A Case Study of Bt Cotton in India : The PLC Framework

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Abstract

This paper aimed to track the marketing journey of GM (genetically modified) cotton in India. It used the basic concepts like PLC (product life cycle) and 4P's framework from the marketing theory to make interpretations. The article underwrote the marketing theory by unifying the theoretical concepts with practicality. The scene was set against the backdrop of India which enhances its significance. The paper revealed that many marketing strategies were used for the introduction as well as penetration of GM cotton in our country. It drew a clear picture of various marketing tactics used by the technology promoters of the product to steer ahead on the path of growth. It also pointed out the legal and procedural irregularities present in the approval system for the new entrants. It further emphasized the fact that GM cotton in India has sailed through many ups and downs in its journey. The marketing strategies adopted were a mix of traditional as well as innovative approaches. The thin line difference between being ethical and unethical also got blurred in some instances.

Keywords: **GM cotton, PLC theory, 4P's framework, commercialization of Bt cotton, competition**

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India has the world's largest hectarage of cotton, and accounts for almost one - third of the total area under cotton cultivation in the world (James, 2013). Prior to 2002, the cotton crop in India faced heavy losses due to its susceptibility to insect pests (Karihaloo & Kumar, 2009). Among the insects, cotton bollworms are the most serious pests of cotton in India, causing annual losses of at least U.S. dollar 300 million. Insecticides valued at U.S. dollar 660 million are used annually on crops in India, out of which about half are used on cotton alone (Rai, Acharya, Virmani, & Aggrawal, 2009).

GM (Bt) cotton contains a gene from the soil bacteria Bacillus thuringiensis (Bt), which allows the plant to produce the Bt protein which kills cotton's major pest, heliothis or the cotton bollworm, when it eats the leaves (Agricultural Biotechnology Council of Australia, 2012). Thus, it reduces the need for pesticide sprays for bollworms and improves the productivity of the cotton crop. In March 2002, Bt cotton was officially released in India (Manjunath, 2004). A transgenic crop plant contains a gene or genes which have been artificially inserted through genetic engineering techniques instead of the plant acquiring them through pollination. The inserted gene sequence may come from another unrelated plant, or from a completely different species. Plants containing transgenes are often called genetically modified or GM crops (Agriquest, n.d.). GM crops carry the gene introduced in them to express desired beneficial, new, stable, or inherited traits. In India, the only GM crop approved for commercial cultivation in the country is Bt cotton.

This study aims to map the lifespan of Bt cotton in India. It utilizes the concept of product life cycle to present a comprehensive picture of the various stages through which Bt cotton has evolved in our country. To expand the descriptive power of this concept, the 4P's framework is used for detailing at each stage. The purpose of the present paper is to draw the product life cycle for GM (Bt cotton) in India and to map out the marketing strategies used by the technology promoters/ marketers at various stages. The article contributes to marketing literature by

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organizing the efforts of the technology promoters under the Product Life Cycle (PLC) framework and earmarking its various stages. It traces different marketing strategies used in these stages - from the introduction to the near decline of GM cotton in our country. Thus, the paper tries to leverage the practical applicability of the theory of PLC, taking Bt cotton in India as a case. It also explores the marketer's struggles which lead to the introduction as well as the adoption of technology in the country through the use of the 4P's framework. It classifies the marketing strategies used according to this framework to clearly pinpoint multidimensionality and simultaneity of the effort. This further increases its relevance in the marketing arena and provides depth to the study. The study becomes all the more apt due to the fact that the Indian context is kept in focus where Bt cotton has been able to penetrate successfully. Due to the fact that GM cotton is an innovation, the study could be of heightened interest and consequence for marketers of innovative products besides scientists, policy makers, and other stakeholders.

PLC : The Conceptual Framework

The PLC is modeled on a fixed cycle of birth, growth, maturity, and death through which higher living organisms pass through (Tellis & Crawford, 1981). The concept of PLC applies to a generic category of product class, product form, or a brand. The concept claims that product sales pass through distinct stages, each with different challenges and opportunities with rise and fall in the profits at different stages (Kotler & Keller, 2012). There are four key life stages a product passes through from inception to death. The pattern of sales is mapped against time representing a bell-like shape of increasing sales toward a plateau and then falling off. Each of the four stages (introduction, growth, maturity, and decline) are distinct because the products in this stage share more market characteristics with other products in the same stage than with itself at a previous or later stage (Nadeau & Casselman, 2008).

