Prices of Biotech Planting Seed and Technology Fees for Biotech Traits

Farmers must pay for the biotech traits they want to use and the price of the trait, commonly referred to as the 'technology fee', varies from country to country, from trait to trait and even among the biotech genes within a given trait. In insect-resistant biotech cotton, many reasons exist for the variation in the technology fee, but the primary criteria that determine how much a farmer will be called upon to pay for a particular trait are: the savings derived from the decreased use of insecticides and the commensurate increases in income resulting from higher yields. Areas where the target insects are not serious pests are, of course, not candidates for the adoption of insect-resistant biotech cotton. Conversely, herbicide-tolerant cotton, particularly Roundup Ready Flex, requires increased use of herbicides. This makes it possible to increase yields by reducing weed infestation, but also increases the cost of weed control (due to repeated use of Roundup or similar products). There are areas where the target pests controlled by insect-resistant genes do attack the cotton crop, but the expected benefits may not justify the additional cost of the technology fee. Declining trends in pest pressure in certain areas may make some locations less attractive for the currently available insect-resistant biotech genes. A comparison of the cost of technology fees in relation to the expected benefits deriving from different traits may require a general reappraisal and may force technology providers to reduce the fees they are charging.

The ICAC has tried to keep track of the technology fees charged in different countries for various traits. Two articles dealing with this subject, "Biotech Cotton and Technology Fees", were published in the March and June issues of the *ICAC RECORDER* in 2009. The present article provides an update of the data published in 2009 for all the countries for which data were available. Comparable data were not available for some countries, and in others, the cotton grown is all biotech.

Technology Fee in Argentina

Argentina started to commercialize biotech cotton in the 1998/99 season but over the following ten years, the area planted to biotech varieties remained below 25% of the total cotton area. The primary reason for the poor adoption rate was the generally low level of yields and net benefits deriving from the adoption of the technology. Another consideration may have been the high cost of the technology fee. Past performance notwithstanding, biotechnology-related developments in Argentina have gained momentum in the more recent past. The creation in 2007 of the Ministry of Science, Technology and Innovative Production focused on the development of state-of-the-art technology in several fields, including biotechnology, and this might be another factor to be taken into account. While the technology fee for a stacked-gene Bollgard II + Roundup Ready cotton is still untenable, it is believed that biotech cotton is currently planted on about 80-90% of the cotton area. Only stacked-gene Bollgard II cotton is approved for cultivation, so herbicide tolerance may be the driving force behind increases in the biotech cotton area. Argentine farmers discontinued the use of single-gene insect-resistant Bollgard cotton as of the 2011/12-crop season (table 1).

Table 1: Technology Fee for Biotech Planting Seed in Argentina

Year	Price of Biotech Seed US$/Ha		
	Bollgard	Roundup Ready	Bollgard + Roundup Ready
1998/99	76.0	Not approved	-
1999/00	70.0	Approved	-
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	-
2009/10	Stopped	120.0	Approved
2010/11	-	120.0	160.0
2011/12	-	120.0	155.0
2012/13	-	120.0	150.0
2013/14	-	80.0	150.0
2014/15	-	80.0	150.0

Technology Fee in Brazil

In Brazil, cotton is at higher risk of being damaged by the bollworm than by any other insect. *H. armigera,* against which biotech cotton has proved to be the most effective recourse, was not even a pest on cotton back in 2006/07 when biotech cotton was commercialized, so its adoption rate was very slow. Given the fact that the presence of the bollworm has been verified over the last two to three years, demand for biotech cotton resistant to the bollworm is expected to grow (table 2).

Technology Fee in China

In China, the technology fee for biotech cotton, which was initially limited to *cry 1Ac*, has always differed from region to region. In 1999, the average price for a non-biotech seed was US$0.35/kg as compared to US$3.00/kg for biotech seed. Demand was high and locally produced genes were not in use yet, but the price differences eventually dwindled. (See complete data on table 3).

