Agriculture: Origins and Revolutions

LEARNING OBJECTIVES

1. Define agriculture and identify its hearths.
2. Distinguish among the first, second, and third agricultural revolutions.
3. Contrast the Green Revolution and the Gene Revolution.

Although we seldom think about it, our lifestyle is intimately connected with and highly dependent on agriculture, especially the ability to produce, process, and transport agricultural commodities. Agriculture involves the ongoing process of **domestication**—selecting plants or animals for specific characteristics and influencing their reproduction. Domestication not only makes plants and animals visibly or behaviorally distinct from their wild ancestors but also increases the interdependency between people and the domesticate. Domestication reflects human agency.

agriculture Activities centered on cultivating domesticated crops and livestock in order to procure food and fiber for human use or consumption.

Until very recently, agriculture employed the highest percentage of people worldwide. As we saw in Chapter 10, the service sector now employs the highest percentage of people—about 43% of the world's workforce. In comparison, the agricultural sector employs approximately 35% of the world's workforce.

This decline in the share of agricultural employment is a testament to the ongoing urbanization of our world as well as the mechanization and industrialization of agriculture. Even so, employment in the agricultural sector differs vastly from one region and country to another. Although women have been involved in agriculture since it began, certain trends increasingly point to a new feminization of agriculture (Figure 11.1).

Origins of Agriculture

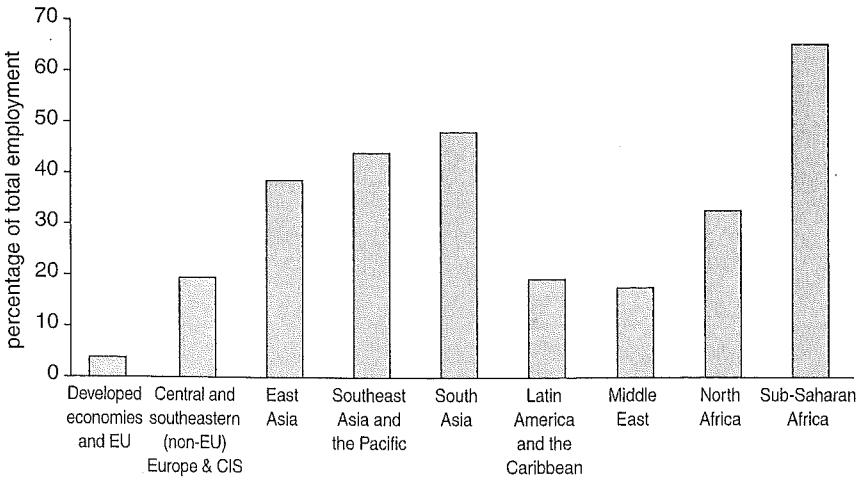
Hunting and gathering is the oldest method of obtaining food, and historically all people obtained their food this way. Most hunters and gatherers moved frequently in pursuit of game and seasonally available plants, although some groups that relied heavily on fishing might settle permanently in one location. Strictly speaking, however, hunters and gatherers are not classified as agriculturalists because they use wild rather than domesticated plants and animals.

hunting and gathering Hunting wild animals, fishing, and gathering wild plants for food.

A geography of employment in agriculture • Figure 11.1

a. Employment in agriculture by region

Agriculture employs a higher percentage of people in Sub-Saharan Africa than in any other world region. For example, in Tanzania, Rwanda, and Ethiopia the share of the labor force employed in agriculture exceeds 80%. (*Source*: Data from ILO, 2008.)



b. Women threshing millet in Niger

Women produce a majority of the food in developing countries. The new feminization of agriculture in these regions stems in part from the migration of men into cities for work, the increase in households headed by women, and the willingness of women to perform tasks once assigned to their children so that their children can attend school.

As a way of life, hunting and gathering is in decline because of the dominance of settled agriculture and its close association with the modern state and global economy. Today hunting and gathering is confined to peripheral areas, where it is practiced by small numbers of people including, among others, the San of southern Africa, some Aboriginals in the interior of Australia, and the Moken of Myanmar (see *Video Explorations*). The notion that hunters and gatherers live on the brink of starvation is a popular misconception; numerous studies have shown that hunters and gatherers are generally well nourished. Historically, the transition from hunting and gathering to farming marks the first of three sweeping revolutions that have transformed the world.

