestock feed, sweetener, or fuel, and the commodity chain for each use would be more specialized and complex than the one shown.

**Technological Improvements**

In 1962, one farmer fed an average of 26 people. By the early 21st century, one farmer fed an average of 155 people. This improvement is attributed to technological advancements in transportation, fertilizers, and harvesting equipment and a deeper understanding of the science of plants and animals. Advances in refrigeration created cool chains, which are transportation networks that keep food cool throughout a trip. Fruits and vegetables from the tropics could be delivered fresh to the temperate climates of North America and Europe at relatively low prices for consumers.
Intensive use of fertilizers, herbicides, and pesticides over large lots of land has increased production. This mass production of agricultural products has accounted for higher crop yields. Whether it is wheat fields in Kansas or banana plantations in Ecuador, large-scale agriculture would not be possible without these advancements in technology.

However, the combination of more intense land use, increased application of chemicals, and reduced amount of time for land to recover has led to environmental damage. The loss of wetlands and large tracts of rainforest cleared to increase farmable land have led to the loss of biodiversity and water resources. Petroleum-based fertilizers, pesticides, and herbicides have caused soil, water, and air pollution, and threatened ecosystems.

Regional Interdependence

The globalization of agriculture has created more interdependence, or connections among the regions of the world. Developed countries such as the United States and ones in Europe rely on producers in Mexico, Chile, and elsewhere in warm climates or the Southern Hemisphere to provide them with fresh fruits and vegetables year-round.

Food on a Global Scale

Food production and consumption are part of a complex global supply chain. For example, nearly half of U.S.-grown soybeans are exported. Major purchasers of U.S. agricultural products include China, Mexico, and Europe.

Low-latitude countries with tropical climates produce products such as coffee, tea, bananas, pineapples, and cocoa that cannot be grown in mid-latitude countries. But the mid-latitudes include developed countries in Europe and North America that provide a large market for these products. These tropical foods are examples of luxury crops, ones not essential to human survival but that have a high profit margin. For example, the cocoa bean (fruit of the cacao) is too bitter to be consumed in its raw form. It is highly processed in several stages beginning in the country where it is harvested and ending in a developed country, where it is commonly processed into chocolate.

The globalized commodity chain provides wealthy consumers with wide choices. However, it can lead to problems in developing countries:

- Farmers who are producing crops might not be able to afford to consume what they produce.
- By focusing on crops for export, the supply of locally grown food decreases, which drives up the cost for local consumers. A farmer in Honduras who grows chili peppers for the global market is not growing corn, beans, or other crops dominant in the diet.
- Finally, production might not be sustainable. Farmers might choose to follow practices that erode the soil or cause chemical pollution that harms the long-term use of the land.
Political Systems, Infrastructure, and Trade

The efficient exchange of food around the world depends on effective political systems, strong infrastructure, and supportive trade policies. These conditions have evolved over time to make agricultural trade vital in most countries.

Colonialism and Neocolonialism

Many connections that exist between Europe and the developing world were established through colonization. Although there are very few colonies in the world today, the economic relationship between developed countries and developing countries resembles certain aspects of colonialism. Neocolonialism, the use of economic, political, and social pressures to control former colonies, can be one way to describe the current state of global food distribution.

For example, while the extraction and processing of cocoa is expensive, the profit margin in selling chocolate is very high. Most of the revenue generated from chocolate remains with the transnational corporation based in the wealthy country while very little revenue finds its way back to the cocoa growers.

Fair Trade

In recent years, many consumers have become more aware of the disparity between high incomes of those in developed countries who manage trade and the low incomes of the producers in the developing world. One result of this awareness is the fair trade movement, an effort to promote higher incomes for producers and for more sustainable farming practices. Fair trade agreements between retailers and producers have been reached for several crops grown in the developing world, including cotton and coffee. While these agreements often increase the prices for consumers slightly, they provide a bigger share of revenue to producers and growers in the developing world.