Shape and length of PLC are affected by many factors, including product characteristics, marketing strategies employed, external environmental factors, and market-related factors (Meenaghan & O'Sullivan, 1986). To some degree, the collective action of the firms offering competitive products in the same category also affect the shape of sales and profit curves for a product category. Even single companies can have an impact. A giant firm may be able to shorten the introductory stage by broadening the distribution or increasing the promotional effort supporting the new product.

The concept of a life cycle is, however, related to a specific market. There are various cases in the product life cycle. For example, maturity is elongated so as to prevent the product from declining as far as possible. A product may be at the maturity or growth stage in a specific country, but it might be at the introduction stage in another. Thus, a product may exhibit different stages of PLC across different countries.

The concept has been criticized on the grounds of simplicity and applicability (Dhalla & Yuspeh, 1976; Gardner, 1987; Rink & Swan, 1979). However, even the criticisms about the theoretical and practical relevance of the PLC concept center on the assertion that the PLC has broad explanatory power and is the ultimate tool for strategy building (Grantham, 1997). Anderson and Zeithaml (1984) supported the use of PLC in strategic formulation. The importance of various factors across various stages has been well documented in the literature (Day, 1981; Midgley, 1981). Thus, though controversial, the PLC is undoubtedly still one of the better-known concepts in marketing (Steffens, 2002). It generally appears to hold as a relevant alternative theory for strategic development also (Nadeau & Casselman, 2008). The present study harnesses this very descriptive power of the concept of PLC to synthesize the strategy for marketing of GM crop (Bt cotton) in India.

Review of Literature

The review of literature on the marketing of GM cotton vouches for the significance of four P's on its diffusion. There are studies that considered the effect of price (Arshad, Suhail, Ashgar, Tayyib, & Hafeez , 2007 ; Fernandez-Cornejo, Alexander, & Goodhue, 2002 ; Frisvold , 2004 ; Loganathan, Balasubramanian, Mani, & Gurunathan, 2009 ; Qaim & Janvry, 2003) on the adoption of Bt cotton. These studies indicated that the low price of Bt cotton

seeds could play an incidental role in facilitating its adoption and spread. Studies (e.g. Arshad et al., 2007) also confirmed the significance of channel partners like pesticide sellers in convincing farmers as they posed as an opinion leader to them. The effect of the availability of a wide variety of hybrids on extent of GM cotton adoption has also been documented (Arora & Bansal, 2012).

Many studies have listed the product performance criteria as being crucial for preferring Bt cotton (Frisvold, 2004 ; Kopainsky & Derwisch, 2009 ; Loganathan et al., 2009). Finally, the literature review endorses the contribution of performance related variables in spreading awareness and increasing the acceptability of GM cotton (Derwisch, Kopainsky, & Troeger, 2011 ; Kopainsky & Derwisch, 2009). Thus, most of the literature which can relate to the marketing of GM cotton has examined the 4P's elements individually. However, there is no comprehensive study which took into account the whole picture of the situation.

The present study aims to address this gap by presenting a unified scenario where the marketing strategy elements adopted by the marketer of GM cotton are discussed at every stage of PLC. Furthermore, the above-mentioned studies are contextually different from India as they were conducted in countries with wide variation in their developmental outlook, economic status, growth rates, and population statistics. The present study attempts to fill this gap by utilizing the data pertaining to our country.

The Pre - Launch Phase of Bt Cotton in India

Monsanto released - in March 2003 - three Bt cotton hybrids with Bollgard I (BG I) trait for cultivation - with GEAC approval and in collaboration with its Indian partner, Maharashtra Hybrid Seed Company (Mahyco) (Pray & Nagarajan, 2010). The Table 1 depicts the events preceding the commercial release of Bt cotton in the country. The Table 1 shows that the approval of Bt cotton in the country was preceded by a large number of laboratory studies and field trials carried out during 1996 - 2001 to demonstrate the safety and benefits of Bt-cotton as per regulatory requirements (Manjunath, 2004). However, there were many problems faced by the technology in its prelaunch period.

