The Experience of Bt Cotton in Developing Countries

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Some results from a project in progress

"*Learning from the Experience of Small-Scale Farmers. The Case of Transgenic Cotton*"
Oxfam-America

+ Field research in China, India, Colombia, South Africa
+ Secondary data from all countries growing Bt cotton
+ Literature reviews

Area in hectares (*and percent of total cotton area*) planted with transgenic, insect-resistant cotton, (single trait or stacked) (2007)

COUNTRY	HECTARES
China	3,830,000 *(69%)*
India	6,475,000 *(73%)*
Argentina	91,000 *(22%)*
Colombia	20,883 *(45%)*
Mexico	58,619 (*53%)*
Brazil	(?)
South Africa	10,113 *(89%)*
Australia	131,688 *(80%)*
United States	3,267,642 *(75%)*

Some questions about the experience of Bt cotton in developing countries

+ ***What has been the impact on yields and insecticide use?***

+ ***What have been the costs?***

+ ***How is access to the technology controlled?***

+ ***How much information is available to farmers?***

+ ***What can we learn from the rapid spread of Bt cotton?***

Changes in Yield and Insecticide Use with Bt Cotton
(various literature sources)

Country	Location or farm type	Year	Change in yield	Change in insecticide cost
CHINA	5 provinces	2001	+11%	-58%
INDIA	Karnataka	2003	+42%	-49%
	Andhra Pradesh		-3%	-19%
	Maharashtra		+52%	+5%
SOUTH AFRICA	Smallholders	1999	+40%	-36%
	Smallholders	2002 2003	+15% (av)	+23% -27%
	Large, irrigated	2000	+19%	-56%
UNITED STATES	Average of 12 states	2004	+9%	-47%

Variability of experience. Three areas in Colombia, 2007

	Tolima	Córdoba	Sucre
Yield increase with Bt	+75%	+10%	+18%
Cost of production increase	+35%	+1%	+17%
Seed cost increase (US$/ha)	+ $80	+ $120	+ $110
Bollworm insecticide saving	- $42	- $35	- $13
Total change in insecticide expenditure	+ $75	-$27	+ $14
(Notes)	(Bt users large farmers, high input use)	(Conventional growers had drainage problem)	(Drought affected all growers)

(1a) Impact – Insecticide Reduction

In 1999, Chinese Bt cotton growers used 85% less insecticide on their cotton than non-Bt growers!
***But we need to look at the context*:**

Amount of insecticide (kg/ha) used on cotton in China
(Huang et al 2008)

Year	*Bt growers*		*Non-Bt growers*	
	All insects	(Bollworm)	All insects	(Bollworm)
1999	11.5	(6.3)	77.5	(69.1)
2000	20.8	(14.2)	47.3	(36.3)
2007	19.6	(8.7)	--	--

(1b) Impact– Yield increase

In 2002, a review of four states in India found that (on average) Bt growers got a 34% higher yield than non-Bt growers!

But we need to look at the context:

*** The base yield was only about 400 kg lint/ ha**
*** The yield gains ranged from +73% to -3%**
*** The Bt growers used 14% more fertilizer and 22% more manure**

(Qaim et al 2006)

(2a) Costs

Cost of conventional and Bt cotton seed (2007)

COUNTRY	Conventional cotton seed (US$/kg)	Bt cotton seed (US$/kg)	Cost ratio (Bt seed: conventional seed)
China	$1.11	$4.44	4.0
India	$19.94 (hybrid)	$42.74 (hybrid, Bollgard I)	2.1
Argentina	$2.00	$4.67	2.3
Colombia	$6.52	$12.52-$15.34	1.9 – 2.4
Mexico	$5.10-$7.50	$15.85	2.1-3.1
South Africa	$2.55	$7.20	2.8
Australia	$4.92	$25.84 (Bollgard II)	5.3
United States	$4.50-$6.50	$7.50-$10.00 (Bollgard)	1.2 – 2.2

(2b) Costs

(i) Up-front risks

Seed as percent of input costs

	Conventional cotton	Bt cotton
India	10%	30%
South Africa (smallholders)	50%	75%

(ii) Seeding rate.

In Colombia, reduction of seeding rate (2-4 kg/ha) and use of precision planters.

