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The Economics of World Wheat Markets: Implications for North America

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The Future of the Green Revolution: Implications for International Grain Markets

Robert W. Herdt

The term Green Revolution has been used by many different people to mean many different things. In this paper, the term is employed in a limited way to mean the rapid, widespread adoption of semi-dwarf rice and wheat varieties and chemical fertilizer that occurred between 1965 and 1985 in the countries of Asia, to some extent in Latin America, and to a limited extent in certain countries in Africa.

The record of the Green Revolution shows a dramatic increase in wheat production and important but less dramatic increases in rice production, from the early 1960s to the late 1980s. Wheat yields rose rapidly during this period, increasing by more than 300 percent in certain areas of Asia, but by only 70 percent in the rest of the world. During the same period, rice yields increased by more than 140 percent in certain areas of Asia, but by only 60 percent in other parts of the world.

Other factors are likely to be more important than biotechnology in future global grain markets.

Modern semi-dwarf varieties of wheat and rice were keys to the yield increases that drove the Green Revolution. A second component was the expansion of irrigated land areas with a 40 percent increase in China's irrigated area and a 70 percent increase in South Asia's irrigated area between the early 1960s and the late 1980s.

Fertilizer was the third component of the Green Revolution. With fertilizer use, yields increased by a factor of twenty in China as contrasted with a factor of less than three in the rest of the world. With the broad acceptance of semi-dwarf varieties and increased use of chemical fertilizer, any future Green Revolution will be generated by a new wave of technological change, presumably generated by biotechnology.

Genetic transformation and molecular markers are two of the primary tools of biotechnology. Transformation enables plant scientists to transfer genes from any source into plants in order to achieve stable intergenerational expression of encoded traits. Molecular marker techniques allow scientists to follow genes from one generation to subsequent generations.

Most current biotechnology research is being conducted in industrialized countries on crops of economic interest in those countries. Of the $2.5 billion in biotechnology research and development funding for agriculture expended worldwide annually, less than $75 million is spent in developing countries.

In recent years, the vast majority of the field trials, one of the last steps before seed is sold to farmers, have been conducted on maize, oil seeds, potatoes, and soybeans. Far fewer field trials have been conducted on rice, wheat, sorghum, and sugar cane—the crops, aside from maize, that provide food for people in developing countries. An estimated 85 percent of the field trials between 1986 and 1995 were conducted in the United States, Canada, and the European Union.

Herbicide resistance, in which a plant, such as a soybean, is made resistant to a broad spectrum herbicide, is the simplest trait to incorporate into a plant. As farmers are encouraged by manufacturers to use herbicides, production of transgenic crops with herbicide resistance is ensured.

Drought is a major problem for most plants. But what are the prospects of a drought resistance gene? Plant scientists recognize drought resistance as having many dimensions: long, thick roots; thick waxy leaves; the ability to produce viable pollen under drought stress; the ability to recover from a dry period, and others. Some of these traits can undoubtedly be controlled genetically, but little progress thus far has been made in identifying the genes that control them.

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Pest resistance genes will raise average yields by preventing damage. While the Green Revolution raised yields through plant breeding, there is little prospect for dramatic changes in yield potential through biotechnology. Hybrid rice is the one exception.

Any future Green Revolution will occur gradually over a period of years. It is unlikely that the impact of molecular biology will be dramatic. An adequate response to the concern relative to the implications of the Green Revolution has two facets for the global grain markets.

First, because the majority of plant biotechnology research is being conducted in industrialized countries, it is likely that any changes in comparative advantage that result will accrue to those countries. The first wide-scale plantings of genetically engineered corn borer-resistant corn and genetically engineered herbicide resistant soybeans were made in the United States in 1996. North American production would be expected to gain relative to other regions.

Relatively little investment has been made in downstream biotechnology on wheat in either the industrialized countries or developing world. Little impact on the global wheat market is expected from genetic engineering. However, rice has been the subject of concerted biotechnology efforts with the expectation that improvements in productivity will result.

Second, changes in the relative efficiency of crops to provide desired product characteristic or functions will be more important than changes in comparative advantage across regions. Even prior to genetic engineering, conventional breeding methods produced canola. Canola has taken market share from corn and other vegetable oils. Oilseed rape is now the subject of extensive and successful genetic engineering efforts. Markets once served by coconuts and soybeans have been eroded by edible rapeseed oils.

The conclusion is that factors other than biology are likely to be more important in global grain markets, at least more important than the productivity effects of biotechnology. For one, the public apprehensions about biotechnology coupled with opportunism have already led to demands for trade barriers against genetically engineered crops.

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About the Author

Robert W. Herdt is Director of Agricultural Sciences and Acting Director for Global Environment at the Rockefeller Foundation. He obtained his Ph.D. from the University of Minnesota. His research interests include agricultural development and the rice economy of Asia.