In the year 1998, Mahyco - Monsanto tied up, and in the same year, the first field trials were permitted by Indian Dept. of Biotechnology's Review Committee on Genetic Manipulation (RCGM). News broke that the trials of Bt cotton were being carried out by Monsanto without the permission of regional governments and without the consent of local communities, and in November 1998, farmers from the Southern India state of Karnataka burnt down the field where Bt cotton was being tested. The operation 'cremate Monsanto' was also launched in 1998 (Herring, 2006). The legality of the field trials was challenged in Supreme Court. On January 8, 1999, the Review Committee on Genetic Manipulation (RCGM) expressed satisfaction over trial results at 40 locations, and in June-Nov 1999, permission was granted for carrying out various field trials. The difficulties in the prelaunch period of the technology further surged with the discovery of its illegal unlicensed spread on more than 10,000 acres of land in Gujarat (Shah, 2005). These hybrids were produced by another Indian company, Navbharat Seeds (Ahmedabad) and contained Monsanto's cry1Ac gene (Sadashivappa & Qaim, 2009). This generated bad word of mouth for the technology.

Thus, there were a number of *illegal issues* that surrounded the initial launch of the technology in India. According to supporters, the issue of taking approval from the authorized body was a procedural irregularity. The Committee, which had authorized the import of Bt seeds in 1995, was empowered only to grant clearances for contained genetic experiments in laboratories or greenhouses. Only the Genetic Engineering Approval Committee (GEAC), an interministerial body, could give permissions for the field trials (Raghuram, 2002).

The mistake made by the technology promoter MMB is attributed to the ambiguity and overlapping in the roles and duties of the government regarding approval of GMOs. However, according to critics, this was an intentional move by MMB to enter the country without attracting public attention. Thus, there were a number of controversies that were created/tackled by the technology promoter Monsanto at the initial launch of the GM cotton technology in India. These controversies caused a delay in the launch of the technology (Scoones, 2003).

Table 1. Chronology of Development and Approval of Bt-Cotton in India

1995	Mahyco applied to DBT (Department of Biotechnology, Govt. of India) for permission to import a small stock of Bollgard® (Bt cotton) seeds from Monsanto Company, USA. DBT gave permission.
1996	A nucleus stock of 100 gms of cotton seeds of the variety Cocker 312 containing the Bollgard® Bt gene, cry 1Ac, was received by Mahyco from Monsanto, USA.
	Initiated crossing with the Indian cotton breeding lines to introgress cry 1Ac gene.
	40 elite Indian parental lines were converted for the Bt trait.
1996-1998	Risk-Assessment studies were conducted using Bt-cotton seeds from converted Indian lines.
	• Pollen escape studies
	• Aggressiveness and persistence studies
	• Biochemical analysis
	• Toxicological studies on ruminants (goats)
	• Allergenicity study on rabbits
1998 - 1999	Multi-location field trials at 40 locations in 9 states to assess agronomic benefits and safety. Data submitted to RCGM (Review Committee for Genetic Modification), Ministry of Science & Technology, Govt. of India.
1999 - 2000	Field trials repeated at 10 locations in 6 states. Data submitted to RCGM.
July 2000	Based on the recommendations of RCGM, the GEAC (Genetic Engineering Approval Committee), Ministry of Environment & Forests, Govt. of India, gave approval for Mahyco to conduct large scale field trials in 85 ha and also undertake seed production in 150 ha.
Kharif 2001	Large scale field trials covering 100 ha. Field trials were also conducted by All India Coordinated Cotton Improvement Project of the Indian Council of Agricultural Research (ICAR).
26 March 2002	GEAC approved Mahyco's three Bt-cotton hybrids, viz., MECH 12, MECH 162, and MECH 184 for commercial cultivation in India. This approval was initially valid for 3 years and also stipulated a few conditions.

