Biotech Cotton and the Technology Fee

(Argentina, Australia, Brazil, Burkina Faso, Colombia, India and South Africa)

Fourteen years after the commercialization of biotech cotton in the mid 1990's, only two traits are available to cotton growers: insect resistance and herbicide tolerance. Each trait has different reasons for adoption. This paper will mainly discuss the insect resistance trait of biotech cotton and the reasons for adopting it. Insect resistance is also the most widely adopted trait, particularly in the developing countries that have commercialized biotech cotton so far. The herbicide tolerance trait follows a different approach. Although both traits target yield improvement, one reduces the use of insecticides while the other encourages the use of herbicides.

Despite appearances to the contrary, there is no one reason for which insect resistant biotech cotton is grown in various countries. The benefits of insect resistant biotech cotton are highly dependent on production practices and thus vary greatly among countries. Countries that have experience with biotech cotton have determined that its benefits are not only increased yields or economic gains. Countries that are exploring the possibility of adopting insect resistant biotech cotton may also expect one or more of the following benefits.

- The primary consideration is that the number of insecticide applications against target insects will be significantly lower. This is true for all production systems, but the number of sprays against non-target insects might increase, particularly those that attack cotton during the period when sprays against target insects have been eliminated. The latter situation has been seen in South America, where the boll weevil is a serious pest and can flourish when insecticides are not sprayed against bollworms. Viewed exclusively in terms of the impact on the number of insecticide sprays, it may or may not be economically advisable to replace insecticides in favor of the biotech toxin in cotton.
- People from different schools of thought can argue about the various aspects of biotechnology, particularly with respect to food crops, but the fact remains that as far as cotton is concerned, the Bt toxin, in the plant are effective against bollworms, budworms and cutworms. Thus, better fruit protection assures better yields if, for any of various reasons, conventional insecticide control should prove to be ineffective. This was the experience in India, although a number of other factors also contributed to increases in yields in India since 2002/03.
- The cost of the technology fee compared to savings on insecticide sprays against target insects is a critical factor in deciding to adopt insect resistant biotech cotton. If the target insects are not serious pests on cotton, or if insecticide control against them costs less than the technology fee, it may not be economically advisable to grow insect resistant biotech cotton.
- Insect resistant biotech cotton eliminates the need for spraying against Lepidopteran insects such as bollworms and budworms. Reports from various countries show that sucking insects increase on biotech cotton when sprays against Lepidopteran insects are eliminated. Wherever this happens, the total cost of insect control through insect resistant biotech cotton may be equal to that of conventional production, thus growing biotech cotton becomes less attractive.
- A number of other benefits that may not have a direct economic bearing are certain. Insecticides are highly toxic compounds and many people inadvertently inhale insecticides from airborne drifts, particularly if they are using hand sprayers, either motorized or unmotorized. Reduced exposure to insecticides by planting biotech cotton results in fewer insecticide-related incidents. Growers save time and money on all insecticide-related issues.
- Even if there are no economic benefits, applying fewer poisonous compounds into the environment contributes to environmental safety and improves long-term sustainability of cotton production.

Argentina

Argentina commercialized insect resistant biotech cotton in 1998/99 with the planting of about 5,000 hectares to Bollgard® varieties. The biotech cotton area doubled every year for the next two years until irregularities in the seed supply system and the use of own-seed by growers affected the interests of the seed companies dealing with biotech varieties. The price of technology for biotech seed shown in the table below refers only to the technology fee and does not include the price of the planting seed, which is usually higher than the price paid for conventional planting seed. The sum total of all costs, including a 21% tax on a 15-kg bag of seed, enough to plant a single hectare, reached approximately US$128/ha

Technology Fee for Biotech Planting Seed in Argentina

Year	Fee for Biotech Cotton US$/Ha	
	Bollgard	Roundup Ready
1998/99	76.0	-
1999/00	70.0	-
2000/01	60.0	-
2001/02	60.0	30.0
2002/03	60.0	30.0
2003/04	40.0	30.0
2004/05	40.0	30.0
2005/06	40.0	30.0
2006/07	40.0	20.0
2007/08	40.0	20.0
2008/09	40.0	20.0

Note: The fee is for 15 kg acid delinted seed enough to plant a hectare.

in two years. Conventional planting seed was sold at US$15-20/ha. Thus, it was commonly believed in Argentina that the technology fee was too high.

