Capturing the benefits of genetically modified organisms for the poor

Transgenics, or genetically modified organisms (GMOs), are the result of transferring one or more genes, usually from a wild species or a bacterium, to a crop plant. In 2006, farmers in 22 countries planted transgenic seeds on about 100 million hectares, about 8 percent of the global crop area (figure E.1). Though transgenics have been taken up more rapidly in commercial farming, they have considerable potential for improving the productivity of smallholder farming systems and providing more nutritious foods to poor consumers in developing countries. However, the environmental, food safety, and social risks of transgenics are controversial, and transparent and cost-effective regulatory systems that inspire public confidence are needed to evaluate risks and benefits case by case.

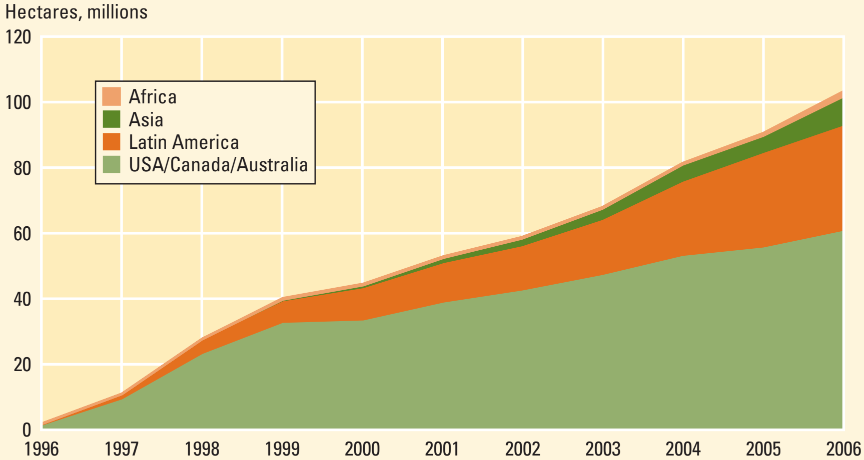
Rapid adoption of Bt cotton

Farmers in developing countries have been adopting transgenics since 1996, largely as a result of spillovers from private research and development (R&D) in the industrial countries. But their use has been limited to certain crops (soybean and maize used for animal feed, and cotton), traits (insect resistance and herbicide tolerance), and countries with commercial farming (Argentina and Brazil). The only transgenic widely adopted by smallholders has been Bt cotton for insect resistance. An estimated 9.2 million farmers, mostly in China and India, planted Bt cotton on 7.3 million hectares in 2006.[1]

The rapid adoption of Bt cotton in China and India attests to its profitability for most farmers. Available farm-level studies largely support higher profits from adoption of Bt cotton, and also document substantial environmental and health benefits through lower pesticide use. But the impacts vary across years, institutional settings, and agroecological zones.[2] In some studies, farmers in China recorded a $470 per hectare increase in net income (340 percent), largely because of a two-thirds reduction in pesticide applications (table E.1).[3] But some reports indicate much smaller reductions in pesticide use and regional variation in benefits.[4] Overall, China represents a successful case in terms of productivity, farm incomes, and equity. Supporting the quick and extensive adoption of Bt cotton in China was its low seed cost, thanks to publicly developed Bt cotton varieties and decentralized breeding that enabled the transfer of the Bt trait into locally adapted varieties.[5]

Likewise, Indian farmers growing Bt cotton used less insecticide and gained significant yield increases,[6] with the additional advantage of more stable yields.[7] While Bt cotton has been rapidly and successfully adopted in Gujarat, Maharashtra, Karnataka, and Tamil Nadu, farmers in Andhra Pradesh initially experienced a loss, largely because of the use of poorly adapted varieties.[8]

Figure E.1 The adoption of transgenics is on the rise in most regions, but not in Africa and Europe[a]



Source: James 2006.
a. The area planted with transgenics in Europe is about 200,000 hectares, mostly in Romania and Spain.

Slow progress in foods

Transgenic food crops have not been widely adopted by smallholders in the developing world. Since 2001, South Africa (mostly large-scale farmers) has been producing Bt white maize (used for human consumption), covering more than 44 percent of its total white maize area in 2006.[9] The Philippines has approved a transgenic Bt maize mostly for feed. China allows cultivation and use of publicly developed transgenic vegetables.

Despite limited adoption, interest in transgenic food crops remains high, and a wave of second-generation products is making its way toward the market. Transgenic rice, eggplant, mustard, cassava, banana, sweet potato, lentil, and lupin have been approved for field-testing in one or more countries. And many transgenic food crops are in the public research pipeline in developing countries.[10]

Many of these technologies promise substantial benefits to poor producers and consumers. Most notable are traits for the world's major food staple, rice, including pest and disease resistance, enhanced vitamin A content (Golden Rice), and salt and flood tolerance. Advanced field testing of Bt rice in China shows higher yields and an 80 percent reduction in pesticide use.[11] The estimated health benefits of Golden Rice are large, because rice is the staple of many of the world's poor who suffer from vitamin A deficiency. In India alone 0.2–1.4 million life-years[12] could be saved annually through widespread consumption of Golden Rice; this would be more cost-effective than current supplementary programs for vitamin A.[13] But despite the promise, the 1990s projections that transgenic varieties of rice would be available to farmers by 2000 were too optimistic.[14]

Africa has benefited the least from transgenic crops, in part because locally important food crops such as sorghum and

Table E.1 Economic and environmental benefits from Bt cotton

	Argentina[a]	China[a]	India[b]	Mexico[a]	South Africa[c]
Added yield (%)	33	19	26	11	65
Added profit (%)	31	340	47	12	198
Reduced chemical sprays (number)	2.4	—	2.7	2.2	—
Reduced pest management costs (%)	47	67	73	77	58

