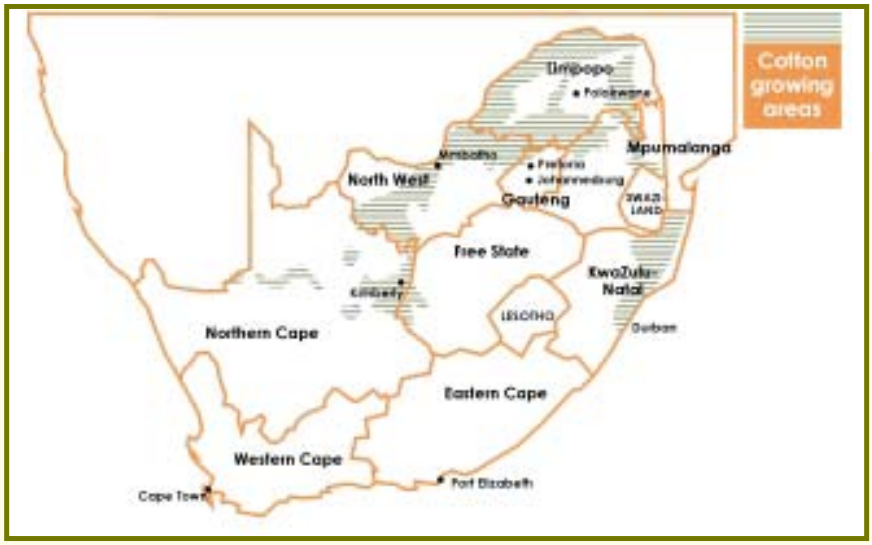
Genetically Engineered Cotton. High risks, low returns.

Cotton has been been adopted more rapidly than any other genetically engineered (GE) crop in South Africa. In the 2002/2003 season GE varieties made up 75% of the cotton produced in South Africa. The country is a small producer by international standards and does not meet more than 50% of local demand. Since the introduction of GE, cotton production has dropped dramatically (47% lower in 2003) resulting in a loss of 24 000 jobs. The United States and China dominate world cotton production, with both countries heavily subsidising their cotton farmers. This makes it difficult for African producers to compete even when their production costs are substantially lower.

This briefing looks at the nature of cotton production in South Africa and at the uptake and impact of GE varieties in the country.



Cotton farming in South Africa

Cotton is grown mainly for the seed hairs, called lint, which can be spun and woven to make cloth. The seeds also yield edible oil used in a variety of foodstuffs. Once the oil is extracted the dry meal is used to produce animal feed. Both small and large-scale farmers grow cotton as a cash crop in South Africa. About 70% of production is dryland and about 30% is under irrigation where yields are up to eight times higher. On most large-scale farms cotton is a secondary product and the area planted varies depending on the anticipated price, and prices expected for other crops like maize and sunflower. Large-scale commercial farmers produce the bulk of the South African cotton crop. In the 2001/2002 season 300 large-scale farmers produced 95% of the crop, while 3 000 small-scale farmers on the Makhathini Flats in Northern KwaZulu Natal and in the south-eastern part of Mpumalanga produced the remaining 5%.

South African cotton producers must keep their prices below the price of imported cotton (including import levies and duty) otherwise the spinners will simply import the cotton which they need, leaving South African producers without a local market for their goods. In addition, export costs will make the South African cotton too expensive to export. For this reason the price paid to cotton growers by ginners is closely tied to the international price.

Cotton research and extension in South Africa is highly problematic. The Agricultural Research Council (ARC), a statutory Science Council, is the main research institution in South Africa working on cotton but funding cuts have curtailed the extent to which it can work on new varieties and provide information to farmers. Government extension services have also been drastically reduced, leaving farmers to rely on information from staff and representatives from private seed companies, who clearly have a vested interest in promoting their products. Support from these companies is also limited to large-scale farmers and mainly covers information on cultivating specific GE varieties and the use of agro-chemicals. The ARC's Industrial Crops Research centre in Rustenburg is engaged in conventional breeding to reintroduce leaf hairiness characteristics, and to introduce a more open canopy growth form, both characteristics that will assist with pest management, but there is an urgent need to look at varieties that will benefit resource-poor farmers. In countries such as India, innovative research has led to the release of new varieties that do not need spraying - without the use of GE - but in South Africa such initiatives are sorely lacking.

biowatch SOUTH AFRICA biodiversity|food security|biosafety|social justice

Briefing No. 3 | 2004

Genetically engineered cotton

Genetically engineered cotton now dominates both large and small-scale cotton production in South Africa in all areas except along the lower Orange River where farmers plant the non-GE Acala OR variety. This variety is owned by the Orange River Co-operative and is specifically adapted for local conditions.