Government Subsidies and Infrastructure

Governments in the developed world often provide subsidies, or public support, to farmers to ensure that consumers have a dependable, low-cost supply of food. The subsidies are designed to achieve three goals:

- to protect national security by insuring a dependable food supply
- to help farmers by increasing agricultural exports
- to help consumers by reducing food costs

Many agricultural products, such as grain or meat, are bulky to transport. Hence, one of the key components in determining the cost of the consumer products made from them is infrastructure (roads, bridges, tunnels, ports, electrical grids, sewers, telecommunications, and so on) that serves the country where they are produced. The U.S. government subsidizes the exports of corn, soybeans, and other agricultural products from the Midwest by spending money to make the Mississippi River navigable for barge traffic. Because water transportation is so inexpensive compared to land travel, these products enter the global food supply chain with a lower price than they would without
the government support. Because of these subsidies, consumers in Mexico City can purchase corn more cheaply from the United States than from parts or rural Mexico.

Most infrastructure improvements in developing countries connect resources to ports so goods can be exported. Often, other infrastructure in the country is lacking. As the map of the west African country Ghana shows, the major rail lines in the country connect the interior, where resources are located, to the ports where they can be exported to the developed world.

TRANSPORTATION ROUTES IN GHANA

GEOGRAPHIC PERSPECTIVES: DIFFUSION OF CROPS

A modern diet is rich in food from around the world. Geographers have traced the diffusion of these crops from their hearths and the networks created through trade.

Crops and Locations
Florida oranges, Irish potatoes, Colombian coffee, Swiss chocolate, and Italian tomato sauces are closely associated with specific geographic locations. But each of these items originated in hearths distant from where they are produced today. Similarly, black pepper from India, cinnamon from Sri Lanka, and nutmeg from the Moluccas are among the many non-native luxuries that diffused to the European mainland. The goal of reducing the friction of distance between Europe and these
faraway lands in order to improve the variety of peoples’ diets was a significant factor in the diffusion of crops from one location to another.

**Rate of Adoption**
But people are creatures of habit, so it can take centuries for the new crops to be accepted by another culture. For example, when Europeans brought tomatoes from the Americas back to Europe, they became popular in Italy—but only for ornamental purposes. Initially believed to be poisonous, tomatoes did not find their way into conventional Italian cuisine until the 19th century.

**Impact of Land and Climate**
Successful diffusion depends on more than what people want. Crops are notoriously fickle with respect to the conditions in which they grow best. A slight change in soil conditions, mean temperature, growing season, moisture, and latitudinal position can severely hinder the production of a crop.

For instance, natural latex, extracted from rubber trees originating in South America, was first introduced to France in the 18th century. Today, over 90 percent of its production is concentrated in Southeast Asian countries such as Thailand, Indonesia, and Malaysia. This primarily has to do with the availability of abundant cheap labor in those regions, as opposed to the Americas. However, this has occurred only because both regions’ distances from the equator and relative climates are very similar.

### KEY TERMS

<table>
<thead>
<tr>
<th>pastoral nomadism</th>
<th>subsistence agriculture</th>
<th>commodity chain</th>
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</thead>
<tbody>
<tr>
<td>ranching</td>
<td>Mediterranean</td>
<td>monoculture</td>
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<td>shifting cultivation</td>
<td>agriculture</td>
<td>suitcase farm</td>
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<td>plantation</td>
<td>dairy</td>
<td>cool chains</td>
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<td>market gardening</td>
<td>extensive farming</td>
<td>luxury crops</td>
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<td>intensive farming</td>
<td>neocolonialism</td>
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<td>milk shed</td>
<td>double-cropping</td>
<td>fair trade movement</td>
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<td>transhumance</td>
<td>agribusiness</td>
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</tbody>
</table>
Rural Land Use Patterns

To most people, this is just dirt. To a farmer, it is potential.
—Anonymous

**Essential Question:** How do farmers and others who live in rural areas decide how to use land?

The distribution of people in rural areas, and the distribution of agricultural production, indicates a great deal about how people in rural areas live. Using the agricultural landscape as his canvas, Johann von Thünen produced one of the most significant models ever created to illustrate the relationship among markets, production, and distance. Because it became the foundation of many economic location models, von Thünen’s work illuminates many areas of geography.

