Relevance of Genetically Modified Crops to Developing Countries

by

C.S. Prakash & Gregory Conko

Originally published in CUMBERLAND LAW REVIEW
34 CUMB. L. REV. 437 (2003)

RELEVANCE OF GENETICALLY MODIFIED CROPS TO DEVELOPING COUNTRIES

C.S. PRAKASH AND GREGORY CONKO[1]

Today, most people around the world have access to a greater variety of nutritious and affordable foods than ever before, thanks mainly to developments in agricultural science and technology. The average human life span—arguably the most important indicator of quality of life—has increased steadily in the past century in almost every country. Even in many less developed countries, life spans have doubled over the past few decades. Despite massive population growth, from 3 billion to more than 6 billion people since 1950, the global malnutrition rate decreased in that period from 38 percent to 18 percent. India and China, two of the world's most populous and rapidly industrializing countries, have quadrupled their grain production.

The record of agricultural progress during the past century speaks for itself. Countries that embraced superior agricultural technologies have brought unprecedented prosperity to their people, made food vastly more affordable and abundant, helped stabilize farm yields, and reduced the destruction of wild lands. The productivity gains from G.M. crops, as well as improved use of synthetic fertilizers and pesticides, allowed the world's farmers to double global food output during the last 50 years, on roughly the same amount of land, at a time when global population rose more than 80 percent. Without these improvements in plant and animal genetics and other scientific developments, known as the Green Revolution, we would today be farming on every square inch of arable land to produce the same amount of food, destroying hundreds of millions of acres of pristine wilderness in the process.

Many less developed countries in Latin America and Asia benefited tremendously from the Green Revolution. Nevertheless, due to a variety of natural and human reasons, agricultural technologies were not spread equally across the globe. Many people in sub-Saharan Af-

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[1] C. S. Prakash is professor of plant biotechnology at Tuskegee University, Alabama and president of the AgBioWorld Foundation. Gregory Conko is director of Food Safety Policy at the Competitive Enterprise Institute in Washington, D.C. and vice president of the AgBioWorld Foundation. This article is adapted from an earlier article titled "Technology That Will Save Billions From Starvation" by the authors published in the The American Enterprise (Special Issue on 'Biotech Bounty'), March 2004; http://www.tae mag.com

rica and parts of South Asia continue to suffer from abject rural poverty driven by poor farm productivity. Some 740 million people go to bed daily on an empty stomach, and nearly 40,000 people—half of them children—die every day of starvation or malnutrition. Unless trends change soon, the number of undernourished could well surpass 1 billion by 2020.

The U.N. Food and Agriculture Organization (FAO) expects the world's population to grow to more than 8 billion by 2030. The FAO projects that global food production must increase by 60 percent to accommodate the estimated population growth, close nutrition gaps, and allow for dietary changes over the next three decades. Food charity alone simply cannot eradicate hunger. Increased supply—with the help of tools like bioengineering—is crucial.

Although better farm machinery and development of fertilizers, insecticides, and herbicides have been extremely useful, an improved understanding of genetic principles has been the most important factor in improving food production. Every crop is a product of repeated genetic editing by humans over the past few millennia. Our ancestors chose a few formerly wild plants and gradually modified them simply by selecting those with the largest, tastiest, or most robust offspring for propagation. Organisms have been altered over the millennia so greatly that traits present in existing populations of cultivated rice, wheat, corn, soy, potatoes, tomatoes and many others, have very little in common with their ancestors. Wild tomatoes and potatoes contain very potent toxins, for example. Today's cultivated varieties have been modified to produce healthy and nutritious food.

Hybridization—the mating of different plants of the same species—has helped us assimilate desirable traits from several varieties into elite specimens. When desired characteristics were unavailable in cultivated plants, genes were liberally borrowed from wild relatives and introduced into crop varieties, often of different but related species. Wheat, rye, and barley are regularly mated with wild grass species to introduce new traits. Commercial tomato plants are commonly bred with wild tomatoes to introduce improved resistance to pathogens, nematodes, and fungi. Successive generations then have to be carefully backcrossed into the commercial cultivars to eliminate any unwanted traits accidentally transferred from the wild plants, such as toxins common in the wild species.