Note: The figures are based on farm-level surveys in important cotton producing regions within each country.
a. Adapted from FAO 2004e.
b. Qaim and others 2006. Other recent studies include Gandhi and Namboodiri 2006, who reported similar trends except for a much higher increase in profits (88 percent).
c. Bennett, Morse, and Ismael 2006. Other studies point to high variability in yields (Gouse, Kirsten, and Jenkins 2003; Gouse and others 2005; Hofs, Fok, and Vaissayre 2006).
— = not available.

cassava have attracted little attention from commercial biotechnology firms.[15] Transgenics could reduce the impact of several of Africa's intractable problems, such as animal diseases, drought, and Striga (a devastating parasitic weed), much faster if they were integrated into breeding programs. A recent study showed that disease-resistant transgenic bananas would likely be adopted by the poorest farmers, particularly given today's high disease losses.[16]

Why the slow progress in transgenics?

There are five main reasons for the slow progress in developing transgenic food staples:

Neglect of pro-poor traits and orphan crops. Investments in R&D on transgenics are concentrated largely in the private sector, driven by commercial interests in industrial countries. Because the private sector cannot appropriate benefits of R&D on smallholder food crops (chapter 7), this research must be led by the public sector. Yet the public sector has underinvested in R&D generally and in biotechnology specifically. The Consultative Group on International Agricultural Research, the global leader in agricultural research targeting the needs of the poor, spends about 7 percent of its budget (about $35 million) on biotechnology, only part of which is for transgenics.[17] Brazil, China, and India have large public biotechnology programs, which together may spend several times this amount.[18] But the numbers are still small in comparison with the $1.5 billion spent each year by the four largest private companies.[19]

Risks. Continuing concerns about possible food safety and environmental risks have slowed release in many countries. These concerns have persisted even though available scientific evidence to date on food safety indicates that the transgenics now in the market are as safe as conventional varieties.[20] Likewise, scientific evidence and experience from 10 years of commercial use do not support the development of resistance in the targeted pests or environmental harm from commercial cultivation of transgenic crops, such as gene flow to wild relatives, when proper safeguards are applied.[21] But despite a good track record, environmental risks and benefits do need to be evaluated case by case, comparing the potential risks with alternative technologies and taking into account the specific trait and the agroecological context in which it will be used. Public perception of risks can be as important as the objective risk assessment based on scientific evidence in ensuring acceptance of the technologies.

Weak regulatory capacity. The capacity of regulatory bodies to assess environmental and food safety risks and approve the release of transgenics is limited in most developing countries. Weak regulatory systems fuel public distrust and ignite opposition to transgenics. Low regulatory capacity is a major factor slowing approvals even of products that have already undergone extensive testing, such as Bt rice in China and Bt eggplant in India.[22] Weak capacity also results in widespread use of unauthorized transgenic seeds in many settings (cotton in India and China, and soybean in Brazil in past years), which further reduces public confidence in the regulatory system.

Limited access to proprietary technologies. With an increasing share of genetic tools and technologies covered by intellectual property protection and largely controlled by a small group of multinational companies, the transaction cost of obtaining material transfer agreements and licenses can slow public research on and release of transgenics (chapter 7).

Complexity of trade in transgenics. Some countries worry about health effects of imports of transgenic foods, including food aid. Exporters fear the loss of overseas markets and of a "GMO-free" brand. They have to consider the costs of segregating the storage and shipments of transgenics from conventional varieties, and obtaining clearance for transgenics for consumption in the importing country.[23] Countries and farmers slow to adopt transgenics may lose their competitiveness in global markets, however, if cost-reducing transgenics, such as Bt cotton, are widely adopted in large exporting countries.[24]

A way forward

The current global controversies and power plays between interest groups supporting either side of the debate on transgenics create much uncertainty, dampen investment in R&D, impede objective assessment of the technology, and discourage adoption and use in developing countries.[25] An important opportunity to contribute to the pro-poor agricultural development agenda will be missed if the potential risks and benefits of transgenics cannot be objectively evaluated on the basis of the best available scientific evidence and taking into account public risk perceptions.

Introducing transgenics requires a cost-effective and transparent regulatory system with expertise and competence to manage their release and use. Open information disclosure, labeling, where feasible, and a consultative process are critical for harnessing public support for transgenics. Strong regulatory capacity does not necessarily mean stringent standards on risks. On the contrary, competent regulators can keep information requirements for approval at an appropriate level to ensure safety, based on knowledge of the trait and the ecosystem into which it will be introduced. High regulatory barriers may impose high costs on society by restricting or slowing access to beneficial technologies. High barriers may also restrict competition in seed markets and reduce options for farmers, because public research organizations and national seed companies may not be able to pay the high cost of regulatory clearance (estimated at more than $1 million for the first Bt cotton varieties in India).

In setting the regulatory standards, decision makers must weigh public risk perceptions and degrees of risk tolerance, which differ among societies. Despite the absence of proven risks, the precautionary approach calls for a broad assessment of the technology's potential risks and benefits in the wider food and ecological system. Risk assessment must also consider the consequences and risks of *not* using transgenics.[26] For example, transgenics offer a powerful tool for nutritional enhancement that may save lives (Golden Rice) or help farmers adapt to climate change through faster integration of genes for drought- and flood-tolerance.

Countries and societies ultimately must assess the benefits and risks for themselves and make their own decisions. The international development community should stand ready to respond to countries calling for access to modern technologies, as in the recent declaration of the African Union.[27] It should be prepared to meet requests to fund the development of safe transgenics with pro-poor traits and to underwrite the high initial costs for their testing and release. If a new wave of safe and pro-poor technologies is developed and accepted, the regulatory costs should fall sharply.