9.1 Window on the World

CLASS SET

The Green Revolution Then and Now

The origin

In 1943, the Rockefeller Foundation provided funds to a group of U.S. agricultural scientists to set up a research project in Mexico aimed at increasing that country's wheat production through expansion of irrigation infrastructure, modernization of management techniques, distribution of hybridized seeds, synthetic fertilizers, and pesticides. Within 7 years, scientists were able to distribute the first modified wheat seeds to Indian farmers. Known as the Green Revolution, the project was eventually expanded to include research on maize as well. By 1967, Green Revolution scientists were exporting their work to other parts of the world and had added rice to their research agenda. Norman Borlaug, one of the founders of the Green Revolution, went on to win the Nobel Peace Prize in 1970 for promoting world peace through the elimination of hunger (**Figure 9.A**).

While the initial focus of the Green Revolution was on the development of seed varieties that would produce higher yields than those traditionally used in the target areas, eventually it came to constitute a package of inputs: new "miracle seeds," water, fertilizers, and pesticides. Farmers who use all of the inputs—and use them properly—can achieve the yields that scientists produced in their experimental plots, which are two to five times larger than those of traditional crops. In some countries, the resulting yields are high enough to enable export trade, generating important sources of foreign exchange. In addition, the creation of varieties that produce faster-maturing crops has allowed some farmers to plant two or more crops per year on the same land, increasing their individual production—and wealth—considerably.

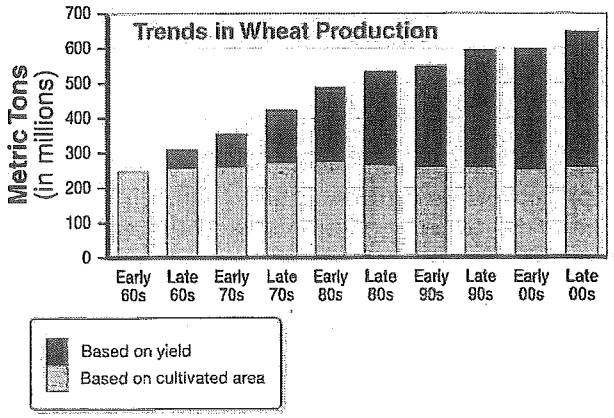
The effects

Thanks to Green Revolution innovations, rice production in Asia grew 66 percent between 1965 and 1985. India, for example, became largely self-sufficient in rice and wheat. Worldwide, Green Revolution seeds and agricultural techniques accounted for almost 90 percent of the increase in world grain output in the 1960s and about 70 percent in the 1970s. In the late 1980s and 1990s, at least 80 percent of the additional production of grains could be attributed to Green Revolution techniques. Thus, although hunger and famine persist, many argue that they would be much worse if the Green Revolution had never occurred (**Figures 9.B.1 and 9.B.2**).

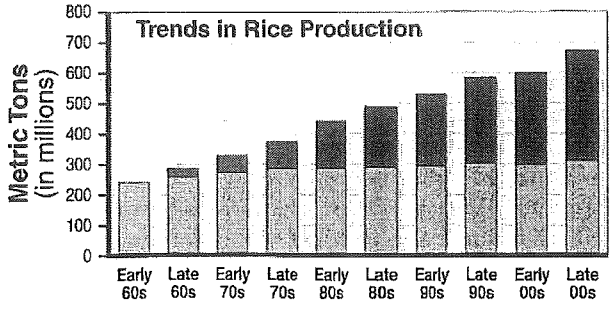
▲ **Figure 9.A Norman Borlaug** Known as the father of the Green Revolution, Borlaug was called "the man who saved a billion lives."

The Green Revolution has not been an unqualified success, however. One important reason is that wheat, rice, and maize are unsuitable crops in many global regions, and research on more suitable crops, such as sorghum and millet, has lagged behind. In Africa, poor soils and lack of water make progress more difficult to achieve. Another important factor is the vulnerability of the new seed strains to pest and disease infestation, often after only a couple of years of planting. Traditional varieties sometimes have a built-in resistance to the pests and diseases characteristic of an area but genetically engineered varieties often lack such resistance.

A social effect of the Green Revolution technology has been a decreased need for human labor. In southeastern Brazil, machines replaced farm workers, creating significant unemployment. Green Revolution technology and training have also tended to exclude women, who play important roles in traditional food production. In addition, the new agricultural chemicals, especially pesticides, have contributed to ecosystem pollution and worker poisonings, and the more intensive use of irrigation has created salt buildup in soils (*salinization*) and water scarcity (**Figure 9.C**).



▲ **Figure 9.B1** Wheat production This table shows the increases in yield achieved on either constant or decreasing amounts of land.



▲ **Figure 9.B2** Rice production As with the companion table on wheat, this table shows a trend of increasing rice yield, though rice yields absorb more land than wheat.