The First and Second Agricultural Revolutions

The development of agriculture constitutes the **first agricultural revolution,** which began with the domestication of plants and animals some 11,000 years ago. Most geographers agree that agriculture was independently invented at different locations and at different times (Figure 11.2).

Video Explorations

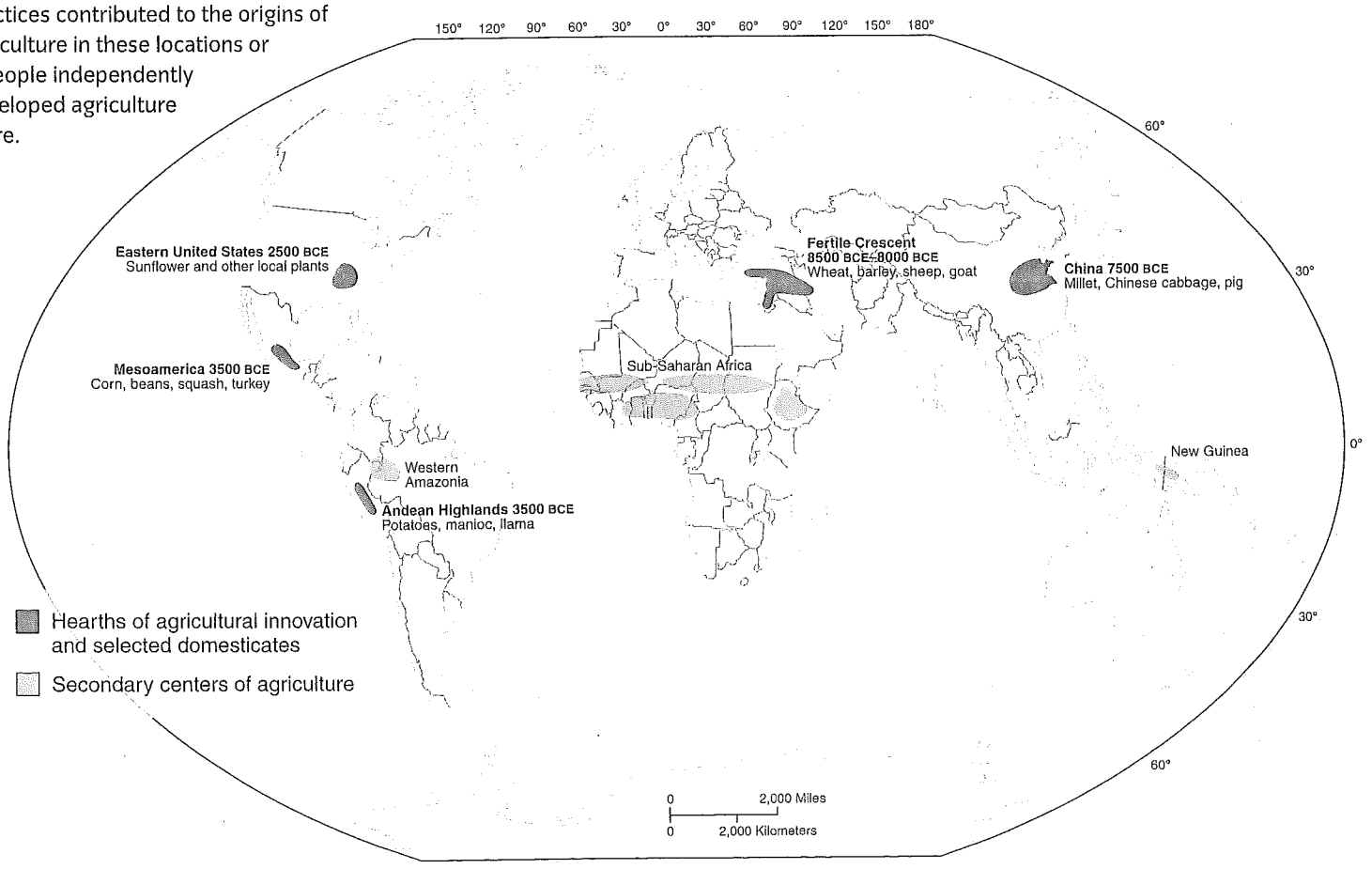
Moken

WILEY PLUS | NATIONAL GEOGRAPHIC Video

This video provides an introduction to the Moken people of Myanmar (Burma), sometimes called hunters and gatherers of the sea.