Technology Fee in Colombia

In Colombia, cotton is grown in two regions and the technology fee differs slightly from one region to the other, despite the

Table 2: Technology Fee for Biotech Planting Seed in Brazil

Year	Price of Biotech Planting Seed/Ha						
	Bollgard	**Bollgard II**	**RR**	**RR Flex**	**Bollgard + RR**	**BG II + RR**	**BG II + RR Flex**
1996/97	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
1997/98	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
1998/99	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
1999/00	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2000/01	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2001/02	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2002/03	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2003/04	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2004/05	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2005/06	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2006/07	111.0	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2007/08	109.0	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2008/09	117.0	Not approved	Not approved	Not approved	?	Not approved	Not approved
2009/10	-	Not approved	Not approved	Not approved	?	Not approved	Not approved
2010/11	-	Not approved	Not approved	Not approved	US$ 60,00	Not approved	Not approved
2011/12	-	Not approved	Not approved	Not approved	US$ 60,00	Not approved	Not approved
2012/13	-	Not approved	Not approved	U$ 80.00	US$ 60,00	Not approved	?
2013/14	-	Not approved	Not approved	U$ 80.00	US$ 60,00	Not approved	US$ 240,00
2014/15	-	Not approved	Not approved	U$ 80.00	US$ 60,00	Not approved	US$ 240,00

Year	Price of Biotech Planting Seed/Ha					
	Wide Strike	**WideStrike + RR**	**WideStrike + RRFlex**	**LibertyLink (LL)**	**GlyTol + LL**	**TwinLink + GlyTol + LL**
1996/97	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
1997/98	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
1998/99	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
1999/00	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2000/01	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2001/02	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2002/03	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2003/04	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2004/05	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2005/06	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2006/07	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2007/08	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2008/09	Not approved	Not approved	Not approved	Not approved	Not approved	Not approved
2009/10	?	Not approved	Not approved	?	Not approved	Not approved
2010/11	?	Not approved	Not approved	?	Not approved	Not approved
2011/12	?	Not approved	Not approved	?	Not approved	Not approved
2012/13	U$ 145.00	Not approved	Not approved	U$ 40.00	Not approved	Not approved
2013/14	U$ 145.00	Not approved	Not approved	U$ 40.00	?	?
2014/15	U$ 145.00	Not approved	Not approved	U$ 40.00	U$ 80.00	U$ 320.00

NOTES: 1. Bollgard II has been aproved only stacked with RRFlex
2. GlyTol has been aproved only stacked with LibertyLink
3. TwinLink has been aproved only stacked with Glytol and LibertyLink

Table 3: Price of Biotech Planting Seed in China

Year	Bollgard		Guokang		Seed Rate/Ha	Exchange Rate/US$
	Yuan/ha	**US$/Ha**	**Yuan/ha**	**(In US$/Ha)**	**(Kg)**	**(Yuan)**
1997/98	375	45.2	-	-	15.0	8.3
1998/99	375	45.3	-	-	15.0	8.3
1999/00	375	45.3	30	3.6	15.0	8.3
2000/01	375	45.3	30	3.6	15.0	8.3
2001/02	375	45.3	30	3.6	15.0	8.3
2002/03	375	45.2	30	3.6	15.0	8.3
2003/04	375	45.2	30	3.6	15.0	8.3
2004/05	375	45.2	30	3.6	15.0	8.3
2005/06	375	45.2	30	3.6	15.0	8.3
2006/07	375	46.6	30	3.7	15.0	8.1
2007/08	300	38.6	2	0.2	12.0	7.8
2008/09	250	34.7	0 to 1.5	0 to 0.21	10.0	7.2
2009/10	250	36.5	0 to 1.5	0 to 0.22	10.0	6.9
2010/11	-	-	270	40.9	22.5	6.6
2011/12	-	-	270	40.9	22.5	6.2
2012/13	-	-	270	40.9	22.5	6.2
2013/14	-	-	225	36.3	22.5	6.2
2014/15	-	-	203	32.7	22.5	6.2

Notes: 1. Exchange rate is for February 15 each year, which is high time for seed sale.
2. There have been no Bollgard seed in China market since 2010.