**The Cultural Landscape of Rural Settlements**

The rural landscape reflects both the economic activities and the cultural attributes of the people who live in an area. Landscape features such as place names, road signs, churches, and the layout of villages often provide evidence of the origins, languages, and religious beliefs of generations of inhabitants. Several factors affect rural settlement patterns. In addition to personal preferences, politics, religion, and the physical landscape can all play a role.

**Clustered and Dispersed Rural Settlement Patterns**

Throughout European history, rural residents commonly lived in clustered settlements, groups of homes located near each other in a hamlet or village. Clustered settlements fostered a strong sense of community and were convenient for sharing services, such as schools and churches. However, farmers spent part of each day walking to and from their fields, and watching over crops and animals was difficult.

In contrast to Europeans, North American farmers usually created dispersed settlements, a pattern in which farmers lived in homes spread throughout the countryside. In Canada and the United States, the governments promoted westward expansion by giving farmers land (in the United States, usually 160 acres) if they agreed to reside on it for several years. As a result, agricultural villages were extremely rare in this region.
Establishing Property Boundaries

In England, fields often had irregular shapes that reflected the location of physical features and traditional patterns of use. Plot boundaries were described using the **metes and bounds** system. Metes were used for short distances and often referred to features of specific points, such as “from the oak tree, 100 yards north, to the corner of the barn.” Bounds cover larger areas, and were based on larger features, such as streams or roads.

The English colonists in America also used metes and bounds. However, beginning in 1785, the United States switched to a system based on surveying rather than landscape features. The government organized land into **townships**, areas six miles long and six miles wide. Each square mile, or **section**, consisted of 640 acres, and it could be divided into smaller lots, such as half sections or quarter sections. The Public Land Survey System created rectangular plots of consistent size.

Two groups of Christians created their own distinctive patterns in order to emphasize their sense of community:

- Hutterites in Canada and the northern United States clustered all homes together in one rectangle, often with a large dining hall in the center where people shared meals. Barns were located in a separate part of the colony.

- Mennonites created street villages. Each family had a house and a barn, but all were along a single street. The land surrounding the region of homes and barns was divided into three areas, with each family working a thin strip of land in each area.

French settlers in North America emphasized the value of access to a river for water and trade. So that many farmers could have some river frontage, they developed the **French long-lot system**, in which farms were long thin sections of land that ran perpendicular to a river. The best examples of this system in North America occur in Quebec and Louisiana.
Von Thünen’s Land Use Model Zones

In 1826, Johann von Thünen, a farm owner in Germany, created an economic model that suggested a pattern for the types of products that farmers would produce at different positions relative to the market where they sold their goods. He assumed that farming was an economic activity, that farmers were in business to make a profit, that there was one market where farmers in the surrounding lands sold their products, and that the market was situated in the center of a plain that is isotropic, which means flat and featureless.

Von Thünen believed that decisions regarding what to produce were based largely upon transportation costs and that these costs were proportional to the distance from the market. The cost of land was another factor that influenced decisions regarding agricultural products, and there was a distance decay pattern between the cost of land and the distance from the market. His model showed similar distance decay patterns existed between intensity of land use and distance from market, as well as between perishability of the product and distance from market.

Description and Explanation of the Model

In the zone closest to the market, von Thünen suggested that horticulture, a type of agriculture that includes market gardening/truck farming,
dairying would occur. Horticulture produces perishable items, and farmers need to get them to market quickly. In the days before trucks and refrigeration, this was particularly important. Growing highly perishable crops, such as tomatoes and strawberries, and dairy farming are considered to be intensive forms of agriculture.

Von Thünen’s second zone included forests. Wood was an extremely important resource in 1826, both as building material and as a source of fuel. Von Thünen thought that wood products would be close to the market because they were not only important, but heavy and hence difficult to transport.

Farther from the market, in the third ring, were crops such as wheat and corn. Though valuable, they did not perish as quickly as vegetables and milk and were not as difficult to transport as wood.

The final ring was used for grazing of livestock such as beef cattle. They could be farther from the market because they could walk when it was time to transport them.

