Adoption of Genetically Engineered Crops

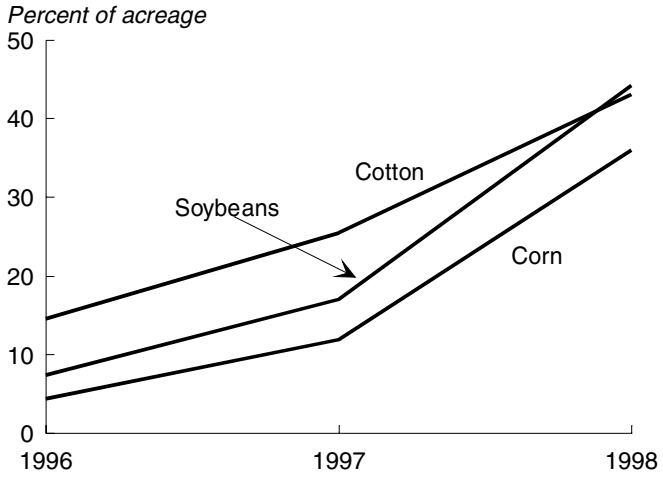
Acreage planted in genetically engineered crops increased rapidly from 1996 to 1997, but even more sharply from 1997 to 1998 (figure 2). Table 7 includes a summary of the ARMS survey results on the extent of adoption of genetically engineered cotton, corn, and soybeans in terms of the percentage of planted acres and production, by type of technology, crop, and region in each year. In addition, table 8 shows the reasons given by farmers for adopting herbicide-tolerant soybeans and cotton as well as Bt cotton.

Adoption Rates

By 1998, around 40 percent of the U.S. cotton acres, a third of the U.S. corn acres, and more than 40 percent of the U.S. soybean acres were planted to genetically engineered varieties (fig. 2) as area increased from about 8 million acres in surveyed States in 1996 to more than 50 million acres in 1998.

Genetically engineered cotton containing the Bt gene protects cotton from the budworm, bollworm, and pink bollworm (see box, p. 2). Bt cotton became available to farmers in 1995 and its use expanded rapidly, reaching 15 percent of cotton acreage in 1996 and about 17 percent in 1998 (table 7). Similarly, Bt corn provides protection from the European corn borer. The Environmental Protection Agency (EPA) approved Bt corn in August 1995, and its use grew from about 1 percent of planted corn acreage in 1996 to 19 percent in 1998.

Figure 2
Adoption of genetically engineered crops, 1996-98: Herbicide-tolerant and Bt technologies



Adoption rates for herbicide-tolerant crops have been particularly rapid. Herbicide-tolerant soybeans became available to farmers for the first time in limited quantities in 1996, and usage expanded to about 17 percent of the soybean acreage in the major States surveyed in 1997 and to more than 40 percent of the soybean acreage in 1998 (table 7). Herbicide-tolerant cotton expanded from 10 percent of surveyed acreage in 1997 to 26 percent in 1998.

Comparison with Other Adoption Estimates

The adoption estimates obtained from the ARMS surveys and shown in table 7 (ERS estimates) broadly agree with industry estimates (Hayenga), with the following exceptions: for herbicide-tolerant soybeans in 1996 and 1998, the ERS estimates are between 4 and 9 percentage points higher than industry estimates; for herbicide-tolerant corn for 1998, the ERS estimates are about 10 percentage points higher than industry estimates; for herbicide-resistant cotton for 1998, the ERS estimates are about 11 percentage points below industry estimates.

Reasons for Adoption

According to the 1997 ARMS survey, the majority of farmers surveyed (ranging from 54 to 76 percent of adopters) indicated that the main reason they adopted genetically engineered crops with pest management traits was to "increase yields through improved pest control." The second reason, stated by 19-42 percent of adopters, was "to decrease pesticide costs." All other reasons combined ranged between 3 and 15 percent of adopters (table 8). These results confirm other adoption studies pioneered by the economist Griliches who showed that expected profitability positively influences the adoption of agricultural innovations. Hence, factors expected to increase profitability by increasing revenues per acre or reducing costs are generally expected to positively influence adoption.[3] A main objective of