Table 4: Technology Fee for Biotech Planting Seed in Colombia (US$/kg)

Year	Conventional + RR		Bollgard I		Bollgard		Bollgard + RR		Bollgard II + RR Flex		Conventional Seed	
	Interior	Costa	Interior	Coastal	Interior	Costa	Interior	Costa	Interior	Costa	Interior	Costa
2004/05	-	-	-	-	11.8	10.6	-	-	-	-	-	-
2005/06	-	6.2	12.5	12.1	12.5	12.1	-	-	-	-	-	6.2
2006/07	6.0	5.7	12.5	12.1	12.5	12.1	-	-	-	-	6.0	6.6
2007/08	10.0	9.6	13.6	13.0	13.6	13.0	16.1	15.5	19.0	18.3	6.8	6.6
2008/09	8.5	11.2	11.5	15.1	14.5	18.9	13.7	17.9	16.2	21.2	5.8	7.6
2009/10	10.1	8.7	17.1	n.a	17.0	14.8	16.2	14.0	19.1	16.5	5.0	4.4
2010/11	10.7	10.3	-	-	-	-	17.0	16.5	21.4	20.8	5.6	5.4
2011/12	10.7	11.0	-	-	-	-	17.1	17.6	21.6	22.2	6.3	8.2
2012/13	11.9	11.2	17.9	-	-	-	17.4	17.5	23.4	23.6	7.0	7.0
2013/14	10.9	11.4	-	-	-	-	-	-	21.4	23.3	6.4	6.8
2014/15	-	11.9	-	-	-	-	-	-	19.7	23.9	5.4	6.4

fact that the seed supplier is the same. Even when the price of the seed and the technology fee are equal in both regions, the seed cost/ha will be higher in the Costa region because of the higher seeding rate used there. Moreover, cotton yields are also lower in the state of Cordova, which is responsible for more than 2/3 of production in the Costa region. The higher technology fee has been a bone of contention from the very beginning for farmers and other segments of the cotton industry, particularly farmer associations and federations, but no other option was available given that the national industry was unable to produce planting seed locally. The government has not intervened and, hence, farmers have not been enticed, but forced, to grow biotech varieties, since conventional cotton seeds are no longer available (table 4).

Technology Fee in India

India is the only country where biotech-planting seed was sold along with the non-biotech varieties. The non-biotech seed compelled growers to adhere to existing refuge requirements. In the beginning, refuge requirements were common to all regions throughout the cotton production belt, but were later revised. Farmers were given a choice: they could opt for a sprayed refuge or an unsprayed refuge. As in the USA and many other countries, farmers were required to plant 80% of their total cotton area to insect-resistant biotech varieties and 20%—or five rows, whichever was greater—to non-biotech varieties. Other restrictions also applied. It has been reported that the sprayed option was more popular among farmers. This was due to the heavy damage suffered by crops in unsprayed areas. Singla *et al.* (2012) examined refuge requirements for biotech cotton in the North, Central and South cotton producing regions of India, focusing on the development of resistance by the American/cotton bollworm, *Helicoverpa armigera,* to the Bt toxins and pyrethroids used on cotton over a long period of time. They based their conclusions on biological factors, yields, and regulatory protocols. They concluded that the refuge requirements considered as optimal varied significantly across cotton-growing regions. The North and Central regions had higher refuge requirements than the South region. The findings suggested that the sprayed refuge was more profitable than the unsprayed refuge. Refuge requirements were found to be sensitive to the relative proportions of pests in natural refuges, as well as to the initial Bt resistance levels in all three regions. A greater population of resistant pests meant that there was more need for a larger refuge area. The biotech planting seed was sold in small packets of 450-gm, in conjunction with 125-gm packets of non-biotech seed, i.e., enough to plant 0.4 hectares. Seed is expensive because prices may vary as a function of the seed varieties and the diverse seed companies, but the average price for Bollgard and Bollgard II genes is US$32/ha and US$36/ha, respectively.

The technology fee in India was originally higher due also to the price of hybrid seed, as the biotech genes could only be sold through hybrids. Thus, the planting seed fee incorporated a factor that was unique to India. Today, biotech hybrids are also sold in China. Biotech cotton in India is often acknowledged as a success story free of any significant controversies thanks to the huge impact it had on cotton yields since 2002/03. It was not only the biotech genes that benefitted India, but also the introduction of modern production practices and programs that led to unexpected increases in yields. Among these factors were:

- At the time of the adoption of biotech cotton, the country's yields were lower than its production potential as measured by the level of technology, the varieties/hybrids available, types and amounts of inputs used and the research conducted. There was a huge recoverable potential that had yet to be tapped.
- The existing insecticide application technology and systems had many drawbacks. Insecticides were used extensively, but were not sprayed properly. The insecticide resistance issue was at its peak and insect-resistant biotech cotton provided a convenient solution to both problems.
- The technology missions of the Government of India came at just the right time. The Central Government, along with the state governments, focused on getting technology transfers into the hands of the farmers, which was the crux of the problem.
- Cotton growers were anxious to explore any option that might help them to raise yields, so they welcomed biotech cotton. The right decisions were made at various levels at the right time. The private sector seed industry came to

the conclusion that the future of cotton was intimately linked to the development of newer biotech genes. India quickly developed its own biotech genes, a factor that also played a major role in getting the technology into the hands of growers throughout the country.

