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Cheaper GM Seeds Could Boost Adoption, Farm Benefits and Company Profits: The Case of Bt Cotton in Argentina

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This article analyzes adoption and impacts of Bt cotton in Argentina against the background of monopoly pricing. Based on survey data, it is shown that the technology significantly reduces insecticide applications and increases yields; however, these advantages are curbed by the high price charged for genetically modified (GM) seeds. Studies show that farmers' average willingness to pay is less than half the actual technology price. A lower price would not only increase benefits for growers, but could also multiply company profits.

Bt cotton is a GM crop into which a gene of the soil bacterium *Bacillus thuringiensis* has been transferred to make it resistant to major lepidopteran insect pests. It was developed by the US company Monsanto and, as one of the first GM crop technologies, it became commercially available in the mid-1990s. Since then, the technology has spread rapidly in the US, Australia, as well as in several developing countries. In Argentina, Bt cotton is patented by Monsanto and was released in 1998 by Genética Mandiyú, a joint venture between Monsanto, Delta and Pine Land (D&PL), and the local company Ciagro. Unlike other countries, however, in Argentina the diffusion of Bt cotton has been rather slow. According to official statistics, four years after its introduction, Bt technology only covered about 5% of the national cotton area (Table 1). This is surprising, in particular when compared to GM soybeans which were adopted almost completely in the country within a similar time frame.

To better understand the low adoption rates, an interview-based survey of 299 cotton farms was carried out in 2001 in collaboration with Argentina's *Instituto Nacional de Tecnología Agropecuaria* (INTA). The survey covered the two major cotton-growing provinces, Chaco and Santiago del Estero, which together account for 88% of the Argentine cotton area. As the number of Bt users is still comparatively small, we employed a stratified random sampling procedure, differentiating between adopters and nonadopters of the technology. The total sample consists of 89 adopters (about 60% of all adopters in the country) and

Table 1. Adoption of Bt cotton in Argentina, 1998-2001.

	Cotton Area (ha)	Bt Cotton Area (ha)	%
1998 - 1999	750,930	5,500	0.7
1999 - 2000	331,890	12,000	3.6
2000 - 2001	409,950	22,000	5.4
2001 - 2002	169,000	9,000	5.3

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210 nonadopters. A check with official statistics showed that the subsample of nonadopters is representative of the Argentine cotton sector in terms of average farm sizes and cultivation practices.

Apart from eliciting general farm, household and contextual characteristics, the survey included detailed questions about input-output relationships in cotton cultivation for two growing seasons – 1999-2000 and 2000-2001. As all Bt adopters had also cultivated at least some conventional cotton, they were asked the same questions for both their Bt and conventional plots. Furthermore, the questionnaire covered aspects of farmers' perceptions about Bt technology.

Farm level effects of Bt cotton

To analyze the farm level effects of Bt cotton in Argentina, we compare cost of production and gross margins per hectare with and without use of the technology (Table 2). This analysis is confined to the sub-sample of adopters. That is, Bt and non-Bt plots are compared on the same farms to reduce a possible selection bias. As expected, Bt technology cuts the expenditure on insecticides. In 1999-2000, the average number of insecticide applications was reduced by 2.4, whereas in 2000-01, it was reduced by 2.3. Moreover, there is a significant increase in the yields that farmers obtained: in both seasons the yield gain is above 30%. Machinery and labor costs are somewhat higher on Bt plots. Although there is a slight decrease in operating expenses for pesticide applications, this is more than offset by elevated harvesting costs on account of higher yields.

Yet the most significant cost change is due to seeds. Bt seeds add to total production cost by one-third and almost double expenditure for the bundle of purchased inputs. Altogether, average gross margins are higher with Bt technology in 1999-2000 and 2000-01. However, there is a big variance in the results. In both seasons, around 40% of the Bt adopters actually experienced a decrease in gross margins. Unsurprisingly, these are largely those farmers who dropped out the following year.