Source: Manjunath (2004)

Four PLCs of Bt (GM) Cotton in India

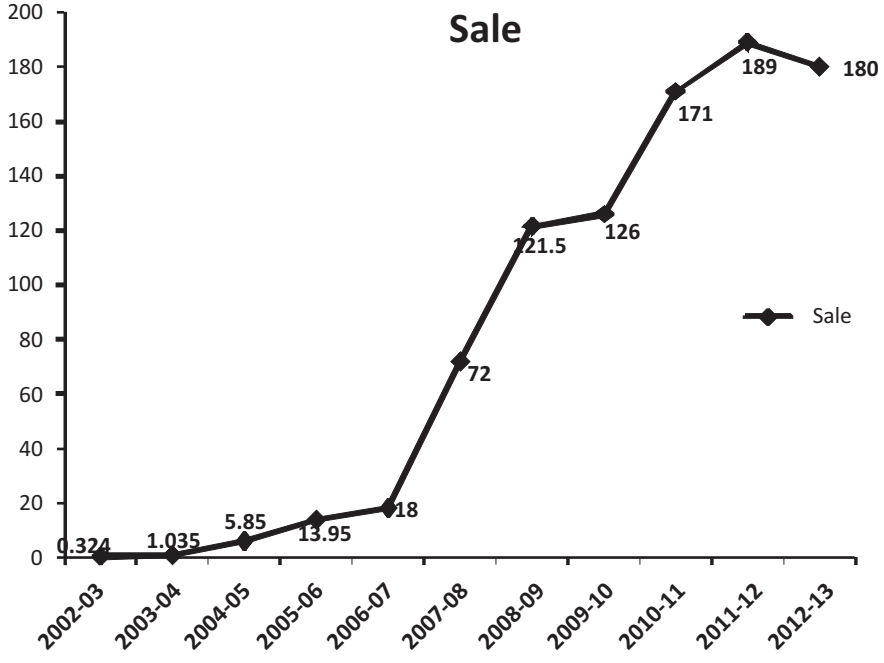
The sale of Bt cotton seeds in the country since its launch is depicted in the Figure 1. The Figure 1 demarcates the various stages of the product lifecycle of Bt cotton in India. The introduction stage is earmarked from 2002 -2005. The period of 2006-2009 showed rapid growth. After 2009, the rate of growth declined, and maturity set in from 2009. The concept of 4P's of marketing is used to lend explanatory power to these stages.

The Introduction Stage

In this stage, there are a number of issues like awareness, distribution, pricing, and so forth which a firm has to deal with. The product sales show a slow growth at the introduction stage. As discussed, Bt cotton was introduced in the country by Monsanto through its subsidiary MMB (Mahyco Monsanto Biotech) Limited. The first Bt hybrids combined the Bt gene from Monsanto with hybrid cotton cultivars from Mahyco. The MMB joint venture also expressed its willingness to license Bt technology to the companies agreeing to meet their financial and other contractual requirements (Pray & Nagarajan, 2010).

(1) Product : In 2004, the Genetic Engineering Approval Committee (GEAC) of the Ministry of Environment and Forest (MOEF) approved one more Bt cotton hybrid of Rasi Seeds for cultivation in the Central and Southern zones of India. This was in addition to the three hybrids of Mahyco, which were given approval for commercialization in 2002 ("India beats China in Bt cotton cultivation," 2007). Thus, at this stage, there were three hybrids across two states and one company with one event containing cry1Ac gene developed by Mahyco for Bollgard I.

Figure 1. Sales of Transgenic Cotton Seeds in the Country - PLC of GM (Bt) Cotton in India



Note: Sale of seeds is expressed in Lakh Kg

The first year of Bt cotton production saw a number of product failures in AP, MP, Maharashtra, Karnataka, and Gujarat (Centre for Sustainable Agriculture, 2005). There are many studies based upon field surveys that gave mixed results during this period (Naik, Qaim, & Zilberman, 2005 ; Sahai & Rehman, 2003; Qayum & Sakkhari, 2005). Bt cotton was reported as a reason for farmer suicides across many states too. This stage saw the emergence of illegal unauthorized/ spurious Bt cotton seeds in many states. Authorities in these regions launched a campaign against illegal sale of Bacillus thuringiensis (Bt) cotton seeds to farmers. It was advised that the farmers should buy seeds which were certified and approved by the government.