Even when crop and wild varieties refuse to mate, various tricks can be used to produce "wide crosses" between two plants that are otherwise sexually incompatible. Often, however, the embryos created by wide crosses die before they mature; thus they must be "rescued" and cultured in a laboratory. Even then, the rescued embryos typically produce sterile offspring. They can only be made fertile again by using chemicals that cause the plants to mutate and produce a duplicate set of chromosomes. The plant triticale, an artificial hybrid of wheat and rye, is one such example of a wide-cross hybrid made possible solely by the existence of embryo rescue and chromosome doubling techniques. Triticale is now grown on over 3 million acres worldwide, and dozens of other products of wide-cross hybridization are common.

When a desired trait cannot be found within the existing gene pool, breeders can create new variants by intentionally mutating plants with radiation, with chemicals, or simply by culturing clumps of cells in a Petri dish and leaving them to mutate spontaneously during cell division. Mutation breeding has been in common use since the 1950s, and more than 2,250 known mutant varieties have been bred in at least 50 countries, including France, Germany, Italy, the United Kingdom, and the United States. A relatively new mutant wheat variety, made to be resistant to a commercial herbicide, was placed on the market in the U.S. as recently as July 2003.

Recombinant DNA (rDNA) methods are a recent extension of the myriad techniques that have been employed to modify and improve crops. The primary difference is that modern bioengineered crops involve a precise transfer of one or two known genes into plant DNA—a surgical alteration of a tiny part of the crop's genome compared to the traditional sledgehammer approaches, which bring about gross genetic changes, many of which are unknown and unpredictable.

Leading scientists around the world have attested to the health and environmental safety of agricultural biotechnology, and they have called for bioengineered crops to be extended to those who need them most—hungry people in the developing world. Dozens of scientific and health associations, including the U.S. National Academy of Sciences, the American Medical Association, the U.K.'s Royal Society, and the United Nations Development Programme, have endorsed the technology. Nearly 3,500 eminent scientists from all around the world, including 24 Nobel laureates, have signed a declaration supporting the use of agricultural biotechnology. A review of 81 separate research projects conducted over 15 years—all funded by the European Union—found that bioengineered crops and foods are at least as safe for the environment and for human consumption as conventional crops, and in some cases even safer.

Crops enhanced through modern biotechnology are now grown on nearly 143 million acres in 16 countries. Of even greater importance, more than three quarters of the 5.5 million growers who benefit from bioengineered crops are resource-poor farmers in the developing world. Unremarkably, most commercially available biotech plants were designed for farmers in the industrialized world. They include varieties of corn, soybean, potato, and cotton modified to resist insect pests, plant diseases, and to make weed control easier. Nevertheless, the increasing adoption of bioengineered varieties by farmers in developing countries over the past few years has shown that they can benefit at least as much as, if not more than, their industrialized counterparts. The productivity of farmers everywhere is limited by crop pests and diseases—and these are often far worse in tropical and subtropical regions than the temperate zones.

About 20 percent of plant productivity in the industrialized world, and up to 40 percent in Africa and Asia, is lost to insects and pathogens, despite the ongoing use of copious amounts of pesticides. The European corn borer destroys approximately 7 percent, or 40 million tons, of the world's corn crop each year—equivalent to the annual food supply for 60 million people. So it comes as no surprise that, when they are permitted to grow bioengineered varieties, poor farmers in less developed nations have eagerly snapped them up. According to the International Service for the Acquisition of Agri-Biotech Applications, farmers in less developed countries now grow nearly one quarter of the world's bioengineered crops on more than 26 million acres.

Bioengineered plants have also had other important benefits for farmers in less developed countries. In China, where pesticides are typically sprayed on crops by hand, some 400 to 500 cotton farmers die every year from acute pesticide poisoning. Researchers at Rutgers University and the Chinese Academy of Sciences found that using bioengineered cotton in China has lowered the amount of pesticides by more than 75 percent and reduced the number of pesticide poisonings by an equivalent amount. Another study by economists at the University of Reading in Britain found that South African cotton farmers have seen similar benefits.