Two companies, Delta and Pinelands (D&PL) and Clark Cotton, dominate the supply of cottonseed in South Africa. D&PL is responsible for the introduction of most GE varieties using Monsanto gene constructs. To counter inconsistent quality, Cotton SA now recommends four varieties for planting each year based on trials. Of the four varieties recommended for planting in the 2003/2004 season, three come from D&PL. They are Delta Opal (non-GE), Nu-Opal Bt (GE) and DP5690 RR (GE). The fourth variety is the non-GE Acala OR3. The number of cotton varieties available to farmers has decreased substantially since the introduction of GE cotton, falling from 12 to 8 varieties for the 2001/2002 season, and then to only 4 varieties in the 2003/2004 season. Spinners have expressed dissatisfaction with the quality of cotton now being produced.

D&PL are the only source of seed outside the Orange River area. The company concedes that this opens them to accusations of unfair influence over the varieties available but argues that they have an extensive breeding programme to develop strains suited to local varieties. They plan to release a hairy leafed GE variety resistant to jassids in the near future. Present GE varieties are all smooth leaved as they are developed mainly from American strains, rather than the hairy leaved, jassid resistant strains used in Africa. Clark Cotton is developing new cotton strains elsewhere in Africa and will introduce them to South Africa when market conditions are more favourable.

GE seed costs more than conventional seed as farmers pay an additional technology fee of R700 per 25kg bag. Despite this, D&PL is confident that GE seed will continue to dominate the market because they believe it simplifies production and saves on overall input costs. Estimates for 2002 indicate that GE seed accounted for 75% of the market: Bt cotton (35 %), RR cotton (10%), and stacked varieties (30%).

Farmers and GE contracts. When they buy GE seed farmers sign a technology agreement, stipulating that the buyer:

- may not use the seed for any other purpose including breeding, research, seed production and analysis;
- may not resell or transfer the seed to anyone else;
- may not save any crop produced from the GE seeds for future planting, or in the case of cotton, rattoon the plants and re-harvest from the same GE plants in future seasons (rattooning is a method of cutting the crop so that it sprouts again); and
- will plant a refuge with non-Bt seed.

In terms of this agreement, Bt growers agree to implement the Insect Resistance Management Programme (IRMP) and RR growers are entitled to a certain amount of Roundup herbicide. Commercial farmers appear to be well informed about procedures for cultivating GE crops, but in the absence of monitoring it is not possible to know the extent to which these are implemented. In contrast, most small-scale farmers are not able to understand these contracts, as they are only available in English and are technically complex. They are also not aware of the refuge requirements and are not implementing them.

Permits issued for GE cotton as of July 2004

Company	Delta & Pinelands		Monsanto		Stoneville	Syngenta	Calgene
Permit type	Field Trials	General Release	Field Trials	General Release	Field Trials	Field Trials	Field Trials
GE Trait							
Insect resistant: Bt Bollgard	18	3	2	2	4	4	
Insect resistant: Bt Bollgard II	2		2	1	4		2
Herbicide resistant: RR	8	5	2	1	6	1	2
Stacked genes: Bt +RR	7		5		7		1

Source: Department of Agriculture website (www.nda.agric.za)

***Note**: These figures are an estimate only as the information provided by the Department of Agriculture is not complete or reliable.*

Impacts of GE cotton

Environmental and health impacts. The environmental risks of GE cotton include the development of insect resistance, toxicity to non-target insects and soil micro-organisms, contamination of non-GE cotton, increased pesticide spraying (which has a host of health and environmental risks) and reduced biodiversity. GE cotton has been planted for a relatively short time in South Africa and it is too early to assess long term environmental and health impacts. However, there is sufficient evidence to suggest the need to adopt a precautionary approach to GE crops.