(2) Price : The prices of Bt cotton in the year of introduction were ₹ 1600 for a packet of 450 gm of Bt seeds and 120 gm of non-Bt seeds (which farmers were supposed to sow as 'refuge' to minimize the potential for development of Bt-resistant insect races in the long run) in comparison to ₹ 300- ₹ 500 for a packet of conventional hybrids (Arora & Bansal, 2011 ; Pray & Nagarajan, 2010). Out of seed price of ₹ 1600, Monsanto charged ₹ 1250 per packet as the technology fee or the trait value (Arora & Bansal, 2012). In 2005, the prices became ₹ 1675 for each state (refer to Table 5). The debate on Bt cotton pricing began in late 2005 when South India Cotton Association urged the seed companies to lower their seed prices. The idea gained popularity among various farmer organizations, which led the state of Andhra Pradesh to impose certain regulations targeted to control Bt cotton seed prices so as to make the technology affordable and accessible to small and marginal farmers in the state (Arora & Bansal, 2011).

(3) Place : The seeds were made available only in the Central and Southern zones of India, and North India was not given permission to cultivate Bt. However, the area under Bt cotton cultivation rose from 0.5% to 1.3% to reach 14.79% of the total area under cotton cultivation in 2004-05, indicating its spread (refer to Table 4).

(4) Promotion : In the Southern zone, Mahyco-Monsanto Biotech (India) Limited launched Bt cotton seed in

Andhra Pradesh amidst a high-decibel campaign in 2002 (Venkateshwarlu, 2006). Aggressive marketing campaigns were also reportedly conducted in Andhra Pradesh (Qayum & Sakkhari, 2005). In the Central zone, advertisements in the newspapers, posters, and televisions were carried out with popular actors like Nana Patekar. The promotion was targeted at the channel partners too. The Bt Cotton companies gave gold and silver prizes to the top retail seed seller and top wholesale merchant for their sales in 2004. In most of the states, testimonial advertisements, incentives, gifts, and so forth were used to lure the farmers ("Marketing of BT Cotton in India: Aggressive, unscrupulous and false...," n.d.).

Thus, the major strategies which were adopted in the introduction stage can be summarized and analyzed as :

[1] The high prices of Bt cotton seeds compared to conventional cotton (Arora & Bansal, 2011 ; Pray & Nagarajan, 2010) indicate skimming pricing strategy that was adopted at the introduction stage. Higher technology fee charged by the promoter turned out to be feasible, given the fact that the product promised to solve the problems of cotton cultivation and MMB was the only player.

[2] MMB used licensing to spread its propriety technology and earn further revenues. According to Manjunath (2004), 19 seed companies joined MMB as sublicenses for Bt cotton till 2004. This specifies the strong intellectual property rights protection which might have backed this move.

[3] The product seemed to be of a basic version. A study by The All India Coordinated Cotton Improvement Project (AICCIP) on Bt cotton trials conducted in the Central and South zones to assess the incidence of diseases (bacterial blight, alternaria leaf spot, and grey mildew) on Bt and non-Bt cotton crops revealed that Bt and non-Bt cotton hybrids were equally susceptible to the three diseases (Krishnakumar, 2005). This points towards the scope for further research to customize and improve the product.

[4] The major launch strategies across Central and **S**outhern zones were advertisements and marketing through various media and celebrity endorsements. Most of the advertisements aimed to spread awareness and initiate trials. Trial offers and sales promotion activities were also carried out ("Marketing of BT Cotton in India: Aggressive, unscrupulous and false...," n.d.).

[5] A lot of public relation activities were carried out to set a platform for further growth. Though the product was initially launched in Central and Southern zones only, in North (Punjab), articles showcasing a positive sentiment for Bt started appearing in leading newspapers from 2003 onwards (Chawla, 2003). It spread out an optimistic wave in such a manner that before the commercial approval of GM cotton in the state (in 2005), around 20,000 hectares of the land area was already under Bt cotton cultivation ("Bt cotton enthuses Punjab," 2005).

