A 2020 Vision for Food, Agriculture, and the Environment

2020 VISION

Biotechnology for Developing-Country Agriculture: Problems and Opportunities

Overview

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Today, almost a billion people live in absolute poverty and suffer from chronic hunger. Seventy percent of these individuals are farmers—men, women, and children—who eke out a living from small plots of poor soils, mainly in tropical environments that are increasingly prone to drought, flood, bushfires, and hurricanes. Crop yields in these areas are stagnant and epidemics of pests and weeds often ruin crops. Livestock suffer from parasitic diseases, some of which also affect humans. Inputs such as chemical fertilizers and pesticides are expensive, and the latter can affect the health of farm families, destroy wildlife, and contaminate water courses when used in excess. The only way families can grow more food and have a surplus for sale seems to be to clear more forest. Older children move to the city, where they, too, find it difficult to earn enough money to buy the food and medicine they need for themselves and their young children.

As these detrimental social and environmental changes are occurring in the developing world, a revolution in biotechnology and associated information technology is improving the health, well-being, and lifestyle of the privileged and creating more wealth in a few rich countries. Can this revolution also be harnessed to serve the food and nutrition needs of the world's poor? What are the opportunities, problems, and risks involved with the new technologies and can they be managed? The last question is particularly pressing in light of the current controversy between the United States and the European Union over genetically modified foods. The benefits and risks of biotechnology weigh differently for food in areas of food surplus than they do for life-threatening diseases in those same areas.

OPPORTUNITIES

In 1998 the global market for biotechnology products (see box for definition of terms) totaled at least US$13 billion. About 80 products, most of them medically related, are on the market or nearly ready for it. In recent years, the fruits of two decades of intensive and expensive research and development (R&D) in agricultural biotechnology has begun to pay off. Approximately 28 million hectares of land were planted with 40 transgenic crops in 1998. Most of these crops were new varieties of cotton, corn, soybean, and rapeseed. Developing countries held 15 percent of the area planted with the transgenic varieties.

Most biotechnology-based solutions for agriculture are likely to be delivered in the form of new plant seeds or new strains of livestock. These solutions continue the tradition of selection and improvement of cultivated crops and livestock developed over the centuries. The difference is that new gene technology identifies desirable traits more quickly and accurately than conventional plant and livestock breeding. Modern biotechnology can also introduce the genes that control desirable traits into plant and animal strains with far greater precision and control than can conventionalmethods.

Definitions of Biotechnology and its Component Technologies

Biotechnology is any technique that uses living organisms or substances from those organisms to make or modify a product, improve plants or animals, or develop microorganisms for specific uses. The key components of modern biotechnology are

- **Genomics: themolecular characterization of all species;**
- **Bioinfomatics: the assembly of data from genomic analysis into accessible forms;**
- **Transformation: the introduction of single genes conferring potentially useful traits into plant, livestock, fish, and tree species;**
- **Molecular breeding: the identification and evaluation of desirable traits in breeding programs with the use of marker-assisted selection;**
- **Diagnostics: the use of molecular characterization to provide more accurate and quicker identification of pathogens;**
- **Vaccine technology: use of modern immunology to develop recombinant DNA vaccines for improving control of lethal diseases.**

Biotechnology applications in agriculture are in their infancy. The first generation of genetically engineered plant varieties have been modified only for a single trait, such as herbicide tolerance or pest resistance. The rapid progress being made in genomics will transform plant, tree, and livestock breeding as the functions of more genes are identified. Breeding for complex traits such as drought tolerance, which is controlled by many genes, should then become common. This is an area of great potential benefit for tropical crops, which are often grown in harsh environments and on poor soils.

To determine if modern biotechnology can benefit the poor in developing countries, policymakers at the national, regional, and international levels need to analyze the problems that are currently constraining agricultural productivity or damaging the environment, assess whether these problems may be solved by integrating modern biotechnology with conventional R&D, and prioritize solutions. This may seem self-evident but such strategic analyses are indispensable for anticipating the potential benefits and risks that may arise while using modern biotechnology to solve specific problems. In addition to analyses, both public and private resources for R&D need to be mobilized if the poor in developing countries are to profit from the genetic revolution.