The extensive nature of grain and livestock farming meant that the farms were larger than those located in the inner ring of the model. While there is more farmland available in the larger outer rings, that was not necessarily the reason for these crops locating here. Grain and livestock farmers could find adequate space in the innermost ring if they were willing to pay enough to acquire the land.

**Land Value**

The value of land was influenced by its relationship to the market. Because the land in the inner ring was closest to the market, it was more valuable. Therefore, most farmers could not afford large amounts of it. Consequently, only farmers who used the land intensely and could make a profit from a small amount of land could be successful in the inner ring.

Land farther from the market was less valuable. Because grain and livestock are less perishable than the crops in the inner ring, the farmers could locate in the area of cheaper land farther from the market and still transport the product to market successfully. Though meat is perishable, and this was a significant concern in 1826, spoilage could be avoided if the animals were walked to market and were slaughtered there.

**The Bid Rent Curve**

In the case of von Thünen’s model, a bid rent curve, also known as a bid price curve, can be used to indicate the starting position for each land use relative to the market, as well as where each land use would end. Each line on the graph reflects the farmers’ willingness to pay for land at various distances from the market. Notice that each type of farmer is willing to pay more closer to the market than farther away. However, how much more varies with the types of activities. In a free market economy, the farmer willing to pay the most at each
location will occupy the land. It is where the uppermost line on the graph intersects with the next uppermost line that represents the start and/or end of a zone.

For example, where the strawberry line intersects the forest line indicates the end of where strawberries will be grown and the beginning of where forests will be found. Where the forest line intersects the wheat line indicates where the forest zone ends and the wheat zone begins.

**BID RENT CURVE AND VON THÜNEN'S MODEL**

![Diagram showing the bid rent curve and von Thünen's model](image)

**Applying Von Thünen's Model**

Von Thünen's model has been valuable in many ways. It has had application far beyond the topic of agriculture. His recognition of the spatial pattern in how farmers made decisions about using resources was the first economic location model. It provided the basis for the industrial location models of Alfred Weber and others who followed.

In addition, even though Von Thünen created his model nearly two centuries ago, it continues to apply today. Like all models, it needs to be adapted to actual conditions and changes in technology.
**Non-Isotropic Plains** Von Thünen’s model assumed that land was an isotropic plain—but real land includes rivers, mountains, and other physical features that make it non-isotropic. Von Thünen considered how various landscape situations would alter the shape of each land use ring. For example, if a river flowed through the plain, making transportation easier and cheaper along the river, then the zones would stretch out along the river. In addition, some areas have better climates or soil conditions for certain crops. These areas have a **comparative advantage**, or naturally occurring beneficial conditions that would prompt farmers to plant crops different from those predicted by von Thünen’s model.

**Multiple Markets** Von Thünen assumed that a farmer had one primary market, but they often have secondary markets as well. A dairy farmer might primarily sell milk to a local dairy. But the farmer might also make and sell some cheese, which does not spoil as quickly as milk, in a distant market.

**Changes in Transportation** The development of trains, cars, planes, and storage techniques such as refrigeration has allowed food to be transported much longer distances without spoiling than in 1826. As a result, the rings in the model are wider than originally. For example, rapidly perishable goods such as strawberries and milk can be produced much farther away from the market than in Von Thünen’s time. But relative locations remain the same. They are still produced closer to the market than are grains and livestock.

The cut flower market demonstrates the impact of transportation on the application of von Thünen’s model. Since cut flowers perish quickly and thus have to arrive at the market quickly, they are similar to horticulture and dairy products that the model predicts will be produced nearby and trucked to market. However, many flowers sold in New York City were grown in the Caribbean and flown to market. While air travel costs from the Caribbean are far higher than truck transport from the outskirts of New York, other costs of flower production are much less. Land, labor, and energy costs are so much lower in the Caribbean than they are in the outskirts of New York that they outweigh the extra transportation costs. Hence, producers can grow flowers for New York more profitably in the Caribbean than in nearby states.
Other Changes in Technology Changes in technology have modified demand for products. Since 1826, wood has been mostly replaced by oil, natural gas, and electricity as a fuel for heating homes, so forests are rarely located near communities today. Now, forested land at a city’s edge is probably highly valued as a greenbelt, an area of recreational parks or other undeveloped land, rather than a source of fuel.