(3) Controlling access to technology

Seed Companies with Access to Transgenes (2007)

COUNTRY	Transgenes	# companies with access to gene	Approx. # of varieties with this transgene)
China	*cry1Ac*	2	3
	cry1A/CpTI	>20	6
	cry1A	>20	53
	cry1Ac/API	1	2
India	*cry1Ac*	20	100
	cry1Ac/Cry2Ab	5	23
	cry1A (China)	3	6
	cry1Ac(event 1)	1	8
Argentina	*cry1Ac*	1	3
Colombia	*cry1Ac*	1	2
Mexico	*cry1Ac*	1	4
South Africa	*cry1Ac*	1	5
Australia	*cry1Ac/cry2Ab*	2	9
United States	*cry1Ac*	5	21
	cry1Ac/cry2Ab	9	49
	cry1Ac/cry1F	1	6

(4) How much information is available to farmers?

Seed

- **In China, 159 Bt varieties found in 945 plots. 70 % of farmers cannot name a single cotton seed company. 40% save seed rather than going back to the market.**
- **In India and China, farmers in the same village tend to use the same variety, although many choices are available.**
- **In South Africa, concerns about confusion between Bt and RR seed for smallholders.**

Insecticide

- **Chinese farmers who buy Bt cotton seed in the village use twice as much insecticide as those who buy seed in town.**
- **In China the average Bt farmer uses 13 different insecticides. Farmers who score low on a test of insect knowledge use much more insecticide than those with high scores.**
- **Most Colombian farmers use more insecticide on Bt cotton than on conventional cotton.**

(5) What can we learn from the rapid spread of Bt cotton?

Two cautions (using examples from the USA):

(a) The breadth of adoption is not necessarily the same as the depth of impact.

(b) Attention to Bt does not mean that other technology is unimportant.

(5a) An experiment in Georgia (USA)

* 15 popular transgenic (Bt, RR, stacked) and conventional cotton varieties
* 4 years of experiments, 2 sites
* Each variety managed according to extension recommendations, economic thresholds
* Costs and returns calculated

Results:

* No significant difference between conventional, Bt and stacked varieties
* “When considered as a whole, no transgenic technology system provided greater returns than a non-transgenic system in any year or location.”
* “The predictability of pest management and the convenience that growers attribute to the transgenic cultivars implies that they save management time…”

P. Jost *et al. Agronomy Journal* 2008.

(5b) Comprehensive Technology Development

USA cotton growers survey: "Over the past 10 years, which innovations have had the biggest impact on the way you produce cotton?"

Innovation	% rating "very important" or "somewhat important"
Transgenic, herbicide- tolerant varieties	89 [a]
Boll weevil eradication IPM	83 [a]
Transgenic, insect-resistant varieties	82 [a]
Cotton modules	72 [b]
Conservation tillage	72 [b]
Disease-resistant varieties	69 [b]
Growth regulators	65 [b]

a,b = Responses with equivalent rating (95% confidence level)
Marra and Martin, *J. Cotton Science* (2007)

Technologies: Biotechnology, plant breeding, crop management, chemistry, engineering

Technology sources: private and public sectors

CONCLUSIONS

- **Quantification of the precise "impact" of Bt cotton is difficult because of great variability between farmers, environments and seasons.**

- **But the overall performance of Bt cotton in most environments has been positive, offering protection from target insects that increases yields and may reduce costs.**

- **The question is not whether Bt cotton is "good" or "bad", but rather how to maximize its contribution to smallholder cotton productivity.**

- **The net benefit of the technology depends on the seed cost (and the possibilities of insuring against financial risks taken early in the season).**

- **Farmers need choices -- among GM varieties and conventional alternatives. In *small cotton seed markets*, there is a danger of monopoly control, which limits options and raises production costs. In *large cotton seed markets*, more regulation and consumer education are required.**

- **There is little evidence to date that farmers who have adopted Bt cotton have been able to take full advantage of it as part of a strategy to lower dependence on insecticides; the introduction of Bt cotton is not a substitute for building farmer management skills.**

- **The widespread uptake of Bt cotton is a result of farmers making rational decisions at the margin, but it does not necessarily signify a revolution in cotton-growing technology**.

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