The Growth Stage

At this stage, sales start to increase rapidly, and firms aim to increase their market share by offering additional features. Distribution is augmented to meet increased demand, while the promotion aims a bigger audience (Sharma, 2013). The scene for the growth stage was set in 2005 when Bt cotton was approved for commercial cultivation in Northern India. However, the takeoff started from 2006, when the sales actually gained momentum. The takeoff is the point of transition from the introduction to the growth stage of the PLC. It is the first dramatic and sustained increase in product category sales (Golder & Tellis, 2004). After takeoff, the sales base became high, which implies that the increase in unit sales was quite substantial. The period from 2006 to 2009 saw a rapid growth. After 2009, the growth rate of the sales declined (refer to Figure 1). The 4P's strategies for this stage are discussed below :

(1) Product : New Bt genes and new events started appearing in 2006. MMB sourced two genes cry1Ac and cry2Ab from Monsanto and developed Bollgard II (BGII). The other two events approved for the sale in the same year were Event-1 (third event) which was developed by JK Seeds featuring the cry1Ac gene sourced from IIT Kharagpur, India ; the GFM event (fourth) was developed by Nath Seeds sourced from China and which featured the fused genes cry2Ab and cry1Ac (refer to Table 2). In contrast to the above four events (which were all incorporated in cotton hybrids) notably, the fifth event known as BNLA-601 was approved for commercial sale in an indigenous publicly bred cotton variety named Bikaneri Narma (BN) expressing the cry1Ac gene (Pray, Nagarajan, Huang, Hu, & Ramaswami, n.d.).

In 2008, Central Institute of Cotton Research (CICR), Nagpur developed desi Bt cotton seeds for distribution among the farmers. It was developed after 10 years of research by CICR. It was approved for commercialization in 2009. This was the first indigenous Bt cotton event developed by the Central Institute of Cotton Research (CICR) along with the University of Agricultural Sciences, Dharwad, Karnataka. Hence, the number of events approved also climbed up to five in 2008 (Choudhary & Gaur, 2010). During this period, a number of companies like Syngenta, Metahelix, and Indo American Hybrid seeds claimed to be working on their own technology (Chowdhary, 2007).

(2) Place : Bt cotton was approved for commercial cultivation in the Northern zone of the country in 2005-06. Six new Bt cotton varieties were approved for the region. In May 2006, the Genetic Engineering Approval Committee (GEAC) approved Bollgard II cotton hybrids containing MON 15985, developed by several seed companies for commercial release. However, this permission was given only for the Central and Northern Zones. In the Southern zone, the Government of Andhra Pradesh (GAP) did not approve the sale of Bollgard II. It asked the GEAC to provide an economic viability report in the context of MMBL's claim that Bollgard II helped farmers cut down inputs (Rao, 2007). Hence, again, there was a selective launch and sale of new GM cotton variety. Area under Bt cotton almost doubled - from 43% with reference to the total area under cotton cultivation in the country in 2005-06 to 89% in 2008-09 (refer Table 4).

(3) Price : At this stage, the pricing issue got to the Centre stage as seed of Bollgard II was sold at ₹ 1,350 per packet for one acre of sowing in the states of Gujarat and Maharashtra. However, GAP wanted it to be sold at ₹ 750, the same as for Bollgard I, irrespective of the pricing in other states (Rao, 2007). In January 2006, the government of Andhra Pradesh filed a case with the Monopolistic and Restrictive Trade Practices Commission (MRTPC) against MMB for indulging in monopolistic trade practices with unreasonably high prices and limited technical developments. MMB reduced the price of Bollgard I from ₹ 1600 for a packet of 450 gms of seed to ₹ 1200 and then to ₹ 750 in June 2006. This pricing directive was soon adopted by other domestic firms such as Nath Seeds Ltd. and JK Agri Genetics Ltd. The other states of India also adopted the same pricing. In 2007, the prices for all the three states became equal at ₹ 750 for a packet of 450 gms. In 2008, prices in North and South stayed the same, but in the Central zone of India, the prices further declined to reach ₹ 650 (Arora & Bansal, 2011, refer Table 6).

(4) Promotion : Testimonial advertisements featuring farmers who had cultivated and were benefited by Bt cotton seeds adoption were shown in the posters and hoardings. Seed companies used booklets of success stories that included Bt cotton farmer photos and stories about their high yields and profits. The companies distributed these booklets to the farmers through seed dealers ("Marketing of BT Cotton in India: Aggressive, unscrupulous and false...," n.d.). In Punjab, the government pushed the Bt cotton seeds by promoting their benefits. When Bt cotton varieties were approved for commercial cultivation, the Chief Minister of Punjab, Captain Amarinder Singh promoted the use of Bt cotton (Tandon, 2006).