Special Circumstances No model accounts for every variation that occurs in practice. For example, von Thünen’s model does not fit some areas of specialty farming, such as citrus farming in Florida, or the variety of crops grown in the Central Valley of California. Nor does it explain the decisions by developers who purchase land close to a city and use it for less intensive agricultural use than they could. They usually want to invest as little money as possible into the farmland while they decide when the time is right to build homes, retail space, or commercial structures on it.

Despite these issues in applying the von Thünen model, it remains important. When adjusted for real circumstances, it can still guide geographers as they study the relative value of land and transportation costs.

Modification of Natural Ecosystems

The development of agriculture significantly modified the natural landscape. Subsistence farming brought some change, but large-scale commercial agriculture brought far more.

Side Effects of Modern Food Production

Modern farming methods have made healthy diets possible for billions of people. However, each change to the natural ecosystem to increase food production has come with costs:

- Farmers have replaced forests with fields. These developed fields are unlikely to ever return to forest. In order to farm these fields year after year, farmers constantly replace nutrients with chemical fertilizers that can pollute rivers and lakes.
- Farmers have grazed animals in areas too arid to support crop production. Herders must be careful to prevent overgrazing or a somewhat productive area can undergo desertification and be unable to produce food.
- Farmers have used irrigation to make some arid areas productive for crops. Irrigation of land near the Nile River and in many parts of the western United States has led to conflicts between farmers and others who need water in these dry areas.
- Farmers have drained lands too wet for agricultural practices. The loss of wetlands can damage the ecosystem and lead to greater flooding.
- Farmers have terraced hilly or mountainous areas in order to produce flat areas for easier and more productive agriculture. Altering the natural flow of water and soil changes the conditions in which wild animals live.
Protecting Natural Ecosystems

To counter the damaging effects of destroying the natural landscape and the various flora and fauna that inhabit it, people are finding ways to preserve or restore ecosystems. At a global scale, people around the world in the 1980s joined a “Save the Rainforest” movement that supported farming and logging practices that did not damage the Brazilian rainforest. At a regional scale, in the tar sands of Alberta, scientists are attempting to return the disturbed landscape from open pit mining to its natural state. At a local scale, many communities have created natural habitats in their parks for plants and animals.

Agricultural Innovations

Agricultural scientists are constantly doing research to increase yields to feed the growing population, improve foods’ nutritional value, and increase the profitability of farming. While agricultural innovations often accomplish at least one of these three goals, people disagree over their other affects. As noted in Chapter 12, the Green Revolution was both successful and controversial. Similarly, other innovations often raise concerns.

Genetically Modified Organisms

A more recent controversial innovation has been the use of genetically modified organisms (GMOs), which are plants or animals that scientists in a laboratory modified by extracting genes of one species and inserting them into the DNA of another species. Compared to traditional foods, GMOs can be more nutritious, more resistant to weather and pest-related damage, and more long-lasting before they spoil. The majority of scientists have found them safe for humans. However, only a few countries such as the United States, Brazil, and Argentina have large GMO production. Many countries, particularly in Europe, have restricted the use of GMOs. Some concerns about GMOs include:

- GMO seeds are too expensive for poor farmers to use, in part because they are often sterile, so new seeds must be purchased each year.
- GMO seeds that are resistant to pests and herbicides might lead to the development of super pests or super weeds.
- GMOs might have potential long-term risks to consumers, such as organ problems or reduced immunity to diseases, that no one yet recognizes.

Organic Foods

The demand for organically grown food is increasing in the United States. Many consumers believe that food produced without the use of pesticides, synthetic fertilizers or other unnatural processes is healthier for them and for the environment. Since organic farming tends to be more labor-intensive than other forms of agriculture, it creates more jobs but the food produced is more expensive.
Organic agriculture has possible drawbacks. One potential environmental cost resulting from organic farming is that it might require more land in order to produce the same quantity of food. This could result in deforestation or destruction of wetlands and the corresponding loss of flora and fauna from these ecosystems. Also, some organic production of such commodities as milk, cereal, and pork produce more greenhouse gases than conventional farming techniques. And while organic farming regulations prohibit the use of synthetic pesticides, they do allow farmers to use naturally occurring chemicals that can be very harmful to humans and other life forms.

