USDA/ARS

Crop Genetic Diversity Boosts Productivity But Faces Threats

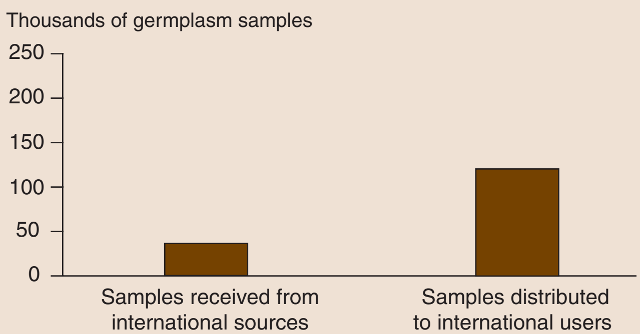
Crop yields have risen steadily over the last century, due in part to sustained research, improvements to seeds, and access to diverse genetic resources. A recent ERS report describes research that estimates a one-time permanent yield increase from genetic improvements for five major U.S. crops that generated an estimated $8.1-billion gain in global economic welfare. Consumers worldwide were the primary beneficiaries.

Crop genetic diversity is threatened by habitat loss, conversion from landraces (farmer-developed varieties) to scientifically bred varieties, and genetic uniformity in scientifically bred varieties. However, fears that loss of diversity will lead to more variability in yields have not yet materialized for major crops. This is partially the result of investments in research and breeders' continued access to genetic resources *ex situ*, in other words, resources collected and stored in genebanks. The U.S. National Plant Germplasm System distributes each year, for free, more germplasm samples than the United States receives from other countries. Nonetheless, a 1997 General Accounting Office study found that *ex situ* conservation efforts in the U.S. may fall short of meeting future crop-breeding needs.

Despite the benefits of maintaining genetic diversity, conservation of diverse genetic resources remains a challenge, in part because genetic resources have the characteristics of a public good: They are openly available and an individual holder cannot easily exclude others from using them, so the private benefits from conservation are small compared to the social benefits. The usefulness of particular genetic resources is highly uncertain, and time horizons for improving genetic resources are long. These characteristics mean that private returns to the holders of crop genetic resources are lower than their values to the world, and are unlikely to provide the incentives to achieve a socially optimal level of crop genetic diversity.

Policies to conserve genetic resources include financial assistance, stronger intellectual property rights, and international agreements. Because many diverse genetic resources lie outside the U.S., the terms of international exchange influence which germplasm is preserved and whether it can be accessed. The International Treaty on Plant Genetic Resources for Food and Agriculture, intended to preserve genetic diversity and promote exchange of germplasm, entered into force in June 2004, but key provisions to implement the treaty have yet to be negotiated. W

"Balance of Trade" of the U.S. National Plant Germplasm System for International Exchange, 1990-95

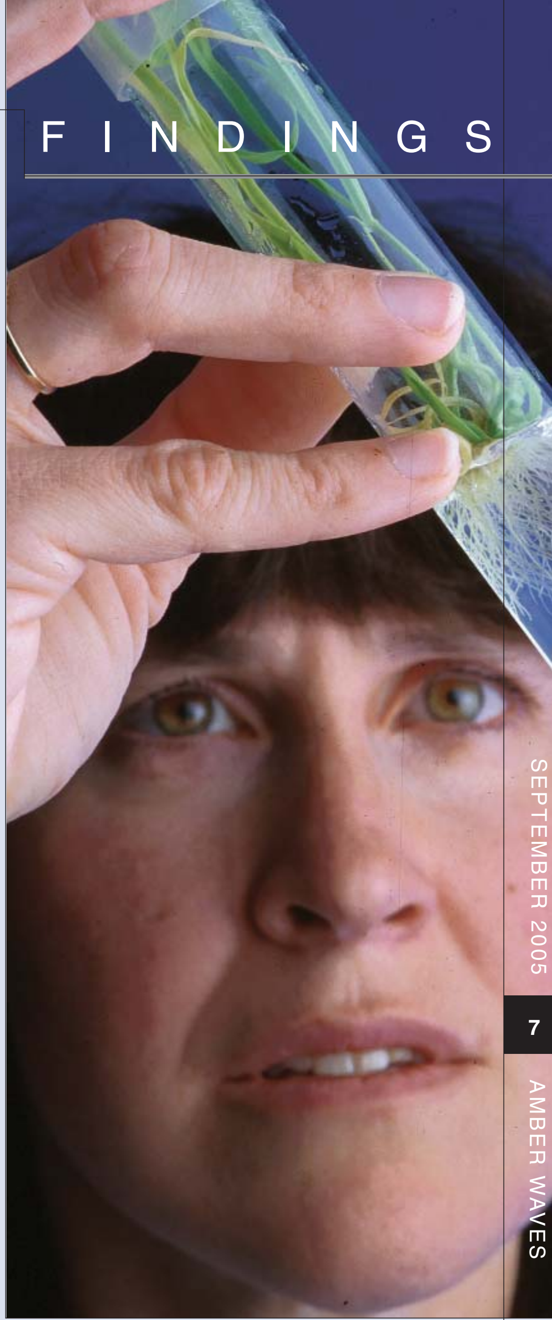


Source: USDA, Economic Research Service and USDA's Agricultural Research Service.