Hence, the major strategies and scenario for this stage were :

[1] Competition began to rise with a boom in the number of companies, hybrids, and new events. To keep the competition at bay, product modifications were made by adding new features like better protection as in the case of Bollgard II (refer Table 2). Customized hybrids better suited to the agro-climatic conditions of the farmers were also offered, thereby widening their portfolio of choice.

[2] Prices were reduced in accordance with the directives provided by various state governments. The AP government had forced the companies to reduce the price of Bt cotton seed first in 2006 and then in 2008 by enacting the Seed Control Act. The trait fee charged by Mahyco-Monsanto Biotech India Ltd. (MMB) also came down to ₹ 140-150 a packet. This helped to further enhance its penetration in the market (Arora & Bansal, 2011).

[3] Promotion efforts included all kinds of media and methods ranging from simple advertisements in the print to testimonials. Lobbying with the political parties and media was also observed in certain cases. For example, in Punjab, as soon as Bt cotton was approved for commercial release, publicity by MMB started with the help of local van and dancing girls ("Marketing of BT Cotton in India: Aggressive, unscrupulous and false...," n.d.). In the whole Northern zone, prices of Bt cotton seeds were reduced from ₹ 1675 for a pack of 450 grams in 2005 to ₹ 650 in 2009 (refer Table 6).

[4] The market for Bt cotton seeds got a boost due to the detective and punitive actions taken against unapproved Bt cotton varieties, which led to a decrease in their sale. The government statistics suggested that in 2007-08, only 5.23% of the samples tested were found to be spurious against 68.91 % back in 2003-04 (Kant, 2008).

The Maturity Stage

At this stage, the sales continue to rise, but at a decreasing rate, until they become stable or reach a peak. Most of the companies have to be aggressive to defend their market shares. Competition becomes intense as compared to the growth stage. In case of Bt cotton in India, the period from 2009- 2012 showed maturity. The sales reached 189 lakh kg and then declined a little (refer Figure 1). The maturity stage was also characterized by a slow rise in the area under cotton cultivation (refer Table 4). This further depicts saturation.

(1) Product : The competition became extreme with an increase in the number of hybrids, companies, and events. The number of events also rose to six by July 2009; Metahelix received approval to sell its new Bt gene. The sixth new event, MLS-9124 was developed indigenously by Metahelix Life Sciences and featured a synthetic cry1C gene. Metahelix Life Sciences became the first Indian private company to develop a commercial gene - cry1C on its own and got approval for its two Bt cotton hybrids. In this novel method, the single gene, cry1C, was expected to provide protection against two major pests (bollworm and spodoptera) which account for more than 60% of the pests that damage the cotton crop (Choudhary & Gaur, 2010). Hence, there was a commercial deployment of five events in hybrids and one event in both variety and hybrids in India at that time.

(2) Promotion : There were a number of public relations exercises undertaken through advertorials and news in print media. In 2008, there was a story about the success of Bt cotton published in a leading newspaper as a customer connect initiative, which looked like a full page report, but was a kind of paid advertisement. The same story was reprinted in 2011 in the same newspaper and hence was criticized as a MMB-media nexus (Sainath, 2012). In 2012, the Advertising Standards Council of India asked Monsanto to drop the claim that GM cotton technology raised the income of Indian cotton farmers (Sharma, 2012).

(3) Price : The prices of Bt seeds' packet declined from ₹ 1600 for a packet of 450 grams (2003) to ₹ 650- ₹ 750 for BG-1 and BG-2, respectively in most of the regions and ₹ 750- ₹ 925 in the Northern region in the year 2009. In

Table 2. List of Bt Cotton Events Approved for Cultivation in India

Event Name	Event Number	Source/Company/Institution	Genes	Year of approval
Bollgard I(IR)	MON 531	Monsanto	cry 1Ac	2002
Bollgard II(IR)	MON 15985	Monsanto	cry1Acand cry2Ab	2006
Event-1(IR)	Event-1	IIT Kharagpur/ JK agrigenetics	Truncated cry 1Ac	2006
GFM Cry1A(IR)	GFM Cry1A	Chinese Academy of Sciences	cry1Ac+cry2Ab	2006
Dharwad/CICR Event(IR)	Dharwad Event(BNLA-601)	UAS, Dharwad/Nagpur	Truncated cry 1Ac	2008
9124(IR)	9124	Metahelix	cry 1C	2009