**Aquaculture**

With population growth increasing the demand for food, and supplies of fish in the ocean and some lakes being depleted by overfishing, people have turned to **aquaculture**, the practice of raising and harvesting fish and other forms of food that live in water. People in China and Southeast Asia have practiced aquaculture for thousands of years, but it is newer in the rest of the world. Aquaculture has dramatically increased the availability of fish protein to many people. Often referred to as the **Blue Revolution**, the practice is now the fastest growing form of food production on the planet and responsible for approximately 50 percent of the world’s seafood.

![The Growth of Aquaculture](image)
As with other forms of food production, there are environmental concerns related to the practice. Critics of open-pen systems, in which a cage or net is moored to the seafloor and the farm fish are able, to some extent, to interact with the wild surroundings, point out these problems:

- High fish density in enclosures means diseases and parasites thrive and spread easily.
- Parasites and diseases can easily spread from fish in the enclosures to the nearby wild stock.
- Chemicals and antibiotics used to counter parasites and diseases can damage the ecosystem around the enclosures.
- Fish can escape pens and may breed or compete with native stocks of fish.
- Excess feed and the concentration of fish waste can produce dangerously high levels of organic matter in the ocean.

There are also social concerns regarding aquaculture. The installation of fish farms can challenge traditional fishing and lead to conflicts between the two groups of fishers, disrupting the local way of life. Another concern is that owners of the aquaculture operations may unethically exploit both the local labor as well as the local environment. Some people are concerned that fish from fish farms contain high levels of pesticides that could harm humans.

**Environmental Issues Related to Agriculture**

Modern agriculture has dramatically modified the natural landscape. Some of these changes constitute significant environmental damage.

**Agricultural Chemicals and Fossil Fuels**

Much of the environmental impact of farming comes from the use of chemicals. Farmers have long used fertilizers to replace nutrients in the soil. Traditionally, the fertilizer was human or animal waste. When used properly, these products both provided the soil with nutrients and disposed of wastes. While some farmers still use waste as fertilizer, most rely more on chemical fertilizers. If too much is applied, the excess contaminates nearby water supplies, producing significant environmental damage, including algal blooms.

A second group of potentially harmful chemicals includes ones designed to kill unwanted insects or plants. Both pesticides and herbicides destroy parts of the natural ecosystem. When used or disposed of incorrectly, they can cause significant damage to other life forms, including humans.

A third group of powerful chemicals are those given to livestock, such as antibiotics to prevent disease and hormones to promote growth. Many consumers fear the consequences of consuming meat from these animals.

Lastly, modern farming machines that run on fossil fuel, such as combines and tractors, result in air pollution from the exhaust, depletion of fossil fuel
reserves, and leaks or spills of various petroleum products that can contaminate soil and water.

**Depletion of Water Supplies**

Farming can also damage the environment by misusing water. Worldwide, approximately 70 percent of all accessible fresh water is used for agriculture. Some of this water is wasted through inefficient irrigation. Farmers sometimes apply more water than their crops need, operate irrigation pipes that leak, or try to grow crops in arid places. Poor irrigation can cause several problems:

- Excessive irrigation can increase the level of salts in the soil, a process known as salinization. This reduces the ability of plants to grow.

- Irrigation can reduce the amount of underground water in aquifers. India, Pakistan, and other countries that adopted the crops of the Green Revolution have suffered from this problem.

- Irrigation can reduce the amount of surface water in rivers and lakes. In central Asia, the Aral Sea has shrunk by more than 60 percent over the past five decades, as the photos below indicate.

