Efforts to Expand Genetically Improved Cotton in Africa

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Abstract

The procedure required to move forward with regard to getting genetically improved cotton accepted and commercially available is discussed. Three steps generally need to be taken, namely getting biosafety guidelines or regulations in place, secondly testing the technology for efficacy and suitability, and then thirdly, moving forward with commercialization thereby making the technology available to cotton growers. This paper also looks at some of the benefits of Bt technology under small scale production, in order to encourage efforts to expand the availability of these technologies in Africa. The adoption of this technology amongst smallholder growers in South Africa has been characterized by a high rate of acceptance, increased yield, reduced spraying and easier crop management.

Introduction

Bt cotton in the form of Bollgard™ received regulatory approval in South Africa in 1997. The technology provides superior control of the species comprising the bollworm complex, namely *Helicoverpa armigera*, *Diparopsis castanaea* and *Earias* spp. The gene components comprising the Bt technology which are introduced into the cotton genome do not alter any of the fibre properties of the variety, and fibre produced from a transgenic variety is indistinguishable from fibre produced under similar conditions in the isoline variety (Kerby et al, 2001). Furthermore, the "behavior" of fibre produced from transgenic varieties is identical to that produced from fibre produced by the isoline variety with respect to dye uptakes, spinning and fabric properties (Ethridge & Hequet, 2000). These properties ensure that lint produced from transgenic varieties is not subject to the controversies surrounding other genetically improved agricultural products, and the lint is marketed without restriction.

The Way Forward for Biotechnology in Africa

Africa needs to be proactive in developing a biotechnology policy. It is very important that Africans decide for themselves whether they wish to adopt these technologies or not, since Africa is faced with its own unique set of circumstances. It is not helpful for Africa to have western organizations making policy for Africa. In developing such an indigenous policy, it is very important too that biosafety guidelines and legislation be developed and put in place. Capacity in the form of institutions and technical personnel need to be developed, so that procedures for testing and assessing these technologies can be done in Africa. Testing of technologies needs to be done on an individual basis – some technologies will be suitable and others not, and Africans must be in a position to make these judgements.

Collaborative research programs must be initiated and supported, with the focus of this research being aimed at crops and technologies that satisfy African requirements. It is also critically important that public awareness of the benefits and disadvantages of these technologies is developed. It is equally important that the debate around biotechnologies is conducted on the basis of factual, scientifically based information, and not on the emotions of different groups that have varying interests in the success or failure of biotechnologies. If a " European" type debate is conducted in Africa, Africa will surely lose out on the benefits that these technologies can offer.

In order to reap sustainable and long term benefits from biotechnology, further scientific capacities need to be developed. This is not to say that these capacities do not already exist in Africa, for they most definitely do. However to be able to test, adapt and implement new technologies rapidly and responsibly, greater capacities will be needed in the future. The rapid and responsible implementation of technologies that are appropriate to African needs will maximize the potential benefits of biotechnology.

Lastly, some form of intellectual property protection needs to be developed, implemented and applied. Initially, investor companies will be more comfortable in investing new technologies in Africa, but more importantly, as indigenous African biotechnologies, which have global value, are developed, they too will require protection.

Protection of Intellectual Property Rights

Currently, plant variety protection and patent protection is only available in South Africa, Zimbabwe and Kenya. Acceptance and implementation of International Union for the Protection of New Varieties of Plants and other international conventions by African countries will contribute greatly to the adoption and expansion of biotechnologies.

Biosafety Guidelines/ Legislation

Although many African countries are working hard to get legislation in place, at present only Egypt, Uganda, Kenya, Zimbabwe and South Africa have acts or regulations in place, which govern the responsible use of biotechnologies.

In Zimbabwe, approval has been granted for the testing of Bt cotton. In Kenya and Uganda, applications for trials to take place have been submitted and are currently under review. Burkino Faso is in the process of developing biosafety legislation. Swaziland and Malawi are showing a strong interest in developing guidelines and legislation, while in Tanzania, strong media support is developing.