The reduction in pesticide spraying also means that fewer natural resources are consumed to manufacture and transport the chemicals. In 2000 alone, U.S. farmers growing bioengineered cotton used 2.4 million fewer gallons of fuel and 93 million fewer gallons of water, and were spared some 41,000 ten-hour days needed to apply pesticide.

Soon, many bioengineered varieties that have been created specifically for use in underdeveloped countries will be ready for commercialization. Examples include insect resistant rice for Asia, virus-resistant sweet potato for Africa, and virus-resistant papaya for Caribbean nations. The next generation of bioengineered crops now in research labs around the world is poised to bring even further improvements for the poor soils and harsh climates that are characteristic of impoverished regions. Scientists have already identified genes resistant to environmental stresses common in tropical nations, including tolerance to soils with high salinity and to those that are particularly acidic or alkaline.

The primary reason why Africa never benefited from the Green Revolution is that plant breeders focused on improving crops such as rice, wheat, and corn, which are not widely grown in Africa. Also, much of the African dry lands have little rainfall and no potential for irrigation, both of which played essential roles in the success stories for crops such as Asian rice. Furthermore, the remoteness of many African villages and the poor transportation infrastructure in landlocked African countries make it difficult for African farmers to obtain agricultural chemical inputs such as fertilizers, insecticides, and herbicides—even if they could be donated by charities, or if they had the money to purchase them. However, by packaging technological inputs within seeds, biotechnology can provide the same, or better, productivity advantage as chemical or mechanical inputs, and in a much more user-friendly manner. Farmers would be able to control insects, viral or bacterial pathogens, extremes of heat or drought, and poor soil quality, just by planting these crops.

Still, anti-biotechnology activists like Vandana Shiva of the New Delhi-based Research Foundation for Science, Technology and Ecology, and Miguel Altieri of the University of California at Berkeley, argue that poor farmers in less developed nations will never benefit from biotechnology because it is controlled by multinational corporations. Altieri contends that biotechnology is primarily profit-driven rather than need-driven and that the thrust of the biotech industry is not to make Third World agriculture more productive, but only to generate profits.

That sentiment is not shared by the thousands of academic and public sector researchers actually working on biotech applications in those countries. Cyrus Ndiritu, former director of the Kenyan Agricultural Research Institute has argued that it is not the multinationals that have a stranglehold on Africa but the hunger, poverty and deprivation. He echoes many African scientists in calling for Africa to embrace biotechnology to help advance food security.

Biotechnology also offers hope of improving the nutritional benefits of many foods. The next generation of bioengineered products now in development is poised to bring direct health benefits to consumers through enhanced nutritive qualities that include more and higher-quality protein, lower levels of saturated fat, increased vitamins and minerals, and many others. Bioengineering can also reduce the level of natural toxins (such as in cassava and kidney beans) and eliminate certain allergens from foods like peanuts, wheat, and milk. Many of these products are being developed primarily or even exclusively for subsistence farmers and consumers in poor countries.

Among the most well known is Golden Rice—genetically enhanced with added beta carotene, which is converted to Vitamin A in the human body. Another variety developed by the same research team has elevated levels of digestible iron. The diet of more than 3 billion people worldwide includes inadequate levels of essential vitamins and minerals, such as Vitamin A and iron. Deficiency in just these two micronutrients can result in severe anemia, impaired intellectual development, blindness, and even death. Even though charities and aid agencies such as the United Nations Children's Fund and the World Health Organization have made important strides in reducing Vitamin A and iron deficiency, success has been fleeting. No permanent effective strategy has yet been devised, but Golden Rice may finally provide one.

The Golden Rice project is a prime example of the value of extensive public sector and charitable research. The rice's development was funded mainly by the New York-based Rockefeller Foundation, which has promised to make the rice available to poor farmers at little or no cost. Scientists at public universities in Switzerland and Germany created it with assistance from the Philippines-based International Rice Research Institute and from several multinational corporations. Scientists at publicly funded, charitable, and corporate research centers are developing many other similar crops. Indian scientists, for example, have recently announced that they would soon make a new high-protein potato variety available for commercial cultivation.