Kelly Day Rubenstein, kday@ers.usda.gov
Paul Heisey, pheisey@ers.usda.gov

This finding is drawn from . . .

Crop Genetic Resources: An Economic Appraisal, by Kelly Day Rubenstein, Paul Heisey, Robbin Shoemaker, John Sullivan, and George Frisvold, EIB-2, USDA, Economic Research Service, May 2005, available at: www.ers.usda.gov/publications/eib2



Jack Dykinga, USDA/ARS

Use of Genetically Engineered Crops Rising Steadily During First Decade

Driven by farmers' expectations of higher yields, savings in management time, and lower pesticide costs, the adoption of first-generation genetically engineered (GE) crop varieties with enhanced input traits has increased rapidly despite consumer resistance in some countries. About 200 million acres of GE crops with traits for herbicide tolerance (HT) and insect resistance (Bt) were grown worldwide in 2004, and U.S. acreage accounts for 59 percent of this amount.

Adoption of GE soybeans, corn, and cotton by U.S. farmers has climbed most years since these varieties became available commercially in 1996. HT crops survive certain potent herbicides, allowing adopters of these varieties to control pervasive weeds more easily. HT soybean adoption has expanded most rapidly and widely, averaging 87 percent of soybean acreage in 2005, followed by HT cotton, at 61 percent of cotton acreage.

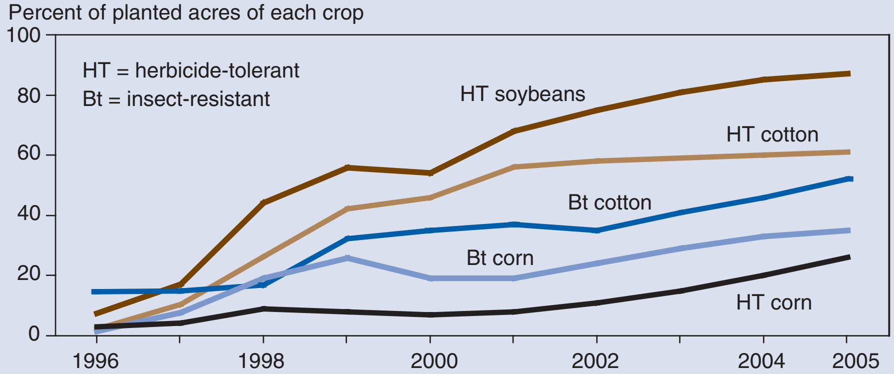
Bt crops contain a gene from the soil bacterium *Bacillus thuringiensis* (Bt) that produces a protein toxic to specific insects. Use of Bt crops is concentrated in areas with high levels of infestations of targeted pests, so acreage shares of Bt corn and cotton are lower than for HT soybeans and cotton, and vary more across States. Bt cotton, which controls tobacco budworm, bollworm, and pink bollworm, was planted on 52 percent of cotton acreage in 2005—ranging from 13 percent in California to 85 percent in Louisiana. Acreage share of Bt corn flattened during 1999-2002 because farmers had already adopted on the acreage where protection against the European corn borer was needed most. Use of Bt corn expanded recently, reaching 35 percent in 2005, following the introduction of a new Bt variety to control the corn rootworm.

ERS research has shown that U.S. farmers are realizing tangible economic benefits from adopting these GE crops through higher yields, lower pesticide costs, and savings in management time. The impacts of GE crops vary with several factors, including pest infestations, seed price premiums, prices of alternative pest control programs, and any premiums paid for segregated crops.

In addition to corn, soybeans, and cotton, U.S. farmers adopted HT canola and virus-resistant papaya and squash. Two GE crops (delayed-ripening tomatoes and Bt potatoes) introduced in the mid-1990s were withdrawn from the market years later due to marketing problems.

Adoption of genetically engineered crops grows steadily in the U.S.

Percent of planted acres of each crop



Data for each crop category include varieties with both HT and Bt (stacked) traits.
Sources: USDA annual surveys.

Other biotech crops are in various stages of development. For example, USDA's Animal and Plant Health Inspection Service has approved field testing for crops with resistance to virus, fungi, cold, drought, and salinity; crops that increase protein and oil content and produce naturally decaffeinated coffee; and crops with added vitamins and iron.

Jorge Fernandez-Cornejo,
jorgef@ers.usda.gov

For more information . . .

ERS data on Adoption of Genetically Engineered Crops in the U.S., available at: www.ers.usda.gov/data/biotechcrops/