

**Bt COTTON IN SOUTH AFRICA: ADOPTION AND IMPACT ON FARM INCOMES AMONGST SMALL- AND LARGE-SCALE FARMERS**

*Johann Kirsten and Marnus Gouse*

**Introduction**

South Africa is one of few developing countries, and the only one in Africa, that has adopted genetically modified crops for commercial production. Insect resistant cotton has been produced since the 1997/1998 season and insect resistant yellow maize since the 1998/1999 season. For the 2001/2002 season, herbicide tolerant cotton has been made available for commercial production and herbicide tolerant soybeans have been introduced on a small scale. Insect resistant white maize has also been released in limited quantities.

In the 2000/2001 season, an estimated 300 large-scale commercial farmers produced 95% of South Africa's cotton crop. The other 5% were produced by about 3,000 small-scale farmers on the Makhathini Flats (KwaZulu-Natal Province) and another 312 farmers in the Tonga area (Mpumalanga Province). A total of 157,515 bales (200kg each) were produced on 56,692 hectares, with smallholders contributing a total of 7,300 bales.

**Reasons for adoption of Bt cotton**

Farmers in the Makhathini Flats have increased their adoption of Bt cotton from 7% in 1997/1998 to 90% in 2001/2002. From looking at cotton seed sales (fig. 1), it is clear that cotton farmers have reacted positively to the introduction of GM cotton seed, with almost 80% of cotton seed used being genetically modified.

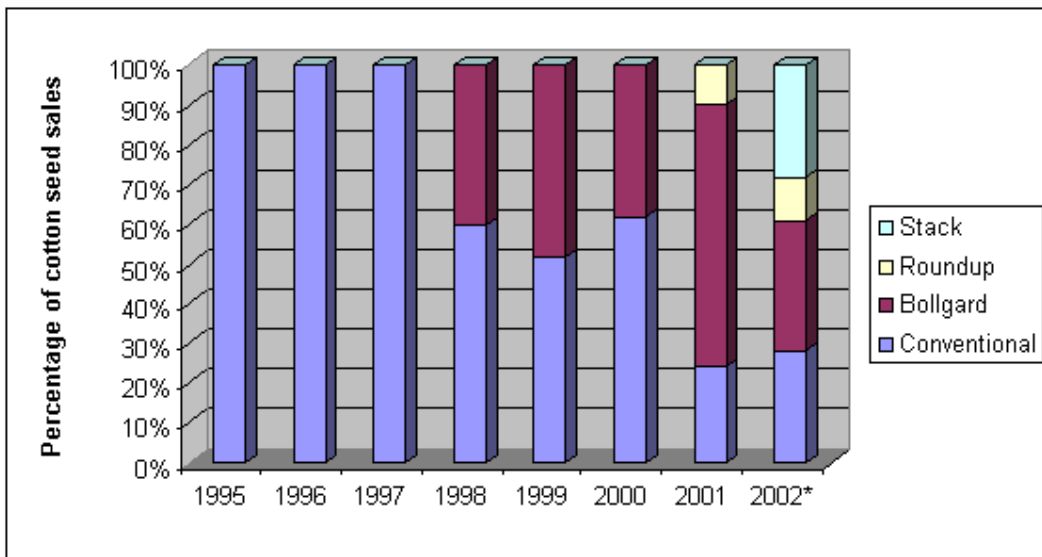


Figure 1: Adoption of new cotton seed varieties (\* Estimation)

Source: Cotton SA, *Journal to the Cotton Industry*

### Reasons for adoption: Large-scale farmers

In an analysis using our current large-scale farmer data set, factors such as area planted, age, education, and credit did not render significant results as reasons of adoption. Later studies will focus more on this aspect. For the purpose of this paper, we hypothesize that the perceived and real benefits, as indicated by seed agents and observed through our own cotton production experience, can be accepted as partial reasons for adoption of the new technology.