The technology fee in India has its own history, one that is not comparable to the experience of any other country that has adopted biotech cotton. In 2004, the cost of the biotech seed needed to plant a hectare of cotton was about US$47 greater than the cost of its isogenic line without the biotech gene. In 2006, the official price for a 450-gram packet of biotech seed, the amount needed to plant an acre of cotton, was around US$36 (Rs. 1,600), i.e., about four times the price of a non-biotech seed. It is estimated that out of the seed price of US$36 charged by companies, US$28 (Rs. 1,250) was defined as the trait value, and US$8 (Rs. 350) as the cost of conventional hybrid planting seed. A surprising turn of events took place in 2006 when the state of Andhra Pradesh imposed a ceiling of US$17 (Rs. 750) on the price of a 450-gram bag of biotech planting seed (Singla *et al*., 2012). The objective was to ensure that the technology would be affordable and accessible to small and marginal growers in the state. Later, other states in India also imposed the same ceiling.

This reduction of more than 50% in the price of a bag of planting seed might have been detrimental to the further spread of the technology in India because of the slimmer income margin accruing to seed companies. However, in practice, seed companies have assimilated the tighter net income margin on the seed and continued to disseminate the technology without any negative impacts from the reduction in the price charged for the seed. At least four factors contributed to the continued focus on furthering the adoption of the biotech cotton. Firstly, the technology adoption rate over the first four years was exceptionally high and the momentum that had already been built up would have required a much bigger obstacle to slow it down. Secondly, the Genetic Engineering Approval Committee changed the approval process to an "event-based approval", rather than a case-by-case approval for each and every variety having the same biotech gene. Event-based approval did not require extensive bio-safety and agronomic testing for each new variety. Thus, event-based approval resulted in a great influx of biotech hybrids, thereby increasing competition in the planting seed industry. Thirdly, just prior to the 2006 planting season, the Genetic Engineering Approval Committee approved Bollgard II for commercial release in the Central and Northern regions. Fourthly, also in 2006, two local seed companies released their own insect-resistant biotech cotton events. All these factors together practically guaranteed that the rate of technology adoption would not suffer a setback, not even with a 50% reduction in the price charged for the technology in the seed.

Technology Fee in Pakistan

Pakistan commercialized biotech cotton in a way that was different from the method followed by other countries. Private seed companies inserted the *cry1Ac* gene in local varieties and prepared to distribute biotech varieties without any advance preparation within the farming community to help them accept the new technology. Agronomic practices were not fine-tuned to obtain the best possible results from biotech varieties and technology transfer messages were not revised commensurately. The planting seed companies locked horns in a desperate struggle to defend their market share and cotton farmers were left to play the role of uninformed bystanders. Having chosen to rely on the advantages of the biotech product, seed companies exploited the biotech trait to improve their respective market shares. The seed industry found itself in a state of such disarray that no safeguards were instituted to prevent the spread of poor quality planting seed or to protect the insect-resistant technology embodied in the seed. Farmers were, of course, in no position to evaluate the quality of a given seed source or to verify the presence or absence of technological traits in the seed. The weak regulatory system and the inexperience of the seed industry itself led to a detrimental situation that could not be sustained by the seed industry.

The deteriorated seed situation in the country motivated policy initiatives to avoid a range of negative consequences and make better use of the emerging new technologies that were being developed in the country. Just recently, when planting for the current season had almost been completed, the Government of Pakistan amended the Seed Act in consultation with the seed sector (including private companies). Private sector companies are now allowed to produce basic seed, which had previously been the exclusive domain of the two public sector corporations in the Punjab and Sindh. Key provisions of the Act, whose primary focus is on eliminating unregulated participation in the seed industry, are listed below.

