A 2020 Vision for Food, Agriculture, and the Environment

2020 VISION

# Biotechnology for Developing-Country Agriculture: Problems and Opportunities

## Developing Appropriate Policies

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Modern biotechnology can enhance agricultural productivity in developing countries in a way that further reduces poverty, improves food security and nutrition, and promotes sustainable use of natural resources. But such benefits from biotechnology require policy action on a number of fronts. The small farmer in developing countries faces a variety of problems and constraints. Crop losses due to insects, diseases, weeds, and drought threaten income and food availability. Acid soils, low soil fertility and lack of access to reasonably priced plant nutrients, and other biotic and abiotic factors also contribute to low yields. Poor infrastructure and dysfunctional markets for inputs and outputs, along with lack of access to credit and technical assistance, add to the problems plaguing the small farmer. Solutions to these problems will benefit both farmers and consumers. Although modern biotechnology cannot solve all these problems, it can provide a critical component to the solution if it is guided by appropriate policies. Four sets of policies are particularly important. Each of these is briefly discussed below.

### POLICIES TO GUIDE RESEARCH FOR THE POOR

Policies must expand and guide research and technology development to solve the problems of particular importance to the poor. These problems include diets with inadequate levels of energy, protein, and micronutrients, and crop losses due to biotic and abiotic factors. Research should focus on the crops of particular importance to small farmers and poor consumers in developing countries. Bananas, cassava, yams, sweet potatoes, rice, maize, wheat, and millet, along with livestock products, feature most prominently in the diets and production activities of the poor. Except for limited work on rice, bananas, and cassava, little biotechnology research currently focuses on helping the small farmer and poor consumer solve their productivity and nutrition problems. The prediction so often heard that the poor in developing countries are unlikely to benefit from modern agricultural biotechnology in the foreseeable future could well come true—not because the technology has little to offer but because it will not be given a chance.

#### *Allocate Additional Public Resources to Agricultural Research*

There are three ways to expand biotechnology research for the benefit of the poor. First, allocate additional public resources to agricultural research, including biotechnology research, that promises large social benefits. Existing national and international agricultural research systems have to be strengthened or new ones built. Low-income developing countries currently invest less than 0.5 percent of the value of agricultural production in agricultural research, compared to about 2 percent in developed countries. Underinvestment is widespread despite high annual economic rates of return from investments in agricultural research. A recent assessment of more than 1,000 research projects and programs found an average annual rate of return of 88 percent. Investments by the private sector are limited to research that permits a large enough profit from the returns. Nonetheless, privately funded research can still generate large benefits to farmers and consumers, as illustrated by a recent study of the distribution of benefits from the use of genetically modified (GM) soybeans in the United States. The private patent holders and private seed companies captured one-third of the total economic benefits, farmers and consumers gained two-thirds. While private-sector agricultural research has increased rapidly in the industrialized countries during the last 10 to 15 years, it currently accounts for a small share of agricultural research in most developing countries.

#### *Convert Some Social Benefits to Private Benefits*

Second, expand private-sector research for the poor by converting some of the social benefits of research to private benefits for the private sector. The public sector can entice the private sector to develop technologies for the poor by offering up front to buy the exclusive rights to newly developed technology and make it available either for free or for a nominal charge to small farmers. The amount of the offer could be determined on the basis of expected social benefits, using an annual rate of return normally expected from agricultural research, for example, 60–80 percent. The risk of failing to develop the specified technology would rest with the research agency, just as it does when technology is developed for the market. The public sector offer would come due to the research agency that first develops the technology, but only when the technology is developed, tested, and made available. Both private- and public-sector agencies could participate in this research. Opportunities for collaboration between multinational life science companies and public-sector agricultural research agencies in both developing and developed countries might increase the probability of success. With necessary refinements, the arrangement proposed here should be of interest to international development assistance agencies. This proposal builds on a similar idea that Jeffrey Sachs of Harvard University proposed for developing vaccines for tropical diseases.

***Protect Intellectual Property Rights***

The third way to expand biotechnology research to help the poor is to protect the intellectual property rights of a private research agency that develops a particular technology, for example, seed with infertile offspring, or that contracts directly with the farmer, in both cases forcing the farmer to buy new seed every season. This would make it easier for the private sector to recuperate the incomes needed to justify the research. But seeds with infertile offspring may be inappropriate for small farmers in developing countries because they pose large risks to food security. Existing infrastructure and production processes may not be able to keep fertile and infertile seeds apart. Small farmers could face severe consequences if they planted infertile seeds by mistake. Monitoring and enforcing contracts that prohibit large numbers of small farmers from using the crops they produce as seed would be expensive and difficult to do.