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**Loss of Biodiversity**

Changes in agriculture often reduce biodiversity. As improved varieties of crops are developed, farmers often abandon older varieties. In addition, many farmers are growing fewer varieties of crops than ever before. Specializing in one crop, which is known as **monocropping**, or **monoculture**, then reduces the diversity of the insects, animals, and other organisms that depend on other varieties of plants. To keep abandoned varieties of plants from disappearing forever, scientists save seeds in international and national seed banks.
Soil Degradation and Erosion

The image of grazing animals seems to suggest very low impact on the natural landscape. In a large open area, the animals will simply wander from area to area seeking better grass and giving the grazed areas time to recover. In restricted areas, farmers move their herds between enclosures to allow for the recovery of the grasslands.

However, if the density of animals is greater than the grasslands can support, then in their search for food, the animals will overgraze, damage the grasslands to the extent that the vegetation will not refresh itself even after the animals leave. Overgrazing most often occurs when farmers or herders have too many animals, they control too little land, or climatic conditions worsen and there is less pasture available than usual. With the right combination of overgrazing and environmental circumstances, catastrophic levels of soil erosion become a real danger. The Sahel region of Africa, a continent-wide belt of land on the southern edge of the Sahara Desert, is an excellent example of where this pressure is occurring.

Overgrazing is increasingly occurring in pastoral nomadism/migratory husbandry situations as the amount of land available to the herders and their families has shrunk in recent decades. Since there is less land available for the migratory herders, they have to remain longer in fewer locations, significantly increasing the risk of overgrazing. Several changes have decreased the availability of pasture land, each of which makes overgrazing more likely:

- Governments have become much more protective of their borders, which makes it much more difficult for some herders to follow their traditional migratory routes that often crossed international borders.
- Some former pasture land is now being irrigated and used for growing crops and housing permanent residents.
- Other areas of former pasture land are now being used for mining and petroleum operations.

Once overgrazing occurs, the grasses will not recover as quickly, if at all, and this leaves the exposed soil much more susceptible to erosion.

The practices mentioned above can all lead to soil degradation and soil erosion. When farmers drain the soil of nutrients from practices such as overuse, lack of crop rotation, or failure to replace nutrients, the soil loses its ability to support plant growth. Once this happens, the soil can be much more easily eroded by wind or water. Overgrazing and over tilling, or plowing, can also result in soils susceptible to erosion by wind and water.

Animal Waste

The raising of animals for food today generally includes the use of feedlots. On these lots, thousands of animals might be contained in a very limited amount of land, consuming high-quality feed for several months before they
are slaughtered. The large amount of waste they produce can include gases such as ammonia, methane, and hydrogen sulfide that can pollute the air, and liquid wastes that can pollute the water supply. Feedlots must be well-managed to avoid causing significant environmental damage. Many scientists are concerned about the concentration of waste in small areas.

**Sustainability and Agriculture**

Farmers today face many challenges to operate in ways that are sustainable in the long term. Maintaining soil fertility without degrading the soil is possible, but it takes careful planning. Sustainable grazing and tilling practices help to minimize soil erosion. Managing chemical levels and sedimentation in bodies of water, conserving water, employing renewable energy resources, and preserving biodiversity are all part of an environmentally sustainable perspective. Farmers have to constantly analyze their decisions in order to strike a balance between immediate profitability and long-term sustainability.

**Changes in Food Production and Consumption**

The broad trends in agriculture over the past century have been toward larger farms, more corporate ownership, more intensive use of machinery and chemicals, and higher output. However, smaller trends are also evident, such as the increase in organic farming discussed previously.

**Fair Trade and Local Food**

Some consumers support the fair trade movement, which is designed to get more money into the hands of the small farmers in poor countries who actually raise the crops, rather than supporting large transnational corporations that manage trade in these products. The most widely sold fair-trade products are coffee, tea, bananas, and chocolate.

Another trend among some consumers is to “eat local”—seeking out food produced nearby. Advocates, sometimes called “locavores,” point out that this both supports local farmers and reduces the use of fossil fuel used to transport products. Farmers markets, where consumers can purchase fruits, vegetables, and other food items directly from farmers, have become more popular in the past three decades. Many farmers who cater to local consumers produce specialty crops such as herbs, mushrooms, and free-range chickens that are provided in small quantities but sold at relatively high prices.