The risk of contaminating non-GE crops and developing herbicide resistant super weeds is lower with cotton than with crops such as maize or canola, but still present. Cotton is generally self-pollinating, but can be cross-pollinating in the presence of suitable insect pollinators such as bees. There is therefore a risk of cross-pollination where GE varieties are grown close to non-GE varieties. It is evident that South Africa should have applied stricter biosafety measures to ensure the protection of valuable African cotton varieties.

▶ *Benefits to farmers*

Some farmers have stated that they are satisfied with Bt cotton as they save on pesticide and have 'peace of mind about bollworms'. However, the evidence is not conclusive. Some farmers say it increases their profits by up to 20% despite the higher cost of seed and the technology fees, while others say they do not make a profit, but find it easier to manage. Some farmers report improved yields but there have also been reports of crop losses because of secondary insect outbreaks, such as stinkbugs.

Bt cotton growers report having to spray for bollworm as well as spraying for leafhopper pests, which were controlled previously by the bollworm spray program. In Australia, pesticide benefits of Monsanto's GE Ingard cotton varieties compared to conventional cotton are reported to be declining. Average use of insecticide in this study was 52% less in 1996/1997 (season of Ingard introduction), 44% less in 1997/1998, and only 38% less in 1998/1999. Economic benefits from the new technology have been variable but typically small when compared to conventional cotton. In addition, savings in pesticide are often swallowed up by the extra cost of the seed. Emerging evidence from South Africa echoes this experience. It is likely that most cotton farmers will continue to plant GE seed for the foreseeable future, despite reports of some commercial farmers switching back to conventional cotton because of high license fees and smallholders being left with big debts after drought and flood related crop failures. This is mainly because of aggressive marketing and a lack of choice as the number of available seed varieties declines.

▶ *Monitoring and Risk Assessment*

A major concern is that there does not appear to be a concerted and structured effort to monitor or conduct research within South Africa about pest resistance or other implications of growing Bt cotton. There is also no ongoing support to growers of Bt cotton to ensure adherence to refuge requirements and other risk avoidance measures. Clark Cotton provides general extension services to all their client growers and seed purchasers. The attitude of D&PL is that they are only responsible for ensuring that their varieties are up to standard, and that the Bt varieties carry the Bt gene. They deny having any responsibility for the effects of the Bt gene and therefore see no need to monitor Bt cotton in the field. Interestingly, as of March 2000 the United States Environmental Protection Agency has required Monsanto to submit monitoring data on the susceptibility of field-collected insect pests to Bt. The obvious question is why South Africa does not require similar measures.

Small-scale cotton farming at Makhathini

Smallholders on the Makhathini Flats and in other areas produce cotton on contract for buyers and receive a package of inputs and extension services. Initially a high percentage of cotton producers on the Flats adopted Bt cotton, but many have not planted any cotton over the last two seasons due to droughts.

These growers receive integrated support from Vunisa Cotton and Monsanto, and get credit from the Land Bank. Without this credit they would not be able to afford GE cotton. Vunisa Cotton was set up by Clark Cotton and dominates input supply and markets, serving as an agent for seed and agrochemical companies in the area as well as buying the cotton from the farmers after harvest. This role has now been taken over by Makhathini Cotton as neither the Land Bank nor Vunisa is currently providing credit and are still trying to recover old debts that farmers could not repay. Makhathini Cotton leases the land from the farmers and undertakes all farming operations.

Farmers growing Bt cotton initially reported a reduction in pesticide use and an increase in yield, which combined to outweigh the higher cost of seed. However, these benefits were short-lived. Subsequent seasons with floods and droughts have left them with huge debts, which they are only able to finance from other sources of income.

