No: Poor Farmers Won't Reap the Benefits

by Miguel A. Altieri

Most proponents of biotechnology portray genetically modified (GM) crops as high-tech manna that will not only help feed the 840 million undernourished people in the world, but will also ease the poverty of the more than 1.3 billion who live on less than $1 per day. Biotech researchers promise new crop varieties that are drought tolerant, resistant to insects and weeds, and enhanced with vital nutrients such as vitamin A and iron. Increased agricultural productivity supposedly will reduce the costs of production and lead to lower food prices.

But before everyone rushes to embrace biotechnology as the solution to feeding the developing world, it is best to remember the maxim that if something seems too good to be true, it probably is. The putative benefits of GM crops may never become reality for the world's rural poor, especially since impoverished farmers will not be able to afford the seeds, which are patented by biotech corporations. Moreover, GM crops could devastate already fragile ecosystems by wiping out indigenous species of plants and insects that have thrived for centuries. This loss of biodiversity has serious implications for food security throughout the developing world: By planting fewer and fewer species of crops, farmers may increase

MIGUEL ALTIERI *is professor of agroecology at the University of California, Berkeley, and chair of the NGO Committee of the Consultative Group of International Agricultural Research (CGIAR), based in Washington, D.C.*

the risk of famine since, in the future, those crops might prove vulnerable to changing climatic conditions or unforeseen diseases.

Although such scenarios have not yet come to pass, GM crops are already eroding food security in the developing world. The seduction of biotechnology has begun to divert public attention and precious resources from more reliable methods of increasing agricultural productivity—proven agroecological techniques that will not only enhance the livelihood of the rural poor, but that will preserve the environment.

Reality Check

Biotech advocates who argue that GM crops are the solution to world hunger tend to overlook the real problem. We are constantly bombarded with statistics implying that food production is failing to keep pace with a global population that is growing by an estimated 77 million people each year. This statistical bombardment persists despite the absence of a proven relationship between the prevalence of hunger in a given country and the density of its population. For every densely populated and hungry nation such as Bangladesh or Haiti, there is a sparsely populated and hungry nation such as Brazil or Indonesia. Indeed, between the late 1960s and the early 1990s, the number of undernourished people fell by only 80 million, even as the amount of food available per capita increased and global food prices declined.

Poverty is the key reason why 840 million people (most of whom live in the developing world) do not have enough to eat. At present, hunger is not a matter of agricultural limits but a problem of masses of people not having sufficient access to food or the means to produce it. At most, biotechnology has the yet-unrealized potential to improve the quality of and increase the quantity of food—but there is no guarantee that this food will be made available to those who need it most.

In the last 25 years, enough food was produced to feed everyone in the world, had that food been more evenly shared. But the truth is that there is no global mechanism in place to undertake such a massive redistribution. Instead, food is rushing to countries that already have more than enough to eat. Developing nations with swelling populations need to become truly self-sufficient. In order to achieve this goal, they must increase food production by improving their domestic agricultural systems. However, this task is constrained by considerable environmental obstacles. An estimated 850 million people live on land threatened by desertification. Another 500 million reside on terrain that is too steep to cultivate. Most of the rural poor live in the latitudinal band between the Tropic of Cancer and the Tropic of Capricorn, the region that will be most vulnerable to the effects of global warming.

Biotech researchers pledge to counter problems associated with food production and distribution by developing GM crops with traits considered desirable by small farmers, such as enhanced competitiveness against weeds and drought tolerance. These new attributes, however, would not necessarily be a panacea. Traits such as drought tolerance are polygenic, which means they are determined by the interaction of multiple genes. Consequently, the development of crops with such traits is a complex process that could take at least 10 years. And under these circumstances, genetic engineering does not give you something for nothing. When you tinker with multiple genes to create a desired trait, you inevitably end up sacrificing other traits, such as productivity. As a result, use of a drought-tolerant plant would boost crop yields by only 30 to 40 percent. Any additional yield increases would have to come from improved environmental practices (such as enhancing soil cover for improved water retention) rather than from the genetic manipulation of specific characteristics.

