## Size and Distribution of Market Benefits From Adopting Biotech Crops

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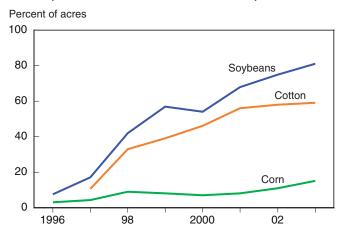
## Introduction

The adoption of agricultural biotechnology has grown rapidly in the United States since its commercialization in 1996.<sup>2</sup> Herbicide-tolerant soybeans have been adopted particularly fast, from 7 percent of total soybean acreage in 1996 to 81 percent in 2003 (fig. 1; Smith and Heimlich; USDA, 2003). The adoption of herbicide-tolerant cotton has been nearly as fast, from about 10 percent of upland cotton acreage in 1997 to 59 percent in 2003.<sup>3</sup> In contrast, the adoption of herbicide-tolerant corn has expanded slowly, from 3 percent in 1996 to 15 percent in 2003. Compared with herbicide-tolerant soybeans and cotton, the adoption of insect-resistant (Bacillus thuringiensis or Bt) varieties has also grown slowly. During 1996-2003, Bt cotton (corn) adoption increased from 15 (2) percent in major producing States to 41 (29) percent nationwide (fig. 2; Smith and Heimlich; USDA, 2003).<sup>4, 5</sup>

Overall, rapid growth in the adoption of biotech varieties reflects a desire by producers for potential crop

Figure 1

Adoption of herbicide-tolerant soybeans, cotton, and corn in the United States, 1996-2003



Sources: Smith and Heimlich for 1996 and 1997 (using data from the Agricultural Resource Management Survey); USDA's March 2000 *Prospective Plantings* report for 1998 and 1999; and USDA's June 2001, 2002, and 2003 *Acreage* reports for 2000 through 2003. Adoption in 1998 and 1999 includes both biotech and conventional varieties with the herbicide-tolerant trait. Adoption rates for corn and cotton include both herbicide-tolerant only and stacked-gene varieties.

yield increases, cost savings in pest control, and greater ease of management (including labor savings). Bt corn and cotton contain a gene that causes these crops to produce proteins that are toxic to certain pests but are harmless to other insects, humans, and animals. Herbicide-tolerant crops (soybeans, corn, and cotton) offer simple and flexible weed control programs and allow producers to use one herbicide without causing crop damage (Fernandez-Cornejo and McBride, 2002). As a result of these perceived benefits, U.S. plantings of biotech varieties increased from about 10 million acres in 1996 to 101 million acres in 2003 (Smith and Heimlich; USDA, 2003).

Consumers as a whole benefit from biotechnology in crop production because of greater supplies and lower market prices. This is especially true for consumers who are indifferent to biotech versus nonbiotech products. Consumers insistent on nonbiotech goods are

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<sup>&</sup>lt;sup>2</sup> For purposes of this study, agricultural biotechnology refers to the use of recombinant DNA technology (DNA formed by combining segments of DNA from different organisms) to alter or move genetic material so that a plant (such as corn or soybeans) exhibits a desired trait as a result of gene insertion. Fernandez-Cornejo and McBride (2000) provide more detailed information about the basic concepts and definitions of agricultural biotechnology.

<sup>&</sup>lt;sup>3</sup> The 2003 estimate for herbicide-tolerant cotton includes stacked-gene varieties, which possess both insect-resistant and herbicide-tolerant traits. Stacked-gene varieties accounted for 27 percent of U.S. upland cotton acreage in 2003.

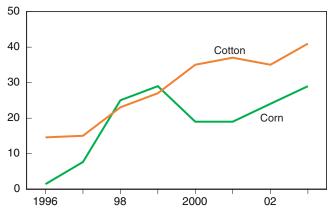
<sup>&</sup>lt;sup>4</sup> The 2003 estimates for Bt cotton and Bt corn include stackedgene varieties, which accounted for 27 percent of total upland cotton acreage and 4 percent of total corn acreage.

<sup>&</sup>lt;sup>5</sup> The decline in the adoption of Bt corn from 29 percent in major producing States in 1999 to 19 percent in 2000 may have been attributable, in part, to low infestation levels of European corn borers in 1998 and 1999 (USDA, 2001a).

Figure 2

## Adoption of insect-resistant (Bt) corn and cotton in the United States, 1996-2003

Percent of acres



Sources: Smith and Heimlich for 1996 and 1997 (using data from the Agricultural Resource Management Survey); USDA's March 2000 Prospective Plantings report for 1998 and 1999; and USDA's June 2001, 2002, and 2003 Acreage reports for 2000 through 2003. Adoption includes both Bt and stacked-gene varieties.

worse off since they have to pay premiums, which reflect the costs of product segregation. This study does not consider the welfare effects for consumers with divergent preferences for biotech foods.

Much debate has centered on how benefits from agricultural biotechnology are shared. Producers may benefit from higher net returns, but consumers may also benefit. Recent studies concur that U.S. farmers receive roughly one-half of the total estimated benefits (Falck-Zepeda et al., 1999, 2000a, 2000b; Paarlberg).

However, some studies cite significantly different shares for U.S. farmers (Frisvold et al.; Falck-Zepeda et al., 2000a; Moschini et al.). These differences are attributable to varying methodological approaches, supply and demand elasticity assumptions, crops analyzed (e.g., herbicide-tolerant soybeans, Bt cotton), study periods investigated, and choice of data sources on farm-level impacts.

The purposes of this report are twofold: (1) to estimate the size of the total benefits that arise from the adoption of agricultural biotechnology; and (2) to measure the distribution of estimated benefits among key stakeholders—U.S. farmers, U.S. consumers, biotechnology developers, germplasm suppliers, and the producers and consumers in the rest of the world (ROW). We focus on market benefits from adopting herbicide-tolerant soybeans as well as Bt and herbicide-tolerant upland cotton in 1997, using data from the 1997 USDA Agricultural Resource Management Survey (ARMS)—the latest data available at the time of analysis—and a private data source for Bt cotton. The ARMS records U.S. producers' production practices, resource use, and financial condition, as well as the economic well-being of farm households. (Biotech corn is excluded from this study because 1996 ARMS data on Bt and herbicide-tolerant corn varieties may be inaccurate and unreliable due to low adoption that year—the first year of commercial availability; more recent data are unavailable.) This study uses ARMS data on potential crop yield gains and savings in pest control costs after isolating the effects of biotechnology on these farm-level effects.