Types of GE cotton

Bt cotton varieties contain a gene from *Bacillus thuringiensis*, a bacteria that is toxic to cotton bollworm. RR varieties have been engineered to tolerate Roundup Ready, a glyphosate herbicide produced by Monsanto, the company that supplies the gene construct. 'Stacked' varieties contain two gene constructs, either two Bt genes or both the RR gene and Bt gene. Field trials on both these types of stacked varieties are underway in South Africa. Australian plant breeders have said that the second Bt gene in Bollgard II is largely there to counter insect resistance. This means that if there are individuals in the bollworm population that are resistant to the first gene, the second gene will kill them.

These second and third generation GE crops are being developed because insects and weeds are almost certain to develop resistance over time. It is therefore crucial that the environmental and health implications of using increasingly potent pesticides are considered comprehensively by scientists with no vested interests. Such assessments need to inform any decisions about whether the benefits of introducing GE cotton varieties outweigh the high risks entailed.

What is a Refuge?

A major concern is that resistance to the Bt toxin produced by Bt crops will develop in target insects. This will render the currently available Bt crops useless, and will compromise the effectiveness of the widely used biological Bt insecticide. The industry has recognised the real possibility of resistance developing and has made it a contractual requirement that users of Bt crops plant refuges of non-GE varieties to ensure that a sub-population of insects is not exposed to Bt toxin. This sub-population will not develop any resistance and will pass on the non-resistant gene, diluting the resistant genes coming from insects that have been exposed to and survived Bt toxin. Contracts for Bollgard® cotton require a 25% non-GE refuge using conventional insect controls; YieldGard® Maize requires a 20% non-GE refuge, also with conventional insect controls.

Conclusion

GE cotton has taken off in South Africa. Because cotton is a crop with exceptionally high pesticide use, the prospect of spraying less has made it very attractive. However, farmers using the next generation of GE cotton, Bollgard II, will have to deal with the problem of insect resistance developing, putting farmers on a GE treadmill. The lack of monitoring and risk management places both farmers and consumers at risk and must be addressed through comprehensive and independent assessments and monitoring plans. The public in South Africa is not aware about the risks and impacts of GE, and the inclusion of GMOs in products, and although cottonseed oil is used in a variety of foodstuffs, suppliers do not require the separation of GE and non-GE seed.

For many small-scale farmers, adopting GE cotton has meant that after two apparently good seasons, they have now accumulated insurmountable debts, making it an unsustainable option, financially, socially and in terms of long-term survival. The danger is that when farmers find out that GE cotton is not working for them, they will be faced with vastly reduced options in terms of varieties as companies continue to assert monopoly control over seed supply. Urgent action is needed to increase the varieties available to both small-scale and large-scale farmers; to provide independent information to farmers about management strategies for cotton, and GE cotton in particular; to undertake research that looks beyond the cotton industry towards alternatives that are more economically and environmentally sustainable in the long-term; and to undertake comprehensive and independent environmental impact assessments for GE cotton, beyond the inadequate desktop risk assessments done to date. Without such steps South Africa will renege both on its international responsibility to protect biodiversity, and on its national imperative to alleviate poverty and promote sustainable development.

References

Research in this briefing paper is based on that done by Biowatch researchers. Other key references include:

1. *Benbrook, C. 2003. Economic and environmental impact of first generation genetically modified crops: Lessons from the US. (http://www.iisd.org/publications/publication.asp?pno=567)*
2. *Committee of the Australian Cotton Growers Research Association. 2002. Resistance management plan for Ingard Cotton 2001-2002. (www.cotton.pi.csiro.au/Publicat/Pest/IRMS/irms0102.html)*
3. *Cotton SA 2003b Cotton Market Report. (www.cottonsa.org.za/economic_info.html)*
4. *Fernandex-Cornejo.J. & McBride, W. 2002. Adoption of Bioengineered Crops. Agricultural Economics Report 810, USDA Economic Research Service, Washington. www.ers.usda.gov/publications/aer810)*
5. *Ismael, Y. Bennet, R. & Morse, S. 2002. Benefits from Bt cotton use by smallholder farmers in South Africa. AgBioForum,5 (1), pp.1-5*
6. *Monsanto 2003 'GM Cotton Agreement'. Available from Monsanto SA.*
7. *Sharma, A. 2004. India Develops New Pest-resistant Cotton Varieties. Financial Express, June 27 http://www.financialexpress.com/fe_full_story.php?content_id=62316*

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