- The amendments would bring the private sector under the purview of the Seed Act. Currently, the Act makes little mention of the private sector, leaving private companies, which were formed under other regulatory statutes (the 1984 Companies Act for example), largely unregulated.
- Anyone seeking to participate in the seed industry would be required to have a seed processing plant or operate as a registered seed dealer.
- Sales of seed without the proper registration or sales of misbranded seed are subject to jail sentences or fines.
- Biotech seeds are not allowed to contain "terminator genes", i.e., genes that prevent the replanting of a crop, but are not found in commercial crops.
- Biotech seeds must have a certificate of approval from the National Biosafety Committee stating that they will not have any adverse effects on human, animal, or plant life and health, or on the environment.

The technology has been extended to almost the entire area planted to cotton in the country. There can be no doubt that the country's 2.2 million cotton growers benefitted from

having to pay a minimal amount for the technology fee. The technology fees charged by private companies were limited and unregulated, but they nevertheless existed. Even now there is no specified technology fee for a given biotech gene, but, on average, a biotech variety planting seed sells at about US$40-44/ha more than a conventional variety seed. Prices vary from company to company, variety to variety, area to area and year to year. The current regulatory system that oversees the development and delivery of improved seed and seed-based technologies has prohibited the stacking of *cry 1Ac* with *cry 2Ab* in the country. However, the seed industry seems to be streamlining its operations in order to utilize third generation insect-resistant genes together with other locally developed biotech products.

Table 5: Technology Fee for Biotech Planting Seed in South Africa (Technology fee is for a 25 kg pack)

Year	Roundup Ready	Bollgard	Bollgard + Roundup Ready	Bollgard II + Roundup Ready Flex	Conventional Seed
1998/99	-	84.5	-	-	
1999/00	-	96.8	-	-	
2000/01	-	86.3	-	-	
2001/02	-	46.5	-	-	
2002/03	33.2	66.4	-	-	28.0
2003/04	46.2	99.1	-	-	46.2
2004/05	56.5	121.5	-	-	57.3
2005/06	57.4	123.4	180.8	-	61.3
2006/07	53.9	116.0	169.9	-	60.6
2007/08	51.8	111.5	163.4	-	61.2
2008/09	44.2	95.0	139.2	-	59.9
2009/10	43.1	92.7	135.8	-	58.4
2010/11	55.3	117.0	167.1	167.1	78.6
2011/12	44.3		178.2	178.2	
2012/13	-	96.7	-	121.0	65.9
2013/14	-	-	-	182.4	61.2
2014/15	-	-	-	178.4	61.2

Notes:
1. Data converted from Rands into US$ using the IMF Principal Rate Period Average (calendar year).
2. Price for BG II + RRF for 2013/14 and 2014/15 includes price of seed and technology fee.
3. Exchange rate varies a lot from year to year.

Technology Fee in South Africa

The technology fee given in table 5, refers to a 25-kg pack of seed, sufficient to plant a hectare of cotton. To derive the full cost of the 25-kg pack of biotech seed, the price of a conventional seed should be added to the technology fee.

Technology Fees in the USA

The technology fee in the USA has changed from a per hectare basis to fixed-quantity seed counts since 2004/05. Data for the Mississippi Delta regions are presented in the table 7.

As a consequence, farmers are more careful to use precision planting and save as much as they can on seed costs without compromising their optimum plant stand. The seed count varies from one variety to another because of seed size and weight. Data for Georgia, Florida and Southern Alabama for 2015 appear in the table 6 (http://www.agri-afc.com).

Analysis of the Technology Fee

Special traits, such as the ones found in transgenic cottons, require special research protocols that are extraordinarily costly and it is simply impossible to compare them with the costs involved in the development of conventional varieties. The difference can be a single gene, two to three genes or an even greater number of genes, as in the case of Starlink™ corn. The issue is that finding a suitable gene, getting it to survive all the biosafety protocols and ultimately having it approved always entails great expense. Thus, it is the markups on the end product that act as an incentive for private companies to continue developing new technologies. The technology fee varies among countries and there are many reasons why this occurs. Prices have been controlled, companies have lowered the prices for the same products, and so on, but the overriding factor determining the end price continues to be the benefit that farmers can reap by planting a biotech variety. In most cases the benefit has been in the form of savings on insecticides along with increases in yields. If the companies do not make any profits, they will cease to develop new products. Farmers desire new products and events and these will continue to be developed only if the companies can recover their investment in the development of new technologies.