All the commercial farmers surveyed had planted insect resistant cotton in the current season or in the past. Of the 43 large-scale farmers interviewed, 39% indicated that the most important benefit of Bt cotton is the saving on pesticides and application cost. Peace of mind about bollworms was the second biggest reason for adoption, with 25% of farmers indicating the benefit as most important. When asked to indicate all the benefits of insect resistant cotton, 77% of farmers indicated peace of mind and 72% indicated better crop and risk management as a benefit. All the surveyed large-scale farmers were involved with other farming activities during the cotton season. Therefore, the large indication of peace of mind is not surprising. Using hired labor, scouting and spraying is especially difficult over the Christmas — New Year period, and this is a crucial time in the production cycle of cotton in South Africa. The very low labor saving perception can indicate that farmers feel that pesticide application is more capital than labor intensive.

### Benefits of Bt cotton as indicated by large-scale cotton farmers

Benefits and reasons for adoption	Most important reason / benefit (% of farmers)	Specific benefit (% of farmers)
Increased yield	7%	52%
Pesticide saving	39%	62%
Better crop and risk management	18%	72%
Better boll worm control	9%	55%
Peace of mind about bollworms	25%	77%
Labor saving	0%	2%
Better for environment	0%	37%
Other		9%

When asked about the disadvantages of Bt cotton, the prominent answer was the cost of seed and the technology fee. This is also the reason why some farmers have stopped planting Bt seed. Large-scale farmers try to stretch a 25kg bag of Bt seed as

far as possible using precision planters. A 25kg bag of Bt seed costs around R210 (\$21) with an additional R600 (\$60) technology fee. An irrigation farmer planting 20kg of seed per hectare indirectly spends R 480 (US\$ 48) on bollworm control. Some commercial farmers who have already invested in spraying machinery feel they can control bollworms for less. Most farmers don't spend R480/ha on the control of bollworms in a normal year, but, when worm pressure is high, chemical and application costs can easily exceed this additional fee. In the 2001/2002 season, Monsanto, in alliance with Delta Pine, implemented a possibly more acceptable technology fee payment system. Farmers can now pay a R400/ha (\$40) technology fee for irrigation land and R120/ha (\$12) for dryland, on the condition that they present a GPS map of the planned cotton field. The R600/bag (\$60) technology fee system is also still available for farmers to use, so a farmer can decide which option is the most cost effective for him.

### Reasons for adoption: Small-scale farmers

The impressive increase in adoption of Bt cotton by small-scale farmers from 7% in 1997/1998 to around 90% in the 2001/2002 season can mainly be attributed to the success of the farmers who first adopted the new technology (Ismael *et al.*, 2001). Looking at the benefits indicated by the adopters and the perceived benefits indicated by the then non-adopters, it is very interesting to compare the before and after benefit perception. While 32% of non-adopters indicated that a yield increase is the most important benefit of Bt cotton, increased yield was only indicated as the most important benefit by 18% of adopters. Increased yield is still indicated as a reason by more than 58% of adopters, but it seems that the most important benefit of Bt cotton after adoption is pesticide saving. In rural areas where infrastructure, transport, and services are almost nonexistent, managing pest infestation in crops is a major problem.

### Difference in adoption behaviour between large-scale and small-scale farmers

Compared to small-scale farmers, the increased yield benefit is not that important to large-scale farmers. Although more than 50% of large-scale farmers indicated increased yield as a benefit, it is seen more as a bonus. The big advantage for large-scale farmers is that insect-resistant cotton gives them the peace of mind and the managerial freedom to go on with other farming activities. As previously mentioned, the whole process of pesticide application is more capital and management intensive than labor intensive for large-scale farmers. Large-scale farmers have to hire an airplane or use their own tractors to apply pesticides. The difficulty lies in scheduling sprays between rain and irrigation events.

### Benefits of Bt-cotton as indicated by small-scale farmers

Real and perceived benefits	Most important benefit (% of farmers)		Specific benefit (% of farmers)	
	Non-adopters	Adopters	Non-adopters	Adopters
Increased yield	32%	18%	62%	58%

Better quality cotton	5%	3%	12%	30%
Higher price for cotton	0%	1%	12%	15%
Pesticide saving	35%	50%	77%	70%
Labor saving	10%	10%	42%	35%
Application saving	5%	3%	30%	18%
Other	10%	13%	27%	40%