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Even if biotechnology contributes to increased crop harvests, poverty will not necessarily decline. Many poor farmers in developing countries do not have access to cash, credit, technical assistance, or markets. The so-called Green Revolution of the 1950s and 1960s bypassed such farmers because planting the new high-yield crops and maintaining them through the use of pesticides and fertilizers was too costly for impoverished landowners. Data show that, in both Asia and Latin America, wealthy farmers with larger and better-endowed lands gained the most from the Green Revolution, whereas farmers with fewer resources often gained little. The "Gene Revolution" might only end up repeating the mistakes of its predecessor. Genetically modified seeds are under corporate control and patent protection; consequently, they are very expensive. Since many developing countries still lack the institutional infrastructure and low-interest credit necessary to deliver these new seeds to poor farmers, biotechnology will only exacerbate marginalization.

Moreover, poor farmers do not fit into the marketing niche of private corporations, which focus on biotechnological innovations for the commercial-agricultural sectors of industrial and developing nations, where these corporations expect a huge return on their research investment. The private sector often ignores important crops such as cassava, which is a staple for 500 million people worldwide. The few impoverished landowners who will have access to biotechnology will become dangerously dependent on the annual purchase of genetically modified seeds. These farmers will have to abide by onerous intellectual property agreements not to plant seeds yielded from a harvest of bioengineered plants. Such stipulations are an affront to traditional farmers, who for centuries have saved and shared seeds as part of their cultural legacy. Some scientists and policy makers suggest that large investments through public-private partnerships can help developing countries acquire the indigenous scientific and institutional capacity to shape biotechnology to suit the needs and circumstances of small farmers. But once again, corporate intellectual property rights to genes and gene-cloning technology might play spoiler. For instance, Brazil must negotiate license agreements with nine different companies before a virus-resistant papaya developed with researchers at Cornell University can be released to poor farmers.

An Environmental Time Bomb

Biotechnology threatens to exacerbate environmental problems in the developing world. The marketing strategy of biotech corporations is to create broad international seed markets for a single commodity—a practice that tends to foster genetic homogeneity. Although some degree of crop uniformity may have certain economic advantages, it has serious ecological drawbacks. History has shown that a huge area planted with a single crop species is highly vulnerable to changing climatic conditions or the emergence of a new, matching strain of a pathogen or pest. For instance, all of the potatoes planted in 19th-century Ireland were descendants of just two genetic varieties, both of which lacked resistance to the blight that plunged the country into famine. Similarly, in the 1970s, Soviet farmers planted 40 million hectares with a new variety of a so-called miracle grain that, despite careful testing, proved unable to survive Russia's harsh winters.

In the developing world, many native crop species are resistant to pests, adapt well to marginal environments, and allow farmers to cope with varying climates. The widespread planting of a single crop species leads to a loss of genetic diversity that reduces the options for farmers in the future.

Biotech crops pose a threat to biodiversity not only by crowding out indigenous species, but by breeding with them. The transfer of genetic traits from crops to other related species through the spread of pollen and seeds is always a concern. But in the developing world, where many countries constitute centers of genetic diversity (tropical forests alone host as much as 90 percent of the world's species), crossbreeding is likely to occur more frequently and with more serious consequences. An environmental group in Chile warns that genetically modified potatoes could contaminate 165 indigenous potato crops grown on Chiloe Island by Huilliche Indians. Especially worrisome is the possibility that GM crops—endowed with traits such as resistance to viruses, insects, and herbicides—might pass those characteristics along to wild relatives, thereby creating "superweeds" that will proliferate in farmers' fields. Today's miracle crops may be the progenitors of tomorrow's invasive species.

Another example of how the development of "beneficial" traits can backfire is the case of Bt corn—which uses a gene derived from the *Bacillus thuringiensis* bacterium to produce a substance specifically toxic to corn borers. But such a substance might be lethal to other insects. A recent European laboratory study demonstrated that the mortality rate of the green lacewing (an insect that preys on crop pests such as aphids) increased by two thirds after it ingested insects that had fed on Bt corn. Ecologists have also discovered that the Bt toxin remains active in the soil for at least 234 days after the crop is plowed under. The Bt toxin can kill important soil organisms, affecting processes such as the breakdown of organic matter, which is essential to soil fertility. This discovery is of serious concern to most poor farmers who cannot purchase expensive chemical fertilizers but who must rely instead on local organic inputs for crop nutrition.