High prices can also become a constraint affecting the adoption of the new technologies. Farmers may wish to use a biotech product, but the returns ultimately obtained may not justify the high cost of the technology fee. Thus, not only farmers but entire countries may refrain from using a certain biotech product, a result that is also detrimental to technology

Table 6: Technology Fee for Planting Seed for 2015 (US$/count) (Georgia, Florida and Southern Alabama)

Trait	Seed Count		
	250,000	230,000	220,000
Bollgard II	209.8	193.0	184.0
Roundup Ready Flex	287.2	264.2	252.7
Bollgard II + Roundup Ready Flex	412.2	379.2	362.7
Bollgard II XtendFlex™	451.7	415.5	397.4
XtendFlex™ Chemistry Discount	39.5	36.3	34.7
Introductory Price	412.2	379.2	372.7

Seed Count Information:
250,000 = Deltapine®
230,000 = Americot®, Croplan Genetics®, NexGen®, Phytogen®
220,000 = ALL-Tex®, Dyna-Gro®, Fibermax®, Stoneville®

Note: These are genuity products.
XtendFlex is tolerant to three group of herbicides: Dicamba, glyphosate and glufosinate
It is only introductory, Dicamba cannot be sprayed in 2015.

Table 7: Technology Fee for Biotech Planting Seed in the USA (Mississippi Delta Region)

Year	BXN	Bollgard	Bollgard II (Cost/1,000 Seeds)	Roundup Ready	RR Flex	BG + RR	BG + RR Flex	BG II + RR	BG II + RR Flex	Liberty Link	BG II + Liberty Link	WideStrike + RR Flex	Conventional Seed
1995/96		1.87.kg+74.1/ha	-	-	-	-	-	-	-	-	-	-	1.87.kg
1996/97		2.21/kg+79.1/ha	-	-	-	-	-	-	-	-	-	-	1.9/kg
1997/98		2.27/kg+79.1/ha	-	2.25/kg+NA	-	-	-	-	-	-	-	-	2.03/kg
1998/99		2.38/kg+79.1/ha	-	2.36/kg+NA	-	-	-	-	-	-	-	-	2.12/kg
1999/00		2.25/kg+79.1/ha	-	2.21/kg+22.2/ha	-	-	-	-	-	-	-	-	2.07/kg
2000/01	3.29/kg+NA	2.38/kg+79.1/ha	-	2.34/kg+22.2/ha	-	2.71/kg+101.3/ha	-	-	-	-	-	-	2.14/kg
2001/02	3.53/kg+NA	8.47/kg	-	4.23/kg	-	10.3/kg	-	-	-	-	-	-	2.29/kg
2002/03	3.57/kg+NA	8.71/kg	-	4.65/kg	-	10.76/kg	-	-	-	-	-	-	2.78/kg
2003/04	3.75/kg+NA	9.11/kg	-	5.42/kg	-	11.71/kg	-	-	-	-	-	-	2.98/kg
2004/05		0.87/1,000 seeds	1.01	0.63/1,000 seeds	-	1.26/1,000 seeds	-	1.41/1,000 seeds	-	0.56/1,000 seeds	-	-	0.30/1,000 seeds
2005/06		NA+0.57/1,000 seeds		0.95/1,000 seeds	-	1.39/1,000 seeds	-	1.61/1,000 seeds	-	0.62/1,000 seeds	-	-	0.19/1,000 seeds
2006/07		0.28/1,000 seeds+NA		0.99/1,000 seeds	1.25/1,000 seeds	1.53/1,000 seeds		NA	NA+1.38/1,000 seeds	0.62/1,000 seeds	-	-	0.18/1,000 seeds
2007/08		NA+0.28/1,000 seeds		0.98/1,000 seeds	1.27/1,000 seeds	1.55/1,000 seeds			1.88/1,000 seeds	0.62/1,000 seeds	-	-	0.39/1,000 seeds
2008/09		Stopped		1.1/1,000 seeds	1.36/1,000 seeds	1.53/1,000 seeds	0.51/1,000 seeds+NA		1.9/1,000 seeds	0.62/1,000 seeds	-	-	NA
2009/10		-		1.29/1,000 seeds	1.55/1,000 seeds	1.68/1,000 seeds			2.02/1,000 seeds	0.62/1,000 seeds	-	-	
2010/11		-	0.76		1.61/1,000 seeds				2.10/1,000 seeds	1.05/1,000 seeds	2.29/1000 seeds	2.04/1000 seeds	
2011/12		-	0.76		1.61/1,000 seeds				2.10/1,000 seeds	1.05/1,000 seeds	1.86/1000 seeds	2.08/1000 seeds	
2012/13		-	0.76		1.67/1,000 seeds				2.17/1,000 seeds	1.15/1,000 seeds	1.91/1000 seeds	2.12/1000 seeds	
2013/14		-	0.76						2.21/1,000 seeds		1.93/1000 seeds		
2014/15		-	0.76						2.23/1,000 seeds		1.95/1000 seeds		