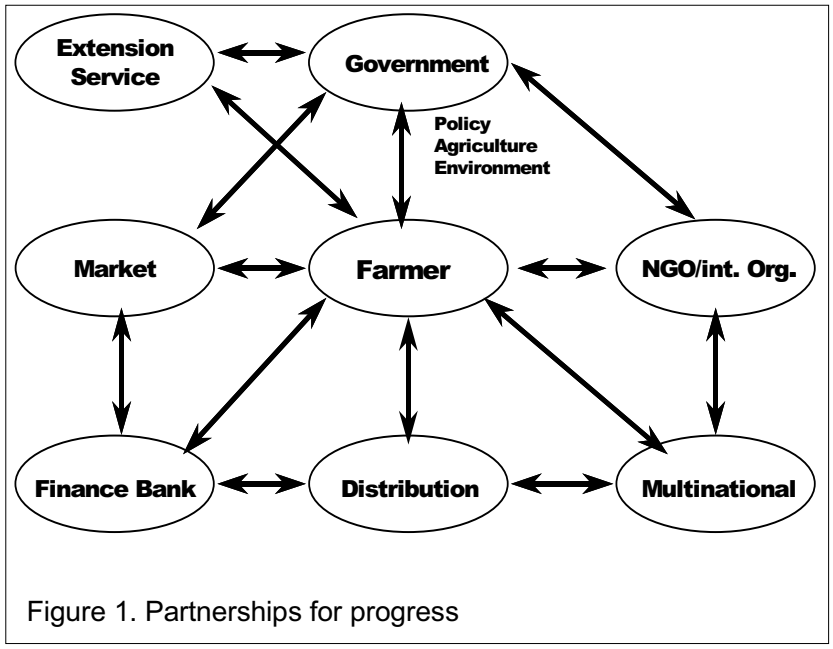

Figure 1. Partnerships for progress

Partnerships for Progress

Current agricultural biotechnologies (so called first generation) are aimed at benefiting agricultural producers. It follows that the farmer should be the centre of efforts to make these technologies available and sustainable. In Africa it is estimated that about 70% of the population is closely connected with an agrarian way of life, thus these first generation technologies seem to be very suitable for Africa. However, all role players need to be involved in developing "partnerships for progress". Governments need to lead in guiding policies in the fields of commerce, agriculture and the environment. They can also develop extension services aimed at increasing farmer success and sustainability. NGO's and other international organisations can assist by providing training and expertise. Multinationals also have a role to play initially, by providing technologies, expertise and know how. The role of multinationals may be expected to diminish in time as local capacities, infrastructures and technologies are developed. Distribution and financing are also opportunities which present themselves through the adoption of these technologies (Figure 1).

What Africans Say

"Africa is already in the biotechnology revolution. We should not be debating whether or not the continent should go for the technology but what specific policies and institutions are required to enable Africa to maximize benefits and minimize risks associated with genetic engineering."

Dr. John Mugabe
Director African Centre for Technology Studies

"Africa missed the Green revolution which helped Asia & Latin America achieve self sufficiency in food production. Africa cannot afford to be excluded from the Biotechnology Revolution".

Dr Florence Wambugu

Bt cotton Benefits to Small Holder Cotton Farmers in the Makhathini Flats, South Africa

Smallholder growers in the Makhathini Flats are organized into some 42 independent farmers associations comprising approximately 4500 growers. Typically, these farmers grow between 1 and 3 ha of rainfed cotton annually, with the total crop covering anything between 2,500 and 10,000 ha. The number of hectares grown each year depends largely on the availability of financing as well as the cotton price. Currently, a single ginnery serves the entire area, with cotton being collected from various depots in the region. Farmers are served to a lesser or greater extent by the ginnery extension personnel, government extension officers and technical advisors from commercial companies. This paper synthesizes the results of several studies conducted in the Makhathini Flats, and presents data on adoption rates, yield, spraying, and some socioeconomic parameters. It is concluded by noting the contribution that these types of technologies can make to the quality of life and the alleviation of poverty across Africa.

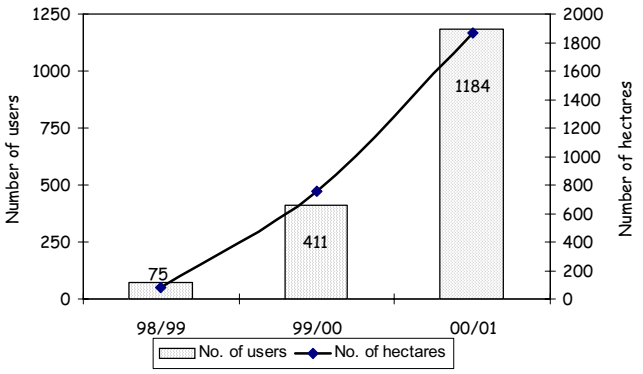

Figure 2. Adoption of Bt technology by smallholder growers

Adoption Rate of Bt Technology

In the three seasons that Bt cotton has been available, the growth in the number of smallholder users has doubled 4 times i.e. a 16-fold increase (Figure 2) (Unpublished Monsanto records). The fact that this response has been observed coupled with the fact that the transgenic seed is more expensive, clearly indicates that real advantages accrue to adopters of the technology.

When questioned on why they adopted Bt technology, 24% cited expected increases in yields as the main reason. 44% of the respondents cited saving on chemicals and pesticides and 10% believed that the labor saving properties of Bt cotton were critical in the adoption decision. Adopters of Bt cotton (35%) felt strongly that pests were their major problem and this prompted them to adopt the bollworm resistant variety. (Ismael et al 2001).