In Argentina, on average, conventional cotton was sprayed with insecticides 4.5 times in 1999/00, versus 2.1 sprays on biotech cotton. The next year insect pressure was slightly higher and conventional cotton required 5.1 sprays, versus 2.8 on biotech cotton. Bollworms and boll weevils appear in the field at the same time in Argentina, and the elimination of sprays against bollworms allows boll weevils to flourish. This might also be a factor in the reduction of biotech cotton area since 2001/02 and thereafter. Informal biotech area may be higher than the area officially reported. Since 2001/02, the technology fee has been reduced significantly, but the farmers' trust in the technology has not been restored.

Australia

In Australia, Bollgard®, called Ingard in Australia, was introduced in 1996/97. Australian growers paid a technology fee (also called license cost) of US$195/ha (A$245/ha) for Ingard cotton in 1996/97. However, there were concerns among cotton growers, and in 1997/98, Monsanto lowered the technology fee to US$167/ha (A$210/ha). The agreement also included the following two conditions:

- Monsanto would compensate growers if the cost of controlling target insects on Ingard cotton was greater than the cost of controlling insects on the equivalent conventional crop.
- If growers sprayed Ingard cotton two times with conventional sprays, they would receive a rebate of US$25 for each hectare of Bt cotton they planted during 1996/97.

Farmers also received a rebate if resistance management requirements were fully implemented. Anticipating the release of Bollgard®II, the Australian cotton industry imposed a self-restriction on Ingard planting under which cotton growers would plant no more than 30% of total cotton area. The 30% limit was reached in 2000/01. Australia waited for stacked-gene insect resistant cotton to be available. Bollgard®II was introduced on a commercial scale in 2003/04. Australia also decided to phase out the Ingard trait by planting 1% of the area to Bollgard®II and 29% to Ingard in 2002/03. Then, in 2003/04, the Bollgard®II area was increased to 12% and Ingard reduced to only 18% of the total area. Ingard was totally replaced by varieties containing the cry 1Ac and cry 2Ab genes (Bollgard®II) in 2004/05, at which time the self-imposed limit of 30% was eliminated.

According to Pyke (2003), Ingard's performance during the first six years of commercial adoption was initially quite variable, but improved over time due to a number of factors, including the introduction of enhanced Ingard varieties, less severe insect infestations, wider adoption of integrated pest management (IPM) practices, introduction of newer, more IPM-compatible insecticides (i.e. spinosad, indoxacarb, emamectin), and overall improvements in the management of Ingard crops.

The costs given below are just for the technology fee and do not include the cost of the planting seed. Prior to the introduction of biotech cotton in Australia in 1996/97, the cost of planting seed was close to US$13/ha under irrigated conditions. Exchange rates are a factor, but the cost in terms of US dollars almost doubled over the next few years. The

Technology Fee for Biotech Planting Seed in Australia

Year	Fee for Biotech Cotton US$/Ha							
	Ingard	Bollgard II	RR	RR Flex	Ingard + RR	BG II + RR	BG II + RR Flex	Liberty Link
1996/97	195.1	-	-	-	-	-	-	-
1997/98	159.9	-	-	-	-	-	-	-
1998/99	95.2	-	-	-	-	-	-	-
1999/00	101.3	-	-	-	-	-	-	-
2000/01	85.9	-	21.6	-	107.5	-	-	-
2001/02	79.1	79.1	25.0	-	104.2	104.2	-	-
2002/03	94.6	94.6	27.7	-	122.3	122.3	-	-
2003/04	142.5	142.5	38.3	-	180.8	180.8	-	-
2004/05	-	148.0	39.7	-	-	187.7	-	-
2005/06	-	183.4	37.4	-	-	220.8	-	-
2006/07	-	237.4	40.4	59.3	-	277.7	296.7	-
2007/08	-	264.5	45.0	66.1	-	309.4	330.6	44.1
2008/09	-	269.3	43.6	64.1	-	312.9	333.5	42.8

Price of Cotton Planting Seed in Australia (US$/Kg)

Seed Class	Fungicide Treatment						
	Dynasty	Amparo	Cruiser	Cruiser/Bion	Bion	Gaucho	Genero
Conventional	4.8	5.6	6.1	6.5	5.8	6.8	6.7
Pima	4.9	5.7	6.2	6.6	5.8	NA	6.8
Monsanto (All traits)	5.3	6.1	6.7	7.4	6.4	7.4	7.2
Bayer (LibertLink)	5.5	6.3	NA	NA	6.4	7.5	NA

technology fee given in the previous table, is for irrigated conditions. The fee for dryland conditions is charged on the basis of "green" hectares planted. Therefore, dryland planting with the same row spacing as irrigated planting commands the same fee, while single skip row (two rows planted/one missed) would be 67% and double skip row (two rows planted and two missed) 50% of the full technology fee under irrigated conditions. More specific data available on the cost of seed for the 2008/09 season reveals the difference in price between biotech and conventional seed, as well as fungicide treatment differences for various chemicals. The cost of acid delinting for all categories is included. On average, 12-14 kg of seed is used to plant a hectare at a row spacing of one meter and a target establishment of 8-10 seedlings per meter.