Notes:
1. Wherever there are two numbers in a cell, the first is the price of seed and second is the price of technology fee. One number denotes seed price+technology fee.
2. 2001/02 - maximum technology fee/ha for BG = US$79.1, BG+RR = $101.3, RR = $22.2
3. 2002/03 - maximum technology fee/ha for BG = US$79.1, BG+RR = $101.3, RR = $25.95
4. 2003/04 - maximum technology fee/ha for BG = US$79.1, BG+RR = $101.3, RR = $25.95
5. 2004/05 - maximum technology fee/ha for BG = US$79.1, BG II = $98.8, BG+RR = $106.3, BGII+RR = $126.1, RR = $35.8
6. 2005/06 - maximum technology fee/ha for BG = US$49.4, BG+RR = $121.1, BGII+RR = $135.9, RR = $69.2
7. 2006/07 - maximum technology fee/ha for BG = US$48.2, BG+RR = $121.1, BGII+RR = $138.4, RR = $71.7, RRF = $98.8, BGII+RRF = $158.1
8. 2007/08 - maximum technology fee/ha for BG = US$48.2, BG+RR = $121.1, BGII+RR = $138.4, RR = $71.7, RRF = $98.8, BGII+RRF = $158.1
9. 2008/09 - maximum technology fee/ha for BG = US$48.2, BG+RR = $121.1, BGII+RR = $138.4, RR = $71.7, RRF = $98.8, BGII+RRF = $158.1
10. 2009/10 - maximum technology fee/ha for BGII+RRF = $166.8 , BG+RR = $129.7, RR = $87.7, RRF = $114.9
11. 2010/11 - maximum technology fee/ha for BGII+RRF = $171.1, BGII = $87.1, RRF = $119.8, WS = $59.3
12. 2011/12 - maximum technology fee/ha for BGII+RRF = $171.1, BGII = $87.1, RRF = $119.2, WS = $59.3
13. 2012/13 - maximum technology fee/ha for BGII+RRF = $154.9, BGII = $77.6, RRF = $107.9, WS = $59.3
14. 2013/14 - maximum technology fee/ha for BGII+RRF = $154.9, BGII = $31.39, RRF = $107.9, WS = $59.3
15. 2014/15 - maximum technology fee/ha for BGII+RRF = $154.9, BGII = $77.6, RRF = $107.9, WS = $59.3

NA **Not available**

developers. In the long run, reduced prices and price controls can have negative implications for product development. Price controls may delay the launch of new products, causing farmers to incur losses in the long run as a result of their lack of access to improved events and new special features.

Technology fees must be sufficiently fair so that farmers can afford to use them and technology developers can make a fair profit to finance further research. Unfortunately, the determination of specific technology fees for specific traits has not always been a transparent process. The win-win solution might be something like the minimum threshold prices that many governments fix for seedcotton, an arrangement where technology developers are assured a fair profit and farmers are not overcharged.

References

Technology fee data for various countries have been collected from many sources, all of which have been acknowledged in the body of the text.

Arora, Anchal and Sangeeta Bansal. 2012. Price Control on Bt Cotton Seeds in India: Impact on Seed Providers, <http://www.jnu.ac.in/sis/citd/DiscussionPapers/DP02_2012.pdf>.

Singla, Rohit, Phillip Johnson and Sukant Misra. 2012. Examination of Regional-level Efficient Refuge Requirements for Bt Cotton in India. *AgBioForum, 15(3): 303-314. 2012.*