❑ AGRICULTURAL BIOTECHNOLOGY AND THE DEVELOPING WORLD

By J. B. Penn, Under Secretary of Agriculture for Farm and Foreign Agricultural Services

Biotechnology has the potential to play a large role in more rapidly advancing agricultural productivity in developing countries while protecting the environment for future generations, writes J.B. Penn, under secretary for farm and foreign agricultural services at the U.S. Department of Agriculture. Penn says biotechnology is simply another crop improvement tool in the long history of cultivation.

Agricultural biotechnology has been changing the face of agriculture since its commercial introduction in 1996 and the widespread adoption of bioengineered crops by farmers in the United States and other countries. However, this technology is not without controversy and is causing political reverberations around the world. While it holds enormous promise for significantly increasing food production and relieving already strained land and water resources, it has become an emotional issue among some consumers and environmental groups. As the science continues to be developed, it clearly will present both opportunities and challenges to participants throughout the food chain.

BACKGROUND ON CONVENTIONAL PLANT BREEDING

Almost all plants can be considered “genetically modified.” Genetic modification occurs when plants within a species simply produce offspring. The offspring is not exactly like either of the parents; it is a genetic combination of both. For centuries, plants have been cultivated and cross-bred by man to produce offspring with specific, desired traits. For example, maize as we know it today barely resembles its ancestor, teosinte, or Zea mexicana, a tall grass that produces finger-length "ears" containing a single row of a few grains. Maize produced today has been cultivated for many years to serve as a food crop, with far different traits than those of its predecessors.

When varieties are cross-bred to produce a hybrid plant, millions of genes are combined in the process. Scientists must select and continually cross-breed the plants, often over a period of several years, to obtain plants with the largest number of desired traits and the least number of undesirable traits.

HOW IS BIOTECHNOLOGY DIFFERENT?

Modern biotechnology is a tool that allows scientists to select a single gene for a desired trait, incorporate it into plant cells, and grow plants with the desired trait. In many ways it is simply a “high-tech” version of traditional plant breeding. This more efficient process prevents millions of genes from being crossed and possibly producing undesirable traits. Biotechnology is also different because it allows scientists to incorporate genes from other species — something that cannot be done via conventional plant breeding. This makes biotechnology a very powerful and useful tool for plant breeders.

Some people fear this tool because it is perceived as “unnatural.” However, most people forget that the food crops we have today would not exist without man's intervention, whether through plant breeding, fertilizer application, delivery of irrigation water or use of modern tractors and equipment. Without cultivation by man over the years, we would still have teosinte instead of conventional maize. The same is true for wheat, tomatoes, potatoes, watermelon and any product on today's supermarket shelf. Thus, biotechnology is simply a modern, additional tool in the long history of plant cultivation and agriculture.

AGRICULTURAL BIOTECHNOLOGY TODAY

While the focus of the first “generation” of biotech crops has been on the considerable economic benefits to farmers, more and more evidence is accumulating that significant food safety and environmental benefits are beginning to accrue.

Farmers have indicated their acceptance of biotech varieties by the unprecedented pace in which they have

been adopted. According to the U. S. Department of Agriculture (USDA), in the United States approximately 80 percent of soybeans, 38 percent of maize and 70 percent of cotton were planted to biotech varieties in 2003. The United States is not alone in experiencing this evolution in agriculture. Adoption rates in other countries, such as Argentina, Canada and China, where biotech varieties are approved, have been similarly rapid.

According to the National Center for Food and Agricultural Policy in Washington, D.C., U.S. farmers have realized the following benefits through the use of biotech varieties:

- Roundup Ready soybeans: 28.7 million lbs. (13,018.3 metric tons)/year decrease in herbicide use; $1.1 billion/year savings in production costs.

- Bt cotton: 1.9 million lbs. (861.8 metric tons)/year decrease in insecticide use; 185 million lbs. (83,916 metric tons)/year increase in cotton production.

- Bt maize varieties: Over 16 million lbs. (7,257.6 metric tons)/year decrease in insecticide use; 3.5 billion lbs. (1,587,600 metric tons)/year increase in production volume.

- Papaya: Virus-resistant biotech papaya saved the Hawaiian papaya industry $17 million/year in 1998 from the devastating effects of ringspot virus.

These results illustrate enormous decreases in pesticide use, with corresponding environmental enhancement, along with equally dramatic increases in production and savings in production costs. While biotech results vary by farm, the economic benefits obviously have been significant. These benefits are realized not only by farmers, but also by the environment and to consumers in general.

- The reduced reliance of biotech varieties on chemical inputs means less water pollution.

- Reduced chemical usage results in safer water supplies and higher quality drinking water as well as a better environment for wildlife.

- Higher yielding biotech crops can help ease the strain on land resources, reducing the need for expansion onto more fragile areas and thus allowing for greater conservation of natural habitats.

- Energy usage on biotech crops is lower because there are fewer passes through fields in applying chemicals. Less fuel use means less carbon entering the atmosphere as carbon dioxide (CO_2).

- Herbicide-resistant crops encourage the adoption of conservation tillage, especially no-till, which reduces erosion of topsoil.

WHAT'S NEXT?

Current research will lead to food crops that are resistant to environmental pressures such as drought, temperature extremes and salty soil. Scientists around the world are also investigating the "second generation" of biotech products — those with direct consumer benefits such as enhanced nutrition levels. Many of us have heard of “golden rice,” which contains higher levels of beta carotene — an important component in vitamin A production. Scientists in India are working to develop a biotech potato variety with higher levels of protein. Edible vaccines could also be produced by plants to provide low-cost, low-maintenance medicines. These are just a few of the numerous examples of cutting edge research that will further the changes we have already witnessed in the global food chain. The possibilities are enormous.

IMPLICATIONS FOR THE DEVELOPING WORLD

Global population projections suggest an additional 725 million mouths to feed in just 10 years. By 2020, this will grow to 1.2 billion more people to feed — equivalent to the populations of all Africa and South America combined. This expansion comes despite the fact that today some 800 million people — nearly one in seven — face chronic hunger. This is especially devastating to the world's children, where one in three is undernourished, and a child dies every five seconds due to hunger.

Biotechnology alone will not feed tomorrow’s world. However, this far-reaching agricultural technology, in combination with political and economic reforms, can increase crop productivity by increasing yields and improving the nutritional content of crops in developing countries. It will also help provide lower-cost food to low-income consumers. Bringing such benefits to developing countries would have far-reaching results, indeed.

An annual increase of 3 to 4 percent in African crop and livestock yields would almost triple per capita incomes while reducing the number of malnourished children 40 percent. Increased agricultural productivity will drive economic growth and expand opportunities to trade, bringing more and better jobs, better health care, and better education.

Consumers in developing countries spend a high proportion of their disposable income on food, which could be reduced with a more efficient food system, thereby leaving more of their income for other products to enhance their quality of life.

The most critical areas in the world for bringing economic prosperity and stability are the developing countries. Agricultural productivity in these countries must advance more rapidly to meet growing food demand and raise incomes while protecting the environment for future generations. Biotechnology has the potential to play a large role in this achievement. ❑