Brazil

The National Biosafety Technical Committee (CNTBio) of Brazil approved Bollgard cotton in March 2005, but commercial production did not actually start until 2006/07. Later, the CNTBio approved two other events with herbicide resistance. However, these events still needed to undergo variety registration, and planting seed had to be multiplied and made available before farmers could start using them. It was expected that the herbicide resistant trait would be approved for commercial production by the end of 2008. Brazil commercialized Bt cotton for the sake of lowering the cost of production and not to realize higher yields. The existence of the boll weevil as a major pest in the Brazilian cotton production system is limiting the benefits of Bt cotton. The technology fee varies slightly among states.

Price of Bollgard and Conventional Planting Seed in Brazil (US$/ha)

Year	Bollgard Seed	Conventional Seed
2006/07	111	39
2007/08	109	52
2008/09	117	39

Note: Exchange rate used is 1US$ = 2.3 Reais

Burkina Faso

In June 2008, Burkina Faso became the second country in Africa to adopt biotech cotton, after South Africa, which adopted it in 1998/99. On average, six calendar sprays are made on conventional cotton in Burkina Faso, mainly against *H. armigera, Earias spp., Diparopsis watersi* (Red bollworm), *Anomis flava* and some sucking insects. At the request of Burkina Faso's Minister of Agriculture, Monsanto became involved in trials of Bollgard® II in Burkina in 2003. Governed by a research agreement with the Institut de I'Environnement et de Recherches Agricoles (INERA), and under the supervision of an ad-hoc Biosafety Committee (made up by the ministers of Agriculture and Environment and their advisors), field trials were conducted by Burkina Faso government researchers (from INERA) on secured government research farms. Bollgard® II genes in Coker 312 were tested in 2003, 2004 and 2005. At the same time, backcrossing work was started in the United States to transfer genes into varieties commercially grown in Burkina Faso. The backcrossing work in Arizona with Burkina varieties was completed in 2006. Immediately thereafter, in 2006/07, system trials were laid out on ½-acre plots at 20 locations. The trials showed that BG II saved 4 sprays, needing only two sprays against sucking insects.

Regulatory submission was finalized in August 2007, and Monsanto completed final commercial release negotiations in April 2008. Finally, Burkina Faso commercialized biotech Bollgard II cotton on June 16, 2008. Local biotech varieties were planted on 9,000 hectares in 2008/09, mainly for seed purposes, but these are commercial fields. Under agreement with Monsanto, no refuge is required as long as the area planted to biotech cotton is less than 80% of the area in any village. If it is greater than 80%, 5% of the area will be planted under unsprayed conditions. The natural refuge scenario will be considered in the future if findings are supportive.

Unlike all other countries that have commercialized biotech cotton, in Burkina Faso the technology fee accruing to Monsanto is dependent on the farmer's income. The general formula is that the value of any increased yield + savings in insecticide sprays will be considered gross income. The gross income will be divided into three parts. Two-thirds will remain at the farm gate (meaning that most of it goes to the farmers) with the remaining one-third to be shared between Monsanto and the seed companies (SOFITEX and other companies that provide planting seed). The cotton sector is well organized into village associations and cotton companies that have exclusive rights to buy seedcotton from producers and provide them with inputs, including seed. Although it is not difficult to estimate the benefits of increased yields and reduced insecticide usage, for farmers some of the changes will only become evident when large-scale commercial planting starts in 2009/10.