Research is already under way on fruits and vegetables that could one day deliver life-saving vaccines—such as a banana with the vaccine for Hepatitis B, and a potato that provides immunization against diarrheal diseases.

It is true that certain aspects of modern farming have had a negative impact on biodiversity and on air, soil, and water quality. But biotechnology has proven safer for the environment than anything since the invention of the plow. The risk of cross-pollination from crops to wild relatives has always existed, and such "gene flow" occurs whenever crops grow in close proximity to sexually compatible wild relatives. Yet, breeders have continuously introduced genes for disease and pest resistance through conventional breeding into all of our crops. Traits, such as stress tolerance and herbicide resistance, have also been introduced in some crops with conventional techniques, and the growth habits of every crop have been altered. Thus, not only is gene modification a common phenomenon, but so are many of the specific kinds of changes made with rDNA techniques.

Naturally, with both conventional and rDNA-enhanced breeding, we must be vigilant to ensure that newly introduced plants do not become invasive and that weeds do not become noxious because of genetic modification. Similarly, we must ensure that target genes are safe for human and animal consumption before they are transferred. But, while modern genetic modification expands the range of new traits that can be added to crop plants, it also ensures that more will be known about those traits and that the behavior of the modified plants will be, in many ways, easier to predict.

The biggest threats that hungry populations currently face are restrictive policies stemming from unwarranted public fears. Although most Americans tend to support agricultural biotechnology, many Europeans and Asians have been far more cautious. Anti-biotechnology campaigners in both industrialized and less developed nations are feeding this ambivalence with scare stories that have led to the adoption of restrictive policies. Those fears are simply not supported by the scores of peer reviewed scientific reports or the data from tens of thousands of individual field trials.

In the end, over-cautious rules result in hyper-inflated research and development costs and make it harder for poorer countries to share in the benefits of biotechnology. No one argues that we should not proceed with caution, but needless restrictions on agricultural biotechnology could dramatically slow the pace of progress and keep important advances out of the hands of people who need them. This is the tragic side effect of unwarranted concern.

In 2002, Zambian President Levy Mwanawasa rejected some 23,000 metric tons of food aid in the midst of a two-year-long drought that threatened the lives of over 2 million Zambians. President Mwanawasa's public explanation was that the bioengineered corn from the United States was "poisonous." Other Zambian government officials conceded that the bigger concern was for future corn exports to the European Union, which observes a moratorium on new G.M. foods.

Zambia is not unique. European biotechnology restrictions have had other, similar consequences throughout the developing world. Thai government officials have been reluctant to authorize any bioengineered rice varieties, even though it has spent heavily on biotechnology research. Uganda has stopped research on bioengineered bananas and postponed their introduction indefinitely. Argentina has limited its approvals to the two bioengineered crop varieties that are already permitted in European markets.

Even China, which has spent hundreds of millions of dollars funding advanced biotechnology research, has refused to authorize any new bioengineered food crops since the European Union's moratorium on bioengineered crop approvals began in 1998. More recently, the International Rice Research Institute, which has been assigned the task of field-testing Golden Rice, has indefinitely postponed its plans for environmental release in the Philippines, fearing backlash from European-funded NGO protestors. Still, the E.U. moratorium continues to persist after five long years, despite copious evidence, including from the E.U.'s own researchers, that biotech modification does not pose any risks that aren't also present in other crop-breeding methods.

Of course, hunger and malnutrition are not solely caused by a shortage of food. The primary causes of hunger in some countries have been political unrest and corrupt governments, poor transportation and infrastructure and, of course, poverty. All of these problems must be addressed if we are to ensure real, worldwide food security.

But during the next 50 years, the global population is expected to rise by 50 percent—to 9 billion people, almost entirely in the poorest regions of the world. And producing enough to feed these people will require the use of the invaluable gift of biotechnology.