Hearths of agriculture • Figure 11.2

The map shows the five hearths of agricultural innovation and three secondary centers. They are secondary centers because it is not clear if diffusion of crops and food production practices contributed to the origins of agriculture in these locations or if people independently developed agriculture there.



THE PLANNER

Four-course crop rotation • Figure 11.3

This system, introduced to England from Holland in the 18th century, is based on a four-year planting regime. This crop cycle balances the planting of food crops with feed crops and incorporates legumes that enrich the soil. By removing the need for a fallow period, this practice also enables higher agricultural yields. Many variations on this system exist today.

Course 1 Small Grain Crop

A small grain, such as wheat, barley, rye, or oats is planted and provides a marketable crop.

Course 2 Root Crop

Fields planted to small grain crops are susceptible to weeds. Thus, root crops, such as turnips, are planted in rows that can be hoed to remove weeds. Turnips also provide feed for livestock.

The roots of the **second agricultural revolution** can be traced to new agricultural practices in western Europe. During the Middle Ages the adoption of two innovations, both of which likely originated in China, significantly raised farming yields. The first was the introduction of a curved metal plate used to make the moldboard plow, which enabled farmers to turn over heavy soils. The second was the use of the horse collar. Prior to the collar's introduction, farmers used oxen—much slower animals.

During the 17th and 18th centuries a modification in the technique of crop rotation helped boost farm yields. Traditional agricultural practice involved planting the same crop in a field each year, which reduced soil fertility; as a result, farmers were forced to periodically leave their fields uncultivated, or *fallow*, so that the soil could recover. The **four-course system** eliminated the fallow period entirely (Figure 11.3).

crop rotation Growing a sequence of different crops in the same field in order to maintain soil fertility and health.

In addition, as a result of the Industrial Revolution, more horse-drawn equipment was developed, while other tools improved the efficiency of farm practices. For example, Jethro Tull's seed drill placed seed directly into small holes. Before the seed drill, farmers often planted seeds by tossing handfuls of them into a field.

The Third Agricultural Revolution

Technological innovations and scientific farming techniques developed in the 20th century form the basis for the **third agricultural revolution.** More specifically, the third agricultural revolution includes extensive mechanization, heavy reliance on irrigation and chemical applications, and biotechnology. The third agricultural revolution is still in progress.

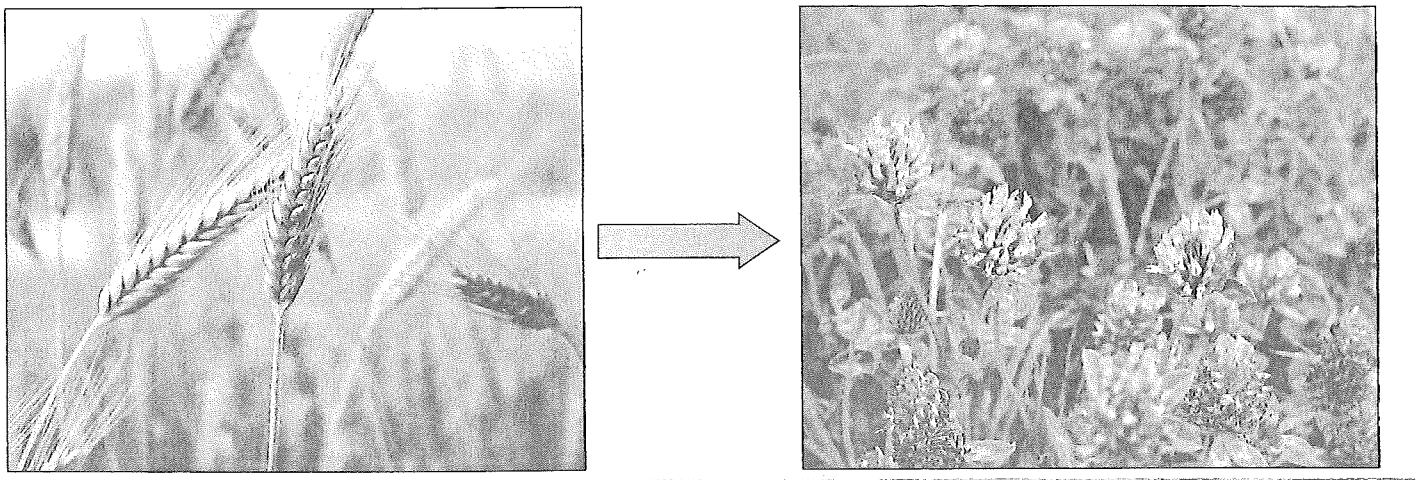
The internal combustion engine, developed in the late 19th century and improved during the 20th century, paved the way for the greater mechanization of agriculture, as gas and diesel engine tractors were more powerful and maneuverable than those powered by steam engines. Beginning in the United States, the tractor contributed to the transformation of agriculture in at least three significant ways. First, tractors reduced the number of laborers required for a