Colombia

Colombia commercialized Bollgard® cotton in 2004/05, Roundup Ready in 2007/08, Bollgard® + Roundup Ready in 2008/9 and Bollgard® II + Roundup Ready Flex in 2009/10. Colombia has a strong breeding program, but most varieties grown in the country were not locally developed. The seed

Technology Fee for Biotech Planting Seed in Colombia (US$/Kg)

Year	Roundup Ready		Bollgard		Bollgard + RR		Bollgard II + RR Flex		Conventional Seed	
	Region		Region		Region		Region		Region	
	Interior	Coastal	Interior	Coastal	Interior	Coastal	Interior	Coastal	Interior	Coastal
2005/06	-	6.3	-	12.4	-	-	-	-	Not available	6.3
2006/07	6.6	5.9	13.6	12.5	-	-	-	-	6.6	6.8
2007/08	10.3	10.1	13.9	13.7	16.5	16.3	19.5	19.2	7.0	6.9
2008/09	8.7	8.7	11.7	11.7	13.9	13.9	16.4	16.4	5.9	5.9

production system is not organized, and the country has traditionally depended on varieties developed in the USA, mostly by the Delta and Pine Land Company. Thus, biotech cotton was commercialized in Colombia through Deltapine germplasm. The technology fee is not different between the two production regions; the slight differences that appear below are due to different exchange rates used for the regions. For the Interior region, the conversion rate is the four-month average from November to February. In the Coastal region, the average is from July through April, corresponding to the planting times, in the two regions.

India

India commercialized biotech cotton in 2002/03, and, of all the countries that have adopted biotech cotton so far, it derived the greatest benefit from the insect resistance biotech trait. The average national yields for cotton soared by over 85% in five years, jumping from 302 kg/ha to 560 kg/ha in 2007/08. No other country has attained such an increase in yields. The final data for 2008/09 is not available yet, but ICAC estimates suggest that there may not be any increase in yields in 2008/09 over 2007/08. Unfavorable weather is blamed for lower production in India in 2008/09, but it may also be that the trait's maximum potential has already been realized, in as much as the area planted to biotech hybrids/varieties reached 77%, with the remaining 20% reserved for refuge crops.

India started with three biotech hybrids approved for commercial production in 2002/03, and now there are 312 hybrids officially approved by the Genetic Engineering Approval Committee (GEAC) for production in the country.

Originally, the only commercial cotton hybrids approved were those for which 1.1 kg of planting seed was enough to plant one hectare of cotton. Seed was sold in 450-gram packets to plant an acre (0.4 ha). Since a smaller amount of seed is used to plant each hectare in India, the seed cost is not comparable with the cost charged in other countries. Including the technology fee, the Bt hybrid planting seed was initially sold at a price equal to four times that of the local hybrids without the Bt gene. The state government of Andhra Pradesh challenged the technology fee. Ultimately, the courts ordered to reduce the fee to almost half the original price (see table below). The State also warned companies that if they did not comply with its instructions, they would be prosecuted under the Essential Commodities Act. The decision was followed in quick succession by two other major cotton-producing states, Maharashtra and Gujarat. Now the same technology fee is charged throughout India and it is the lowest in the world on a per hectare basis. In fact, the regulatory authorities instructed the seed companies to provide 120g of non-biotech seed along with the 450g packet of biotech seed for planting a refuge crop. Thus, the price of US$17.3 (Indian Rs. 750) includes the 450-gram packet of biotech seed and a 120-gram packet of non-biotech seed.

The recommended standard for the refuge crop is to plant four rows of a non-biotech crop of the same variety/hybrid all around the field.

Five types of insect resistant cotton have been approved to date: Bollgard®, Bollgard® II, JK (JK Agrigenetics, India), GFM (Chinese, Guokang), and CICR (Indian, public sector). In 1999, a private company started negotiations with the Chinese Government to acquire Guokang and arrived at a final agreement in 2001. In July 2002, the company obtained official permission from the Government of India to import the Chinese gene and began testing the Guokang gene in local germplasm extensively around the country, including trials by the All India Coordinated Cotton Improvement Project. In April/May 2006, the Ministry of Environment and Forests of the Government of India, approved Guokang (GFM) for commercialization. A synthetic Bt gene (a modified form of cry 1Ac) from Metahelix and stacked Bollgard II with Roundup Ready Flex have already reached the large-scale testing stage and are undergoing various steps of regulatory approval. WideStrike, from Dow Agrosciences, and a JK stacked gene cotton (cry 1Ac+cry 1EC) are also in advanced stages of medium- and large-scale testing.