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	Biochemical	Mechanical	Social
Innovations	Hybrid seed selection, use of fertilizers, herbicides and pesticides	Diesel and electric pump powered irrigation, mechanization, transport improvements	Land reforms, loans, changes in distributive system
Consequences	Increased yields, weeds and pests controlled, increased costs for farmer, possible environmental degradation	Water supply controlled, less labor needed, increase in arable area, increase in access to markets	Farm consolidation, better seeds and other inputs available to poor farmers

▲ **Figure 9.C Three elements of the Green Revolution** Notice that the Green Revolution was not just a change in agricultural practices but a social change as well affecting not just the larger social system but individual farmers and farming households.

Criticism of the model

Critics have argued that the Green Revolution has magnified social inequities by allowing wealth and power to accrue to a small number of agriculturalists while causing greater poverty and landlessness among poorer segments of the population. In Mexico, a black market developed in Green Revolution seeds, fertilizers, and pesticides. Poorer farmers, coerced into using them, accrued high debts that they could not even begin to repay. Many lost their lands and became migrant laborers or moved to the cities and joined the urban poor.

The new seed varieties sometimes produce grains that are less nutritious, less palatable, or less flavorful. The chemical fertilizers and pesticides that must be used are derived from fossil fuels—mainly oil—and are thus subject to the vagaries of world oil prices. Furthermore, the use of these chemicals, as well as monocropping practices, has produced environmental contamination and soil erosion. Water developments have benefited some regions, but less well-endowed areas have experienced an exaggeration of already existing regional inequities. Worse, pressures to build water projects and to acquire foreign exchange to pay for importation of Green Revolution inputs have increased pressure on countries to grow even more crops for export, often at the expense of production for local consumption.

There are two final criticisms that have raised concern about the overall benefits of the Green Revolution. The first is that it has decreased the production of biomass fuels—wood, crop residues, and dung—traditionally used in many peripheral areas of the world. The second is that the Green Revolution has contributed to a worldwide loss of genetic diversity by replacing a wide range of local crops and varieties with a narrow range of high-yielding varieties of a small number of crops. Planting single varieties over large areas (monocultures) has made agriculture more vulnerable to disease and pests (Figure 9.D).

In response to these criticisms scientists are developing plants that will increase production of biomass in the form of animal fodder and fuel residues, as well as of food, and that will give optimal yields when intertilled—a very common practice in Africa. In the Sahel, scientists are working on crops that mature more quickly to compensate for the serious drop in the average length of the rainy season the region has recently experienced.

Despite criticisms, it is clear the global agricultural system has grown spectacularly. And yet, the rapid growth in agricultural output that was the hallmark of the twentieth century has declined in the twenty-first century to the point where demand is vastly outstripping supply, driven not just by population growth but also by changing food preference among developing countries like China. With consumption outstripping supply, stockpiles of wheat, rice, soybeans, and grain are also being diminished, creating serious concern among policymakers. As shown in Chapter 4, climate change has been identified as one of the most harmful and least easily remediable factors behind lessening food supplies. Drought in California, Ukraine, and Australia, linked to climate change, has cut agricultural production in these places and raised the price of food. Thus, while the Green Revolution has come under much justified criticism over the years, its main objective of finding innovative new ways to feed the world's peoples must be respected. In the process, the world's agricultural system has been expanded into hitherto very remote regions, and important knowledge has been gained about how to conduct science and how to understand the role that science plays in improving agriculture.

The **Borlaug hypothesis** (named after Norman Borlaug), states that because global food demand is on the rise, restricting crop usage to traditional low-yield methods (such as organic farming) requires either the world population to decrease or the further conversion of forest land into cropland. While there are signs that world population is beginning to decline, the Borlaug hypothesis—which is controversial—proposes that high-yield biotechnological techniques aimed at saving forest ecosystems from destruction are essential for saving the planet from ecological crisis. We discuss biotechnology and agriculture later in this chapter as well as the relative merits of sustainable organic agriculture and biotechnological commercial agriculture in the Future Geography section.

1. What is the Green Revolution? How is it different from the Blue Revolution?
2. What are three aspects of the Green Revolution that have made it controversial?

▲ **Figure 9.D Rice paddy, India** The introduction of high-yielding, semi-dwarf types of rice, starting in 1962 with the Green Revolution, emphasized the intensive use of fertilizers and pesticides. Rice production increased substantially. However, this achievement was made at a cost to the environment where semiaquatic organisms, including wild fish, frogs, shrimps, clams, and snails, which have always been part of these ecosystems, have disappeared. Moreover, to keep soil salinity low, a large quantity of additional water is needed but is seldom available resulting in soil degradation as well as species loss.

Prompt: Analyzing the causes and consequences of the Green Revolution, *evaluate the extent to which the Green Revolution was successful.*

Define the Green Revolution?		
Positive Effects	**vs.**	**Negative Effects**
	Social	
	Cultural	
	Economic	
	Environ-mental	
	Political	