Course 3 Small Grain Crop

Barley is planted next, providing another marketable crop.

Course 4 Legume

A forage legume, such as clover, is planted. Legumes boost soil fertility by converting atmospheric nitrogen into a form more useful for plants. Livestock are grazed on the clover and their manure, also nitrogen rich, helps fertilize the soil.



particular task and simultaneously improved the efficiency and productivity of farming. Second, the tractor helped bring more land into cultivation. Third, tractors facilitated the shift to monoculture, leading to a substantial alteration of environments and landscapes. Similar impacts have occurred elsewhere as adoption and use of tractors continue.

monoculture
Planting a single crop in a field, often over a large area.

Scientific farming, another hallmark of the third agricultural revolution, relies on technology and synthetic chemicals to promote crop growth, deter crop disease, prevent weeds, or solve other agricultural challenges. Although irrigation has long been practiced, improved irrigation technologies have facilitated the spread of crops into areas once considered too dry for them. Since the 1960s, for example, the amount of irrigated land in the world has more than doubled. Although use of chemical fertilizers and pesticides has increased yields, our dependence on them has significant ecological costs—including pollution and greater reliance on petroleum, which is used to apply and manufacture many of them.

Agricultural biotechnology, or agro-biotech, is an additional facet of the third agricultural revolution. Broadly speaking, **agro-biotech** seeks to improve the quality and yield of crops and livestock through the use of such techniques as cross-breeding, hybridization, and, more recently, genetic engineering. The impact of agro-biotech developments on agriculture can best be understood by distinguishing between the Green Revolution and the Gene Revolution. In this context, *green* refers to the expansion of productive agriculture, not to the adoption of organic or eco-friendly practices in the way we popularly use the term today.

Green Revolution
The dramatic increase in grain production between 1965 and 1985 in Asia and Latin America from high-yielding, fertilizer- and irrigation-dependent varieties of wheat, rice, and corn.

Gene Revolution
The shift, since the 1980s, to greater private and corporate involvement in and control of the research, development, intellectual property rights, and genetic engineering of highly specialized agricultural products, especially crop varieties.

There are two fundamental differences between the Green Revolution and the Gene Revolution. The first is that innovations associated with the Green Revolution,

Geography InSight The Green Revolution • Figure 11.4

The Green Revolution grew out of an effort to alleviate world hunger. In the 1950s, scientists in Mexico developed a high-yield strain of wheat responsive to fertilizer and irrigation. High-yielding seed varieties were exported to India and Pakistan in the 1960s; in less than a decade, wheat production nearly doubled in both countries.

b. This farmer in the Punjab region of India examines his wheat crop.

a. The Green Revolution transplanted a new system of agriculture dependent on irrigation, heavy inputs of synthetic fertilizers, greater mechanization, and the monoculture of wheat or rice. (*Source*: Adapted from Borlaug and Dowswell, 2004.)

Year	Area irrigated in million hectares (acres)	Fertilizer nutrient use (million tons)	Tractors (millions)
1961	87 (215)	2	0.2
1970	106 (262)	10	0.5
1980	129 (319)	29	2.0
1990	158 (390)	54	3.4
2000	175 (432)	70	4.8

c. Government policies encouraged farmers to adopt this new system. These policies were implemented in India.