Summary of Cotton Hybrids Released by GEAC for Commercial Production

Year	Released during Year						Cumulative Release*					
	BG-I	BG-II	JK	GFM	CICR	Total	BG-I	BG-II	JK	GFM	CICR	Total
2002	3					**3**	3					**3**
2004	1					**1**	4					**4**
2005	16					**16**	20					**20**
2006	28	7	4	3		**42**	48	7	4	3		**62**
2007	56	13	4	3		**76**	104	20	8	6		**138**
2008	48	97	8	20	1	**174**	152	117	16	26	1	**312**

* There are hybrids that have been released for more than one zone and are calculated as separate hybrids

Status of Price, Technology Fee and Share of Technology Provider (In US$/Packet*)

Year	Price				Technology Fee					Monsanto Share in Tech Fee		Remarks
	BG-I	BG-II	JK	GFM	BG-I	BG-II	JK	GFM	CICR	BG-I	BG-II	
2002	34.4				26.1					15.1		
2006	30.5	37.3	21.5	21.5	21.5	28.3				12.5	16.4	
2006	17	20.9	17	17	5.9	9.8				3.4	5.7	Effective from June, 2006 in Central & South Zone
2008	17.3	21.4	17.3	17.3	6	10.1			0	3.5	5.8	
2008	15	17.3	15	15	4	5			0	2.3	2.9	Effective from 26 May, 2008 in Maharashtra and 11 June, 2008 in Gujarat states only

*Packet = 450 g biotech seed+120 g non-biotech seed which is enough to plant 0.4 ha (one acre)

South Africa

South Africa is the first African country to commercialize biotech cotton. Bollgard varieties were approved in 1998/99 and now over 90% of total area is under biotech varieties. Herbicide resistant and stack gene varieties are also approved in South Africa. There are two types of growers, large and small. Small growers plant cotton mostly under rainfed conditions while large growers plant cotton under irrigated as well as non-irrigated conditions. The technology fee is different for irrigated and dryland conditions. The situation in South Africa has been slightly different from other countries because of the fact that only Deltapine varieties are popular in South Africa. There is a public sector cotton breeding program, but commercial varieties have not been developed. Growers have to rely on varieties developed by the Delta and Pine Land Company, and the company has a strong breeding program based in South Africa. So, Deltapine/Monsanto was able to set the technology fee as a monopolist in the field of planting cotton seed. Clark Cotton was a major supplier of planting seed in South Africa in the late 1990's, but with the introduction of biotech varieties, Deltapine took over the market in three years.

Planting seed was sold in 25 kg bags, and reports show that growers, particularly large scale growers using precision planters, tried to stretch 25 kg seed to as much area as they could. The objective was to reduce the fee per unit area. Under dryland conditions, most farmers used about half the quantity of planting seed compared to irrigated conditions, so the technology fee for dryland farming was about half on a unit area basis. The technology fee in 1998/99 was a maximum of US$84.52/ha for irrigated and 36.13/ha for dryland depending on the seed rate. In 1999/00, the fee was US$96.77 per bag of 25 kg seed.

A lot has been published about biotech cotton in South Africa, particularly in the early years of its adoption and with reference to small growers in the Makhathini Flats. A number of independent surveys have been conducted, and one of the prominent concerns has been the technology fee and cost of the planting seed. This is also the reason why some farmers stretched seed to a larger area than recommended. The high cost of the technology fee and seed could also be a reason for the sharp decline in cotton area in South Africa since the adoption of biotech cotton. Data show that the technology fee has been close to the cost of insecticide control. The year-to-year variation in the technology fee in the table is largely due to variation in exchange rates.

The second part of this article covering the technology fee in China (Mainland), Mexico and the USA will be published in the June 2009 issue of *THE ICAC RECORDER*.

Technology Fee for Biotech Planting Seed in South Africa

Year	Fee for Biotech Seed US$/Kg			Conventional Seed (Per Kg)
	Roundup Ready	Bollgard	Bollgard + Roundup Ready	
1998/99	-	3.4	-	
1999/00	-	3.9	-	
2000/01	-	3.5	-	
2001/02	-	1.9	-	
2002/03	1.3	2.7	-	1.1
2003/04	1.8	4.0	-	1.8
2004/05	2.3	4.9	-	2.3
2005/06	2.3	4.9	7.2	2.5
2006/07	2.2	4.6	6.8	2.4
2007/08	2.1	4.5	6.5	2.4
2008/09	1.8	3.8	5.6	2.4

Notes:
1. Data converted from Rands into US$ using the IMF Principal Rate Period Average (calender year).
2. 2008 conversion is at 1US$ = Rand 8.27 (Sept., 2008 average).

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