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 hunter, 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 Fates 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>
</tr>
</thead>
<tbody>
<tr>
<td>10,000 to 12,000</td>
<td>Southwest Asia (Fertile</td>
<td>Barley, Wheat, Lentils,</td>
<td>North Africa, Southern Europe,</td>
</tr>
<tr>
<td>Years Ago</td>
<td>Crescent)</td>
<td>Olives, Oats, Rye</td>
<td>Central Asia</td>
</tr>
<tr>
<td>10,000 Years Ago</td>
<td>Southeast Asia</td>
<td>Mango, Taro, Coconut</td>
<td>Southeastern Asia</td>
</tr>
<tr>
<td>9,500 Years Ago</td>
<td>East Asia</td>
<td>Rice, Soybean, Walnut</td>
<td>North Central Asia, Korean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>peninsula</td>
</tr>
<tr>
<td>7,000 Years Ago</td>
<td>Sub-Saharan Africa</td>
<td>Yam, Sorghum, Cowpeas, Coffee, African rice</td>
<td>Western Africa, North Africa</td>
</tr>
<tr>
<td>5,500 Years Ago</td>
<td>Mesoamerica</td>
<td>Squash, Peppers, Maize (corn), Potato, Sweet potato, Cassava</td>
<td>North America, South America</td>
</tr>
</tbody>
</table>
**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.

---

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

**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.