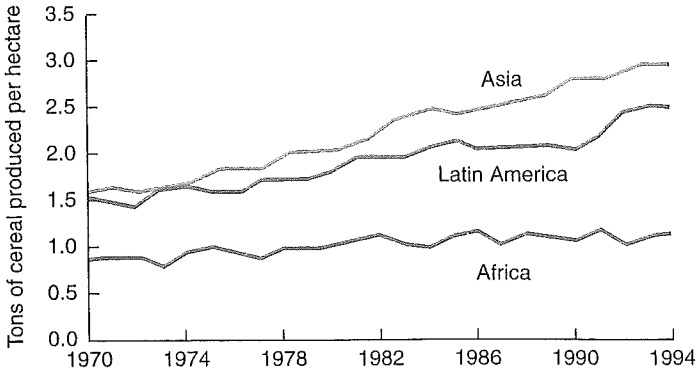
Selected government policies implemented in India

- A minimum support price for wheat and rice: If the market price of the grain fell below this price, the government reimbursed the farmer the difference. This policy lessened the financial risk of adopting high-yielding strains.
- Subsidies for synthetic fertilizer
- Subsidies on electricity, which is necessary to power well pumps for irrigation
- Increased opportunities for agricultural loans and credit-based purchases of various supplies (seeds, fertilizer, pesticides) and equipment

such as high-yielding varieties, were shared with governments and agencies in developing countries, whereas genetically engineered crops produced during the Gene Revolution have been protected by patents. The second difference is that the Gene Revolution is more closely associated with multinational corporations and the spread of global capitalism. See Figure 11.4 for a visual depiction of other facets of the Green Revolution.

The Green Revolution staved off famine in Asia and enabled India to become self-sufficient in grain production. However, yields have begun to level off, raising concerns about future food security. Will advances associated with the Gene Revolution help extend the gains of the Green Revolution? This is a contentious issue, in part because it leads many critics to question the motives for and consequences of the Gene Revolution. For

d. The diffusion of the Green Revolution has been highly uneven. Within Asia and Latin America, regions with more reliable rainfall and regions where irrigation is possible have benefited the most. Africa, which depends more heavily on other crops, such as sorghum, millet, and cassava, remains largely untouched by the Green Revolution.