Table 2. Comparison between the performance of Bt cotton and non-Bt cotton in Argentina 1999-2000 and 2000-2001

	Yield kg/ha)	No. of insecticide sprays	Insecticide cost ($/ha)	Seed cost ($/ha)	Gross margin ($/ha)
			1999-2000		
Bt	2,063	2.1	17.07	104.90	174.32
Non-Bt	1,558	4.5	32.43	14.64	135.28
Difference	505	-2.4	-15.36	90.26	39.04
			2000-2001		
Bt	2,183	2.8	22.83	102.22	19.27
Non-Bt	1,625	5.1	42.33	18.17	12.53
Difference	558	-2.3	-19.50	84.05	6.74

Compared with other countries where Bt cotton is grown, farm-level benefits in Argentina are rather small. In the US, average per-hectare benefits ranged between $50 and $80 in recent years (Gianessi et al., 2002). For China, Pray et al. (2002) reported gains of over $400 for the 1999-2001 period, and in Mexico, Traxler et al. (2001) found average net benefits of $295 per hectare for 1997 and 1998. While in these countries, the major advantage of Bt technology is a drastic reduction in pesticide expenditures, in Argentina the main effect is an increase in effective yields. The increase in total production cost associated with Bt intensifies the financial risk that farmers face. Net benefits mainly depend on extra revenues, which are also a function of cotton prices. A downward trend in world market prices, as observed in recent years, therefore lessens the technology's comparative advantage. Although yield increases in Argentina were similar in both growing seasons, the absolute gain in gross margins was much lower in 2000-01 because of the decline in cotton prices. Lower prices for Bt seeds could increase the technology's attractiveness from the point of view of farmers. This is reflected in the rising demand for Bt seeds from the black market, which are sold at around $35-40 per hectare.

Willingness to pay for Bt cotton

Using a contingent valuation approach, we estimated farmers' willingness to pay (WTP) for Bt cotton seeds. For the full sample, the average WTP is $48, less than half the actual market price of $103. Farmers' price responsiveness is high: at $48, the area under Bt technology in Argentina would be around 250,000 ha, more than 10 times the area actually planted in 2000-01. The analysis also shows that larger farmers are willing to pay more than smaller ones. The mean WTP for minifundios (less than 20 ha of land) is $38, for small farms (20-90 ha) it is $52, and for medium and large farms (more than 90 ha) it is $83.

Company profit

It is obvious that net benefits for farmers would increase with lower prices for Bt seeds. But what about the benefits for Genética Mandiyú, the technology supplying joint venture? Our study shows that the current price for Bt cotton seeds is almost 80% higher than the level that would maximize the company's profits. At the profit-maximizing price level of $58, profits could be about 3.6 times higher than they are today, and we predict a Bt cotton area of 184,000 hectares.

Conclusion

Given that the lepidopteran insect pests which lend themselves for control by Bt are important in Argentina and that Bt farmers benefit from increased yield and decreased cost of insecticides, the issue of why official adoption of Bt cotton has stagnated at 5% deserves to be addressed. Although the limited flow of information was also identified as an adoption constraint, the main hurdle for wider dissemination is the high price of Bt seeds. Farmers have to pay around $103 per hectare, which is more than double the total cost that average cotton growers spend on purchased inputs. In many cases, the price markup outweighs the monetary benefits. Subtracting the actual seed cost from the total price of $103 results in a $78 technology

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fee per hectare ($32 per acre), which is the same as that charged for Bt cotton in the US. However, agronomic and socioeconomic circumstances are different. The low-cost and subsidy-free production conditions in Argentina lead to lower returns and a lower value of Bt technology from the farmers' point of view. Therefore, Bt seeds should be priced differently in Argentina than in the US. Simulated demand functions for Bt cotton indicate that a lower technology fee would not only increase adoption and benefits for growers, but could also multiply the profits of the monopolist technology supplier. Reasons for the sub-optimal pricing strategy are unclear. But they might have to do with pressure from the US farm lobby, that fears competitive disadvantages when US technologies are marketed more cheaply abroad than at home.

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