THE DISTRIBUTION OF BENEFITS FROM THE INTRODUCTION OF TRANSGENIC COTTON VARIETIES

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Some concern has been expressed about the potential for abuse of monopoly power in the marketing of genetically modified (GM) seeds in the United States (U.S.). Are the firms marketing GM seeds extracting all of the benefits generated by their products? We attempt to partition the benefits from the introduction of *Bacillus thuringiensis* (Bt) cotton in the United States among United States domestic and rest of the world consumers of cotton lint, the gene-supplying firm, the germplasm-supplier, and U.S. cotton farmers. The benefit calculations were based on comparisons of pest control costs and yields for Bt and conventional cotton varieties. We estimate that an average of more than $200 million per year in benefits were generated by the use of Bt cotton. In each year, U.S. farmers received the largest single share of benefits, ranging from 42% to 59% of total surplus generated. The combined share of Monsanto and the seed firms ranged from 26% to 44%.

Key words: genetically modified (GM) seeds; benefits; *Bacillus thuringiensis* (Bt) cotton; surplus; Monsanto.

A handful of vertically coordinated "life science" firms have been the key players in ushering in the biotechnology revolution in the United States. These firms have been successful in linking useful genetic events with high quality germplasm to create genetically modified varieties (GMVs) with the ability to gain rapid market penetration and to capture value for the creators. These life science firms have fundamentally altered the structure of the seed industry, using mergers, acquisitions and licensing agreements to ally their financial, scientific, and organizational strengths with the genetic resources of traditional seed companies such as Pioneer, Delta and Pineland, Asgrow, DeKalb and dozens of smaller seed companies.

Intellectual property right (IPR) laws have been used to provide incentives for inventors to invest in research since the founding of this country. IPR protection provides inventors with limited monopoly power, increasing their ability to appropriate the benefits created by their research effort. The firm producing the IPR-protected innovation is able to price their product above the marginal cost of producing the input, thereby appropriating profit that would otherwise be passed on to consumers through lower prices. Major changes have also taken place in the laws and enforcement of IPR for biological innovations so that protection is now similar to that afforded to discovery in other sectors, but it is really only the specifics of how IPR laws apply to biological innovations that have changed in recent years.

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Protection of intellectual property creates monopoly power by preventing competitors from copying product innovations. The ability of a monopolist to charge a higher price than would be possible under perfect competition means that less of the product will be sold. This decreases *static* social welfare -- consumers lose from a resulting lower level of output due to under-adoption of the innovation. On the other hand, Schumpeter (1942), suggests that monopolies may increase longer-run, or dynamic, social welfare through an increased rate of investment in research and development (R&D). Empirical research on the tradeoff between static losses and dynamic welfare gains has focused on the manufacturing sector, with little research directed to agriculture. Relatively little research has been completed on the effects of recent changes in IPR protection in agriculture, other than some initial impressions that these changes have increased private investment in plant breeding (Perrin, Hunnings, & Ihnen, 1983), and have begun to inhibit the free exchange of germplasm among plant breeders. A number of important questions remain to be addressed, including the effect of increased IPR on the distribution of investment among basic and applied research activities, and the effect on the welfare of farmers.

Some concern has been expressed about the potential for abuse of monopoly power in the marketing of genetically modified (GM) seeds in the U.S. Certainly the price of GM seed is higher than that for seed of conventional varieties, and technology fees are charged on top of such high prices for GM seeds. Does this mean that the marketing firms are extracting all of the benefits generated by the innovation? No, because clearly farmers must be receiving some benefits, or they would not choose to adopt. In fact, it is difficult to conceive of a situation in which all benefits from a new product would go to the marketer. It will generally be true that an innovator will only be able to extract part of the economic surplus created through their research effort. There will always be benefit “spillovers” to be enjoyed by other members of society.

Monopoly profit is difficult to identify in empirical work because of the difficulty in estimating marginal production costs, making it a relatively difficult empirical task to untangle the exact proportions in which benefits from an innovation are shared. Nonetheless, in a recent study (Falck-Zepeda, Traxler & Nelson, 1999) we attempted to partition the benefits from the introduction of Bt cotton in the United States among U.S. domestic and rest of the world (ROW) consumers of cotton lint, the gene-supplying firm (Monsanto), the germplasm-supplier (Delta & Pine Land), and U.S. cotton farmers.