[3] Other factors may also affect the adoption decision. For example, research results of the probit analysis for the case of herbicide-tolerant soybeans indicate that larger operations and more educated operators are more likely to use herbicide-tolerant soybean seed. Use of conventional tillage on

(please see next page for continuation of footnote 3)

Table 7—Extent of Bt and herbicide-resistant seed technologies used in corn, soybean, and cotton production, by region, 1996-98

Technology/region	1996		1997		1998[1]	
	Acreage	Production	Acreage	Production	Acreage	Production
			Percent			
Bt corn						
All surveyed States	1.4	1.5	7.6	7.8	19.1	20.7
Heartland	1.5	1.6	8.1	8.0	19.4	20.3
Northern Crescent	id	id	id	id	16.2	18.3
Prairie Gateway	id	id	id	id	19.2	23.7
Herbicide-resistant corn[2]						
All surveyed States	3.0	3.1	4.3	3.9	18.4	19.4
Heartland	2.8	2.8	4.8	4.3	19.7	20.6
Northern Crescent	id	id	id	id	9.5	11.6
Prairie Gateway	id	id	id	id	18.3	16.7
Herbicide-resistant soybeans[2]						
All surveyed States	7.4	7.2	17.0	17.5	44.2	44.8
Heartland	6.9	6.8	14.7	16.1	44.3	45.1
Mississippi Portal	9.8	10.1	30.8	29.2	46.6	45.5
Northern Crescent	id	id	15.2	14.8	27.5	28.0
Prairie Gateway	id	id	17.5	20.2	59.2	64.4
Southern Seaboard	id	id	17.3	19.1	72.0	76.3
Eastern Uplands	id	id	id	id	59.0	57.4
Bt cotton						
All surveyed States	14.6	19.0	15.0	18.3	16.8	23.5
Mississippi Portal	23.8	25.3	23.1	23.3	34.8	38.0
Southern Seaboard	id	id	21.5	24.7	18.2	18.2
Fruitful Rim	id	id	22.2	22.9	18.9	22.7
Herbicide-resistant cotton						
All surveyed States	id	id	10.5	11.1	26.2	29.3
Mississippi Portal	id	id	16.9	16.2	24.5	23.0
Southern Seaboard	id	id	16.1	14.5	28.1	31.7
Prairie Gateway	id	id	id	id	34.2	56.9

id=insufficient data for a statistically reliable estimate.
[1] 1998 estimates for corn and cotton include acreage and production with stacked varieties (with both Bt and herbicide-resistant genes).
[2] Includes seed obtained by traditional breeding but developed using biotechnology techniques that helped to identify the herbicide-resistant genes.

pest management in agriculture is to reduce crop yield losses. Thus, there is an incentive to adopt innovations that reduce yield loss. However, yields also depend on locational factors, such as soil fertility, rainfall, and temperature. The physical environment of the farm (e.g., weather, soil type) may affect profitability directly through increased fertility and indirectly through its influence on pests. For these reasons, empirical studies often control for location, using States or regions as proxies, or separate analyses are conducted for some regions.

(continuation of footnote 3)
soybean acreage is a factor that significantly reduces adoption since farmers use conventional tillage to help control weeds, while herbicides are used with conservation or no-till practices. Also, weed infestation levels are positively correlated with the adoption of herbicide-tolerant soybeans (USDA, ERS, 1999b).

Table 8—Main reason stated by U.S. farmers for adopting herbicide-tolerant soybeans/cotton and Bt cotton, 1997

Stated reason for adopting genetically engineered crops	Percent of acreage among adopters		
	Herbicide-tolerant soybeans	Herbicide-tolerant cotton	Bt cotton
	Percent		
1. Increase yields through improved pest control	65.2	76.3	54.4
2. Decrease pesticide input costs	19.6	18.9	42.2
3. Increased planting flexibility (for example, easier to rotate crops, reduce carryover, use reduced tillage or no-till systems, etc.)	6.4	1.8	2.2
4. Adopt more environmentally friendly practices	2.0	0.9	0.0
5. Some other reason(s)	6.8	2.3	1.2