The large percentage of small-scale farmers indicating that pesticide saving is the most important benefit is not really surprising. When one includes saving on application cost and labor along with pesticide saving, more than 63% of small-scale Bt-adopters agree on the entire bollworm control benefit of Bt cotton. Pesticide application implies huge difficulties for small-scale cotton farmers—with a low level of education amongst small-scale farmers, problems with mixing pesticides and calibrating knapsack sprayers for different pesticides cause concern about the real efficacy and effectiveness of pesticide application. Applying pesticides is very labor intensive for small-scale farmers. Walking with a knapsack sprayer on his back, a farmer has to cover a distance of between 10 and 20 kilometres per hectare. Water is a very scarce commodity (especially in the Tonga community) and has to be fetched from communal water points with water trucks or some other transport. By the time a farmer has noticed bollworms, bought pesticides, and started to spray, severe damage has already been done.

Large-scale cotton farmers indicated other indirect benefits of Bt cotton. Spraying less pesticide or none at all has caused predator insects to flourish. More than 46% of farmers noticed more beneficial insects on their Bt cotton fields.

### **Impact on farm income**

The adoption of Bt cotton impacts farm income in three main ways:

- Decreases input cost through savings on pesticide chemicals and application costs
- Increases input cost through higher seed price and additional technology fee
- Increases yield

### **Yield effects**

The average cotton yield of adopters was significantly higher than that of non-adopters for both large-scale and small-scale farmers. There was also a yield difference between the cotton produced under pivot irrigation and flood irrigation.

### Cost effects

It is normally argued that Bt technology would save costs mainly through decreased use of pesticides. The clear cost advantage of applying less pesticide is wiped out when the higher cost of Bt seed and the technology fee are taken into account.

### Impact on net farm income

Despite a higher seed cost and the additional technology fee, both large-scale and small-scale farmers realize higher net incomes per hectare due to the higher yield and savings on pesticide chemicals. This income benefit will increase even more when cost of application is taken into account. The advantage of fewer chemical applications for small-scale farmers is both financial and health related—less labor and water transport needed, and there is less exposure to toxic chemicals. Large-scale farmers save on fuel, repairs, and maintenance or on flying costs. There is also less tractor traffic in the cotton fields, causing indirect benefits to soil quality.

**Income effect of adoption of Bt-cotton**

	Small-scale farmer	Large-scale farmer	
	Dryland (R/ha)	Dryland (R/ha)	Irrigation (R/ha)
Mean yield benefit per hectare @ R2.75/kg	498.19	314.44	1740.75
Mean reduced pesticides benefit (chemicals)	32.17	113.83	292.91
Mean increased seed and technology fee detriment	(163.08)	(234.17)	(570.23)
Income advantage	367.28	194.10	1463.43

### Conclusions

The very impressive adoption rate of insect resistant cotton in South Africa can be attributed to different benefits enjoyed by adopters. Both large-scale and small-scale farmers enjoy financial benefits due to higher yields and despite higher seed costs. It is encouraging to hear reports of cross-pest control improvements due to less spraying. Certainly, diverse analysis of the results from the various surveys are underway and promises to deliver interesting results on the various impacts Bt cotton is having on the South African cotton industry.

### References

- Anthony M. 2002. Department of Agriculture, Mpumalanga, Personal communication.
- Bennett A. 2001. Monsanto South Africa, Personal communication.
- Cotton SA Katoen. A Journal for the Cotton Industry.* 2002. Vol 5 Nr. 2, May.

*Cotton South Africa*. 2002. 4<sup>th</sup> Cotton Crop Report for 2001/02 production year, May.

Ismaël Y, Beyers L, Piesse J, and Thirtle C. 2001. Smallholder adoption and economic impacts of Bt cotton in the Makhathini Flats, Republic of South Africa. *Report for Dfid Natural Resources Policy Research Programme*, Project R7946, April 2001.

Olivier D. 2002. Delta Pineland South Africa, Groblersdal, Personal communication.

Van Jaarsveld J. 2002. Delta Pineland South Africa, Makhathini Flats, Personal Communication.

*Johann Kirsten and Marnus Gouse*  
*Dept. of Ag. Economics, Extension and Rural Development*  
*University of Pretoria, South Africa*  
[mgouse@tuks.co.za](mailto:mgouse@tuks.co.za)