Agronomic Benefits of Bt cotton

Yield Improvements and Spray Reductions

In a set of four strip trials, yields were compared between the Bt variety and its non-transgenic isoline. A mean yield increase of 27.3 % (388 kg seed cotton/ha) was observed (Table 1) (Bennett, 2001). In the same set of strip trials, the numbers of sprays between the two treatments was also observed. On average, 5.8 fewer sprays were required by the Bt cotton compared with the non-transgenic isoline (Table 1). Taking the variable costs involved, including the additional technology cost, it was calculated that the Bt cotton delivered a direct incremental benefit of R 943.00/ha ($112/ha) over the non-transgenic cotton.

In a recently conducted independent study (Ismael et al 2001), in which 100 Makhathini farmers were investigated, it was found that:

- The farmers who adopted the Bt cotton variety in the 1998 and 1999 seasons benefited from the new technology, according to all the measures used.
- Using a stochastic frontier model, Bt adopters were 81% efficient on average over two season, compared with 57% efficiency of non-adopters
- Similarly, determinist frontier results for both years show that the adopters were over 62% efficient, while the non-adopters averaged only 46%.
- Finally, there was no evidence that wealthier farmers gained more than the less affluent: indeed, income inequality was slightly reduced.

Savings

Non-transgenic cotton requires up to 8 or more sprays for bollworm. Bt cotton can eliminate this requirement almost completely and provide savings in the following:

- Time and labor: To properly spray one hectare of cotton with a knapsack takes the best part of a day and entails walking at least 20 km.
- Water: The provision of good quality water for the spraying of insecticides is difficult, and Btcotton largely obviates this.
- Insecticide and equipment costs: Less insecticide is required for Bt cotton, with concomitant savings in inputs.

Improved Safety

- Bt cotton reduces the need to handle hazardous chemical insecticides.
- Insecticide containers are often used to transport drinking water - Bt cotton reduces the numbers of containers available for this dangerous practice.
- Reduction in insecticide usage reduces the risk of contamination of domestic water sources in rural areas, e.g. streams and dams.

Table 1: Comparison of Bt and non-Bt yields in the Makhathini*

Trial no.	Yield (kg/ha)		Yield increase		Value of increase	Spray Cost R/ha			Total benefit inclusive of tech cost (R/ha)	Number of sprays saved
	Bollgard	non-Bt	kg/ha	%	@ R2.50 / kg	Bt	non-Bt	difference		
1	2,349.40	2,005.30	344.1	17.2	860.25	0	172.2	172.2	807.45	7
2	1,507.80	1,205.50	302.3	25.1	755.75	0	147.6	147.6	678.35	6
3	1,475.00	1,149.30	325.7	28.3	814.25	29	189.8	160.8	750.05	6
4	2,090.40	1,509.40	581	38.5	1,452.50	34.8	147.14	112.34	1,339.84	4
Mean	1,855.70	1,467.40	388.3	27.3	970.69	22.61	220.48	197.87	943.56	5.8

*Bennett et al, in press
1 US$ = App.8.4 Rands (R)

Improved Bollworm Control Efficiency

- The effect of weather on bollworm control is reduced. Wind during spraying affects insecticide coverage negatively, and rain after spraying can necessitate a re-spray, with additional costs.
- Even under optimum spraying conditions, bollworm control is not as efficient as with Bt cotton.

Socioeconomic and Environmental Benefits of Bt Cotton

Economic Upliftment

In the Makhathini, average yields have increased since the introduction of Bt cotton. Prior to the past season, the highest average yield for the region was 620 kg/ha. The 2000/01 season realized an average yield of 980 kg/ha with the improvement being ascribed to Bt technology, since the variety composition has not changed (Grey, pers.comm). Yield increases of these magnitudes result in greater inflows of cash into the region, and increased economic activities.

Bt Technology Provides for more Efficient Land Utilization Through Superior Yields

- Varieties containing Bt technology provide higher yields than the same varieties without Bt technology.
- Improved yields ensure more efficient land utilization, and land is fast becoming a limited resource.

Bt Technology Reduces the Use of and Reliance on Broad-spectrum Insecticides

- Reduced broad-spectrum insecticide usage lessens environmental pollution.
- In rural areas, pesticide runoff often enters bodies of water and rivers, which are used as a source of drinking water for the rural population.
- Reduced broad-spectrum insecticide usage promotes the biological control of secondary pests. (aphids and spider mites), which further reduces the number of sprays on cotton.

Conclusions

Effective Bt technology in cotton represents an effective and safe means of controlling major pests. This results in increased yields, more efficient land usage and reduced environmental impacts from pest control in cotton production. The successful and rapid adoption of this more expensive technology in the Makhathini Flats provides an initial model for smallholder cotton farmers in Africa, and testifies to the incredible benefits that can be achieved through the responsible implementation of agricultural biotechnologies.

These benefits can be realized across Africa when biosafety legislation, intellectual property protection, additional capacity building, public awareness based on facts and partnerships for progress are implemented.

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