A Better Solution

Alternatives to reinventing agriculture through biotechnology already exist in the developing world. A perfect example is the problem of vitamin A deficiency, which threatens the health of as many as 250 million children worldwide. Genetically modified rice capable of producing

Killing the Canary

Imagine a field of crops filled with weeds, insects, and birds. Those weeds, and the animals that feed on them, can reduce harvests and might carry crop diseases. Now picture another field of crops—this one made up of genetically modified plants—free from weeds and largely devoid of wildlife. Much better, right? Surely this is the way farm fields should be.

Or maybe not. Biotechnology has given us fields of insect-resistant and herbicide-tolerant corn, beets, and canola. But in doing so, it might have deprived us of a very valuable early warning system.

We can learn from past mistakes. Thirty years ago, ecologists in the United Kingdom discovered that the falcon population was declining in cropped areas. Accomplished predators, the falcons were preying on small birds and mammals that were feeding on plants and insects in areas sprayed with the pesticide DDT. It soon became clear that something alarming was happening in farmers' fields: Accumulating levels of DDT and other pesticides were making their way up through the food chain to the falcons. The afflicted falcons laid thin-shelled eggs that did not survive. Had these toxic chemicals found their way into human beings, they could have damaged our reproductive and nervous systems.

Like canaries in a coal mine, the wildlife that lives within crops gives us a cheap and easy way of detecting potentially dangerous effects of pesticides before the food involved ever reaches human stomachs. In developing countries, where farmers sometimes use pesticides banned in industrialized nations, public safety may depend on monitoring farmland wildlife. The illegal use of locally made DDT on crops in India has caused a slump in vulture populations, showing that the early warning system still operates there.

As modern farming clears fields of wildlife, this mechanism is fading fast. Over vast tracts of landscape, native species are confined to roadsides, woodlands, and riverbanks, but are rarely in direct contact with crops. In the future, it would be wise to allow weeds and insects to thrive on the outskirts of both genetically modified and conventional crops, not only to preserve biodiversity in our increasingly bleak farmlands but to keep the canary alive and well.

–Dr. Brian Johnson
Head of the Biotechnology Advisory Unit at English Nature

vitamin A is being heralded by the biotech community as the best hope for these children. But food preferences in rural areas of the developing world are culturally determined, and it is unlikely that Asians will consume this "orange rice" while traditional white rice is plentiful. Providing a rich alternative source of vitamin A, both wild and cultivated leafy greens grow in abundance in and around paddy rice fields. Although these greens are peripheral to the diet of the peasant household, many peasant communities gather them to supplement family nutrition and income. Lack of awareness is often the key reason why these vitamin-rich vegetables do not play more of a role in the family diet throughout the developing world. Ironically, biotechnology threatens the viability of these leafy green plants. Because some GM crops are resistant to weed-killing herbicides, farmers are inclined to spray large amounts of chemicals, such as glyphosate, that kill all plants except the genetically modified ones.

Much of the food needed in the developing world can be produced by small farmers using "agroecological" technologies, which foster self-reliance and protect the environment. Agroecology emphasizes the conservation of vital resources (soil, water, and financial capital), the use of natural inputs (such as organic fertilizers) instead of synthetic toxic products, the diversification of crops, and social processes that emphasize community participation and empowerment. For example, in Central America, thousands of hillside farmers are using the bean *Mucuna deeringiana* ("velvet bean") as "green manure"—a term to describe a crop that is plowed under to act as fertilizer. Green manure crops provide large quantities of nitrogen for soil, protect the land from wind and water erosion, and even provide a potential source of fodder to be sold or fed to animals. But unlike chemical fertilizers, they are nontoxic, inexpensive, and self-sustaining. Central American farmers who have integrated green manure into their soil have more than doubled corn production while conserving topsoil—even amid the destruction wrought by Hurricane Mitch.