Table 1 presents estimates of the welfare distribution from the use of Bt cotton in 1996 and 1997. The study used an economic framework presented by Moschini and Lapan (1997) to model the situation in which IPR protection imparts temporary monopoly power in the introduction of an input market innovation. The benefit calculations were based on comparisons of pest control costs and yields for Bt and conventional cotton varieties. We estimate that an average of more than $200 million per year in benefits were generated by the use of Bt cotton. In each year, U.S. farmers received the largest single share of benefits, ranging from 42% to 59% of total surplus generated. The combined share of Monsanto and the seed firms ranged from 26% to 44%. The main conclusion of our study is that even under monopoly conditions, the innovator is only able to extract a portion of the surplus that it creates. The monopolist must provide farmers with an adoption incentive by setting a price that makes the new input more profitable than existing options. This principle is well established in the adoption literature (Griliches, 1957; CIMMYT, 1988, pp.34-35).

Table 1. Distribution Of Benefits From The Introduction Of Bt Cotton In The US In 1996 And 1997.

	1996		1997	
	Surplus ($US m)	**% total surplus**	**Surplus ($US m)**	**% total surplus**
U.S. consumers	21.6	9	14.0	7
U.S. farmers	140.8	59	80.0	42
Monsanto	49.8	21	67.1	35
Seed companies	13.1	5	17.7	9
ROW producers	(21.6)	–	(12.1)	–
ROW consumers	36.5	–	23.4	–
Net ROW surplus	15.0	6	11.2	6
Total world surplus	240.3	100	190.1	100

From "Rent Creation and Distribution from Biotechnology Innovations: The Case of Bt Cotton and Herbicide-Tolerant Soybeans" by J.B. Falck-Zepeda, G. Traxler, and R.G. Nelson, June 24-25 1999, paper presented at the Transitions in Agbiotech: Economics of Strategy and Policy NE-165 Conference, Washington, DC.

The study described above did not account for potential environmental impacts of Bt cotton. No detailed studies of the environmental impacts of GM crops in the U.S. have yet been published. There is some evidence of positive externalities associated with the use of Bt cotton through reduced use of chemical pesticides. There appears to have been a drop of the use of chemical insecticides on cotton since the introduction of Bt cotton in 1996 in some production areas, but more careful study is needed before this can be conclusively attributed to the use of GM cotton varieties (see table 2).

The introduction of GM crops has occurred at a time when changes in market structure are occurring. This has caused concern in some parts that farmers and consumers may not be sharing in the benefits from the new technologies. Our preliminary estimates suggest that the input suppliers passed on a significant share of the benefits. The relatively modest share of surplus appropriated by the innovators is largely explained by the fact that the innovators did not attempt to price discriminate – essentially the same price was charged to farmers in all production areas. The size and distribution of benefits will change as Bt cotton varieties continue to diffuse in the United States, as Bt varieties are released in other countries, as substitute technologies for controlling pyrethroid resistant lepidopteran pests appear, and possibly as opportunities arise to price discriminate.

Table 2. Average Number Of Insecticide Applications To Control Budworm-Bollworm Complex, Selected States.

State	1993	1994	1995	1996	1997
Alabama Central	4.0	8.0	9.6	0.0	0.2
Alabama North	4.0	2.7	6.7	0.2	0.6
Alabama South	7.0	5.0	5.9	0.1	1.0
Florida	5.3	5.3	5.7	1.1	1.0
Georgia	2.7	4.3	3.4	1.7	2.5
Louisiana	4.7	4.8	4.7	3.9	3.2
Mississippi Delta	4.5	4.8	4.5	2.5	3.2
Mississippi Hills	4.0	3.1	8.2	1.5	1.3
North Carolina	2.5	3.6	2.6	3.1	2.0
South Carolina	4.9	4.4	4.7	4.2	3.3
Texas S. Central	4.2	3.7	2.6	2.3	1.7
Unweighted Average	4.3	4.5	5.4	1.7	1.7

From "Cotton Insect Losses 1995," by M. W. Williams, 1997, Proceedings 1996 Beltwide Cotton Conferences, pp. 670-89; and "Cotton Insect Losses 1996," by M. W. Williams, 1997, Proceedings 1997 Beltwide Cotton Conference, pp. 834-53; and "Cotton Insect Losses 1997," by M. W. Williams, 1998, Proceedings 1998 Beltwide Cotton Conference, pp. 834-53.

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