**Location of Food Production Facilities**

Traditionally, companies located food processing facilities in rural areas or small towns. By locating facilities close to where the harvest occurs, companies could work with very fresh products—and benefit from the lower labor and land costs in rural areas. However, improvements in roads, truck efficiencies, and storage techniques have prompted many companies to close older, smaller
facilities and open new, larger, more efficient ones. These new facilities have
allowed them to take advantage of economies of scale. This change has shifted
jobs from rural to urban locations.

The importance of transportation and storage techniques is clear in the
lobster industry. Worldwide demand for fresh live lobster is so high that lobster
processors now use very expensive air freight to ship millions of pounds of
live lobster from the east coast of Canada to destinations in Europe and Asia.

**Gender Roles in the Food System**

In most cultures throughout history, males and females have had distinct roles
in producing and preparing food. However, some of these roles have changed
as technology has changed.

**Food Production** Women have played a major role in agriculture since
people first started farming. Today, they make up about 40 percent of the
world’s agricultural labor force. In regions where subsistence farming remains
common, the figure is 70 percent:

- In many areas of the developing world, men migrate to urban areas in
  search of employment, while women stay at home and work their farms
  along with their children. In operations where farms sell their farm
  products at local market, women are often the sellers.

- Where farming has modernized and machines have been introduced,
  women have become less involved with the field work.

- In large-scale agribusinesses, women have taken on newer roles. Besides
  raising crops and tending animals, and processing products, they work
  in management, sales, distribution, and research.

**Food Preparation** How people prepare food has changed as people
changed where they live and work. As people moved from rural areas to urban
areas, they grew less of the food they consumed and purchased more of it. And
as more women worked outside of the home, they had less time to prepare
food.

One result of these changes has been that women spend less time
preparing food than did women in previous generations. People purchase
more convenience foods than previously, from cake mixes to entire meals that
simply need to be heated. The demand for these foods has grown so much
that food companies are committing significant research money to developing
visually appealing, tasty, healthy food products. In addition, in the regions
of the world with greater gender equality, men have become more involved in
food preparation, particularly in households where both partners are working.

A second result is that people eat in restaurants more than ever before. In
2015 for the first time in history, Americans spent more money eating out than
they spent on groceries.
GEOGRAPHIC PERSPECTIVES: LAND USE FOR ORGANIC FOOD

Washington, Oregon, and California line the west coast of the United States. Despite their location on the edge of the country, they have become the center of organic farming in the United States.

**Chemical and Organic Farming**
The production of food by means of modern chemical farming—utilizing synthetic fertilizers, pesticides, herbicides, and fungicides—is largely extensive in nature. It is lucrative over vast areas of land.

In contrast, organic farming—which is more expensive—has proven to be more profitable through further intensification. While organic agricultural sales have boomed over the past decade, both the number of farms and total acreage of land have declined, where the individual farms have become more productive.

While the organic food industry has grown, its market share remains under five percent. Furthermore, while non-organic modern agriculture produces food for the masses and is often sold globally, organic food has been largely seized upon by local-food movements.

**The Distribution of the Organic Food Market**
As is the case with virtually all industries, the location of organic food consumption can be best explained through the spatial analysis of socioeconomic factors, and the concentration of these locations is predictably uneven. Farmers markets and supermarkets offering organic foods are largely found in the more affluent regions. Almost half of all organic food is sold and consumed within 100 miles of its production. Moreover, most consumption takes place around urban areas, where the market demand is greatest, such as Portland, San Francisco, and Seattle.

### KEY TERMS

| clustered settlements | market gardening/truck farming |
| dispersed settlements | bid rent curve/bid price curve |
| metes and bounds | comparative advantage |
| township | greenbelt |
| section | genetically modified organisms (GMO) |
| French long-lot system | organic food |
| von Thünen Model | aquaculture |
| isotropic | Blue Revolution |
| horticulture | monoculture/monocropping |
| biodiversity | overgrazing |
| fair trade | pastoral nomadism/migratory husbandry |
| economics of scale |