Such approaches, now being spearheaded by farmers' groups and nongovernmental organizations throughout the developing world, are already making a significant contribution to food security at household, national, and regional levels in Africa, Asia, and Latin America. Increasing the agricultural productivity of small landowners not only expands food supplies, but reduces poverty among the people who are perpetually denied the benefits of the "new-and-improved" agricultural technologies periodically introduced to the developing world. A failure to promote such people-centered agricultural research and development by diverting funds and expertise to biotechnology will foreclose on a historic opportunity to increase agricultural productivity in environmentally benign and socially uplifting ways.

WANT TO KNOW MORE?

Gordon Conway's ***The Doubly Green Revolution*** (Ithaca: Comstock Publishing Associates/Cornell University Press, 1997) offers a balanced and well-researched evaluation of both the benefits and shortcomings of the Green Revolution and argues that future efforts to increase food production in the developing world must also safeguard the environment. Two articles that examine the role biotechnology can play in the next Green Revolution are Ismail Serageldin's **"Biotechnology and Food Security in the 21st Century"** (*Science*, July 16, 1999) and Charles Mann's **"Crop Scientists Seek a New Revolution"** (*Science*, January 15, 1999). Mae-Wan Ho offers a critical assessment of biotechnology in ***Genetic Engineering: Dream or Nightmare? The Brave New World of Science and Business*** (Bath: Gateway Books, 1998). Readers can find a review of the book in the Winter 1998-99 issue of FOREIGN POLICY.

One of the best overviews of the global debate over whether genetically modified crops can feed the developing world comes from the proceedings of an October 1999 conference convened by the Consultative Group on International Agricultural Research (CGIAR) and the U.S. National Academy of Sciences: ***Agricultural Biotechnology and the Poor*** (Washington: CGIAR, 2000). The volume's most noteworthy papers include: **"Feeding the Developing World in the Next Millennium: A Question of Science?"** by Andrew F. McCalla and Lynn R. Brown, **"Genetically Modified Crops and Other Organisms: Implications for Agricultural Sustainability and Biodiversity"** by Brian Johnson, **"Ethical Challenges of Agricultural Biotechnology for Developing Countries"** by Klaus M. Leisinger, and **"Intellectual Property Protection: Who Needs It?"** by David L. Richer. There are also several papers that provide perspectives on biotechnology from countries in Africa, Asia, Latin America, and the Middle East.

In **"The Pharmageddon Riddle"** (*The New Yorker*, April 10, 2000), Michael Specter examines how the backlash against genetically modified foods has impacted biotech corporate giant Monsanto. In **"A Removeable Feast"** (*Foreign Affairs*, May/June 2000), C. Ford Runge and Benjamin Senauer argue that current trade barriers threaten food security throughout the developing world.

The World Wide Web provides a wealth of information on biotechnology. The Summer/Fall 1999 issue of the quarterly online magazine *AgBioFourm* was the venue for a lively debate including **"Ten Reasons Why Biotechnology Will Not Ensure Food Security, Protect the Environment, and Reduce Poverty in the Developing World"** by Miguel A. Altieri and Peter Rosset and **"Ten Reasons Why Biotechnology Will Be Important to the Developing World"** by Martina McGloughlin. Many excellent publications on agricultural development and biotechnology can be downloaded from the Web site of CGIAR's **International Food Policy Research Institute (IFPRI)**, such as **"World Food Prospects: Critical Issues for the Early Twenty-First Century"** by Per Pinstrup-Andersen, Rajul Pandya-Lorch, and Mark W. Rosegrant (Washington: IFPRI, 2020 Vision Food Policy Report, 1999), as well as a series of issue briefs titled ***Biotechnology for Developing-Country Agriculture: Problems and Opportunities***, Gabrielle J. Persley, ed. (Washington: IFPRI, 2020 Vision Focus 2 Briefs, 1999). A very brief but useful overview of the environmental degradation now taking place in the developing world can be found in ***Food in the 21st Century: From Science to Sustainable Agriculture***, by Mahendra Shah and Maurice Strong (Washington: CGIAR, 1999). Anti-biotech activists have launched a series of Web sites, such as the **Greenpeace True Food Campaign** and **Biodevastation 2000**. The biotech industry has responded with its own Web site, the **Council for Biotechnology Information.**

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