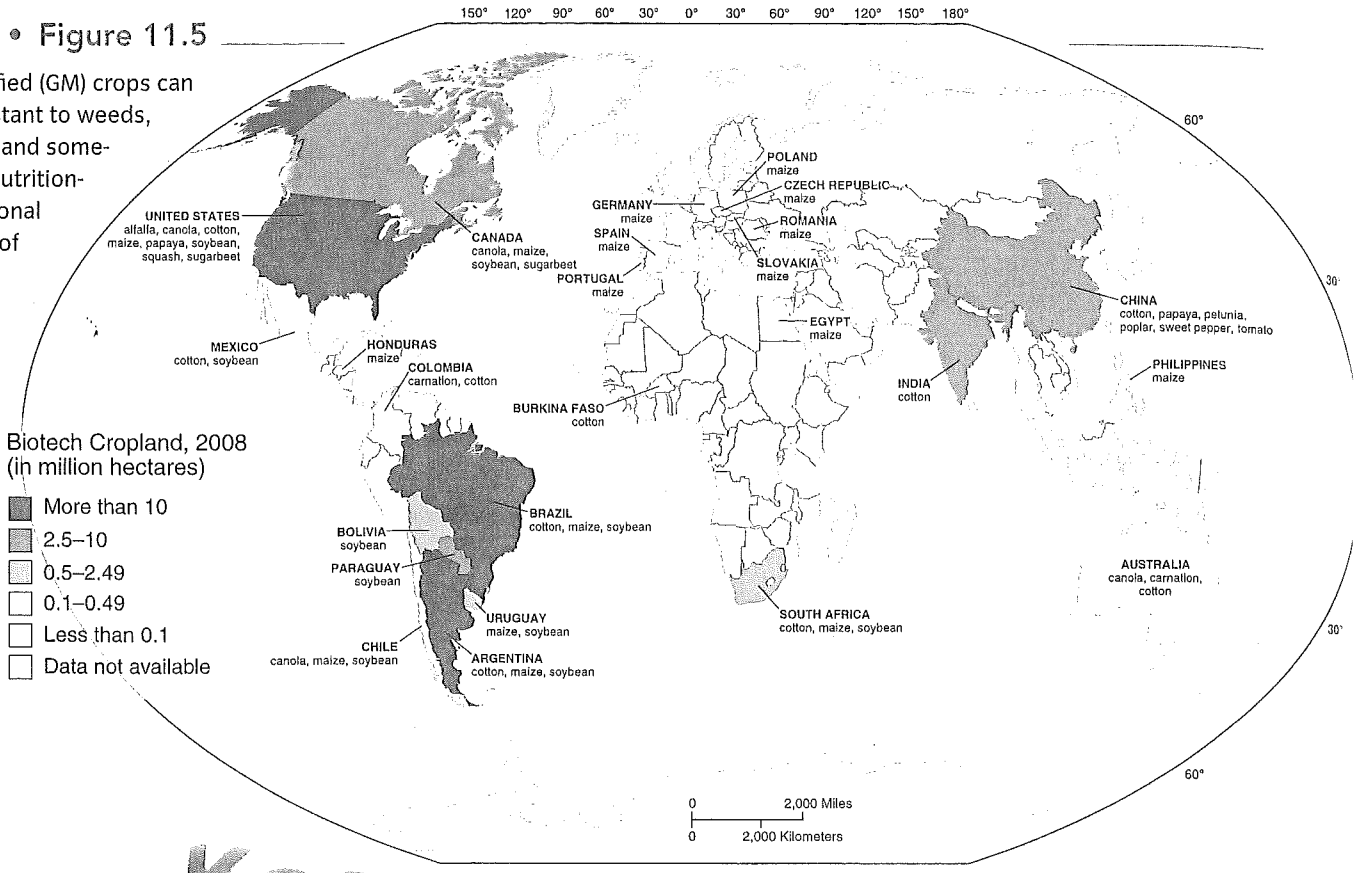
e. The Green Revolution has also brought about some problems. Farmers' debt has risen, groundwater has been overexploited, soil fertility has declined, and fertilizer and pesticide residues have built up in the environment. Ironically, pumps for irrigation are electric, but many households lack electricity and rely on dung, shown here being shaped into patties by a Punjabi woman, as a source of fuel.

example, whose interests are served when the genetic makeup of crops is protected by patents? Monsanto, an agro-biotech multinational, acquired the company that developed *terminator seeds*—seeds that produce sterile plants so that farmers have to purchase new seeds from Monsanto each year. Monsanto has not marketed these seeds because of public outcry, but the example is instructive nonetheless.

As we have seen, genetic engineering is an important part of the Gene Revolution. More specifically, genes with the code for certain traits, such as drought tolerance or stronger stalks, are transferred from one organism to another. Part of the controversy of this kind of genetic engineering is that genes from animals or even viruses can be transferred to crops in ways that are at odds with natural reproductive processes. Plants and animals changed as

GM cropping • Figure 11.5

a. Genetically modified (GM) crops can be made more resistant to weeds, pests, and disease, and sometimes have higher nutritional value than traditional crops. The number of countries planting GM crops climbed from 6 in 1996, the first year they were introduced, to 25 in 2008. GM varieties are used to plant about 40% of the total acreage sown to soybeans, maize (corn), cotton, and canola. (*Source*: Data from ISAAA, 2008.)



NATIONAL GEOGRAPHIC

b. GM crops remain controversial because they mix genes from different organisms. Also, some GM foods were originally marketed without labeling to indicate that they had been genetically modified. This protest is in London.

a result of biotechnology are referred to as *transgenic* or *genetically modified organisms* (GMOs). Proponents of this kind of genetic engineering consider it a viable means of overcoming environmental problems and generating more reliable yields, though the long-term ecological consequences of genetic engineering are not fully understood (Figure 11.5).

CONCEPT CHECK

STOP

1. Why do geographers distinguish between hearths of agriculture and secondary centers of agricultural innovation?
2. What agricultural advances led to the movement from the first to the second to the third agricultural revolutions?
3. What are the similarities and differences between the Green Revolution and the Gene Revolution?