POLICY FRAMEWORK

Modern biotechnology will not solve all the problems of food insecurity and poverty. But it could provide a key component to a solution if given the chance, and if steered by a set of appropriate policies. These policies should guide (1) increased public investments in R&D, including that in modern biotechnology; (2) regulatory arrangements that inform and protect the public from any risks arising from the release of genetically modified organisms (GMOs); (3) intellectual property management to encourage greater private-sector investment; and (4) regulation of the private seed and agricultural research sector to protect the interests of small farmers and poor consumers in developing countries.

Public-sector R&D. Pro-poor policies can help expand agricultural R&D, including traditional and modern biotechnological research, in order to solve problems of particular importance to the poor. The problems of orphan commodities (important subsistence food and/or tropical export commodities that hold little commercial interest for the private sector) require particular attention. Given the high rates of return, more public support for agricultural R&D should be encouraged in most developing countries. Additional public financial support for R&D at the national, regional, and international levels would help to develop public goods the poor can afford.

Biosafety. The term biosafety describes a set of measures used to assess and manage any risks associated with GMOs. Such risks may transcend or be inherent in the technology and need to be managed accordingly. Technology-transcending risks emanate from the political and social context in which the technology is used. They include concerns that biotechnology may increase the prosperity gap between the rich and the poor, and may contribute to a loss of biodiversity. Ethical concerns about patenting living organisms and moving genes between species also fall into this category.

The principles and practices for assessing and managing technology-inherent risks are well established in several countries. They take into account the nature of the organism, the familiarity of the product, any distinguishing features of the process by which a product was produced, and the environment into which it will be introduced. A science-based assessment of these factors on a case by case basis, and identification of any concerns expressed by stakeholders, enable regulators to find out what risks may be associated with a particular product and to make appropriate recommendations. A regulatory system that enjoys the confidence of the public and the business and farming communities is essential for the effective use of biotechnology. The current and proposed international agreements that govern movements of GMOs also contribute to biosafety.

Intellectual Property Management. The purpose of intellectual property management is to protect local inventions and enable access to technologies developed elsewhere. Trade-related intellectual property rights (TRIPs) are a matter of ongoing concern within the World Trade Organization. The present patent system favors those countries that have a strong innovation base. Despite much effort, no satisfactory system exists to recompense traditional owners and improvers of germplasm. The lack of intellectual property protection also constrains private-sector investment in developing countries.

The Private Sector. The participation of the private sector is critical to the development and delivery of new biotechnology products. The enabling environment to encourage private-sector participation includes a regulatory system that accurately informs the public of the benefits and risks involved in the use of new technologies; a legal framework for protecting intellectual property; adequate infrastructure for power, transport, and telecommunications; a fair tax system and investment incentives; a skilled workforce, including a well-supported university sector; public funding for R&D; and incentives to establish innovative public-private collaboration and joint ventures at the national and international levels.

DELIVERING SOLUTIONS FOR THE POOR

The successful application of modern biotechnology to the problems that cause undernourishment and poverty could be called a biosolution. The delivery of new biosolutions to the problems of food security and poverty will require continual policy development and actions at the national, regional, and international levels. These efforts will involve the following five areas: (1) determining priorities and assessing relative risks and benefits in consultation with the poor, who are often overlooked while others decide what is best for them; (2) setting policies that benefit the poor and that minimize technology-transcending risks that adversely affect the poor; (3) establishing an environment that facilitates the safe use of biotechnology through investment, regulation, intellectual property protection, and good governance; (4) actively linking biotechnology and information technology so that new scientific discoveries worldwide can be assessed and applied to the problems of food insecurity and poverty in a timely manner; and (5) determining what investments governments and the international development community will have to make in human and financial resources in order to ensure that biosolutions to the problems of food security reach the poor. ■

For further information, see John J. Doyle and Gabrielle J. Persley, New Technologies: An International Perspective, in *Investment Strategies for Agriculture and Natural Resources: Investing in Knowledge for Development*, ed. G. J. Persley (Wallingford, U.K.: CABI, 1998); and Ernst and Young, *Bridging the Gap*, 13th biotechnology industry annual report, 1999 (available through www.ey.com).

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