## POLICIES TO PROTECT AGAINST HEALTH RISKS

GM foods are not intrinsically good or bad for human health. Their health effect depends on their specific content. GM foods with a higher content of digestible iron are likely to benefit consumers with iron deficiencies. But the transfer of genes from one species to another may also transfer characteristics that cause allergic reactions. Thus, GM foods need to be tested for allergy transfers before they are commercialized. It was precisely such testing that avoided the commercialization of maize with a Brazil nut gene. GM foods with possible allergy risks should be fully labeled. Labeling may also be needed to identify content for cultural and religious reasons or simply because consumers want to know. Finally, labeling may be required to identify the production process itself when that, rather than any specific health risk, interests consumers.

Failure to remove antibiotic-resistant marker genes used in research before a GM food is commercialized presents a potential although unproven health risk. Recent legislation in the European Union requires that such marker genes be removed before a GM food is deemed safe for consumers. Risks and opportunities associated with GM foods should be integrated into the general food safety regulations of a country.

## POLICIES TO ADDRESS ECOLOGICAL RISKS

Effective national biosafety regulations should be in place before modern biotechnology is introduced into a country's agriculture. Such regulations should be country-specific and reflect relevant risk factors. The ecological risks policymakers need to assess include the spread of traits such as herbicide resistance from genetically modified plants to plants (including weeds) that are not modified, and the build-up of resistance in insect populations. Seeds that produce infertile offspring may be an effective solution to the risk associated with cross pollination but, as mentioned earlier, they may be inappropriate for small farmers. The approach used to develop terminator seeds, however, offers great promise for the development of a seed that will avoid the spread of new traits through cross-pollination. The seed would contain the desired traits, such as pest resistance or drought tolerance, but each trait would be activated only after treatment with a particular chemical. Without treatment, the seed would maintain its normal characteristics. Thus, if a farmer planted an improved seed, the offspring would not be sterile; rather they would revert back to being normal seeds (before improved traits were introduced). The farmer would then have the choice of planting the normal seed or bringing back the improved traits by applying a particular chemical. Contrary to the terminator gene, this approach complies with the principle of doing no harm.

Both food safety and biosafety regulations should reflect international agreements and a society's acceptable risk levels, including the risks associated with not using modern biotechnology to achieve desired goals. The poor should be included directly in the debate and decisionmaking about their desire for technological change, the risks of that change, and the consequences of no or alternative kinds of change.

## POLICIES TO REGULATE THE PRIVATE SECTOR

Recent mergers and acquisitions have resulted in increasing concentration among companies engaged in biotechnology research. The outcome of this growing concentration may be reduced competition, monopoly or oligopoly profits, exploitation of small farmers and consumers, and successful efforts to gain special favors from governments. Effective antitrust legislation and institutions to enforce the legislation are needed, particularly in small developing countries where one or only a few seed distribution companies operate. Effective legislation is also required to enforce intellectual property rights, including those of farmers to germplasm, along the lines agreed to within the frameworks of the World Trade Organization and the Convention on Biological Diversity.

## CONCLUSIONS

Modern biotechnology research may help reduce poverty, improve food security and nutrition, and make the use of natural resources more sustainable, only if it focuses on the problems and opportunities poor people in developing countries face and only if appropriate policies accompany it. Modern biotechnology is not a silver bullet, but it may be a powerful tool in the fight against poverty and should be made available to poor farmers and consumers. ■

**For further information, see Per Pinstrup-Andersen, Rajul Pandya-Lorch, and Mark W. Rosegrant, *World Food Prospects: Critical Issues for the Early 21st Century*, 2020 Food Policy Report (Washington, D.C.: IFPRI, 1999); Per Pinstrup-Andersen, Modern Biotechnology and Small Farmers in Developing Countries, *Research Perspectives* (IFPRI newsletter), vol. 21, no. 2, 1999; and Nuffield Council on Bioethics, *Genetically Modified Crops: The Ethical and Social Issues* (London: Nuffield Council on Bioethics, 1999).**

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