Source: James (2010)

Table 3. Growth of Bt Cotton Hybrids in the Country (Numbers)

2003	2004	2005	2006	2007	2008	2009	2010	2011*	2012	2013*
3	4	20	62	131	274	522	780	884	-	1095

Source: Choudhary & Gaur (2011) and James (2013)

Table 4. Expansion in the Area under Bt Cotton Cultivation in India Since its Launch

2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-2010	2010-11	2011-12	2012-13
.5	1.3	5	14.79	43	68	80	89	91	95	89	92

Note: The area is expressed as percentage of total area under cotton cultivation in the country.

Source: Based on statistics provided by (a) Cotton Corporation of India (n.d.) ; (b) The International Service for the Acquisition of Agri-biotech Applications (2001-2010) ; (c) James (2013)

2010-11, these prices rose to ₹ 825 in case of BG-1 and ₹ 1000 for BG2 in the Northern zone ; the prices were ₹ 830 for BG1 and ₹ 930 for BG2 in the Central and Southern zones (refer Table 6).

(4) Place : Area under cultivation of Bt cotton grew to 89% in 2008-09 and 92% in 2012-13. The Table 4 shows that the percentage of area under Bt grew at a slow pace and even depicted a downward trend in 2011-12. This was probably due to less supply of seeds as compared to their demand in the states like Maharashtra (Ganesh, 2012).

Hence, the various strategies adopted at this stage were :

[1] In order to achieve a rise in the price of Bt cotton seeds, debatable measures were used across various states. These included hoarding of seeds, black marketing, and creating artificial scarcity in the market. In July 2012, MMB was served a show cause notice under such charges (Ganesh, 2012).

[2] Paid editorials in alliance with print media were used for promotion. The company was also held liable for using false claims in its advertisements (Sharma, 2012).

[3] The number of approved events reached six in 2009 (refer Table 2). There was an increase in the number of approved Bt cotton hybrids from three in 2003, to 884 in 2011, and 1095 in 2013 (refer Table 3).

[4] MMB was also blamed for supplying inferior quality seeds and the sale & distribution of its Bt cotton seeds was banned in Maharashtra ("Maharashtra company challenges ban on Bt cotton seeds," 2014). In the 2013 Kharif season, the Maharashtra government allowed Mahyco to sell seeds subject to certain conditions ("Mahyco allowed to sell Bt cotton seeds," 2013).

Table 5. Price Trends for Bollgard I Across Various Zones (in ₹)

Year	Central Zone	Northern Zone	Southern Zone
2002	1600		1600
2003	1600		1600
2004	1600		1600
2005	1675	1675	1675
2006	750	1390	750
2007	750	750	750
2008	650	750	750
2009	650	650	650
2010	650	650	650
2011	830	825	830
2012	830	825	830

Conclusion

The findings of the study are summarized in the tables which show the path traversed through many market parameters. The Table 2 depicts that the number of events approved for commercialization of Bt cotton rose from one to six since its launch. The Table 3 and Table 4 show the increase in the number of Bt cotton hybrids approved for commercialization and expansion of area under Bt cotton, respectively. These tables point towards the rapid diffusion of technology and its acceptance by the market players. The fall in prices of Bollgard I across various zones (which have been compiled in the Table 5) further spearheaded its growth and spread.

The Table 3 indicates the research focus of the industry and surge in competition in the market. According to Table 4, the total land area under cotton was almost saturated by GM cotton. The Table 5 shows that the prices for the Central zone and South zone moved in tandem, but in the North, there was a little variation in prices. Moreover, the data reveals that Bollgard II was priced ₹ 100 - ₹120 higher than others for a packet of 450 grams. Hence, the Tables 2- 5 indicate the adoption, spread, and penetration of GM cotton in the country. The analysis of these tables along with the PLC and 4P's strategies lead to the conclusions which are depicted in the Table 6.

The Table 6 can be further used to make following inferences :

The above analysis reveals that the journey of GM cotton in India was full of many hurdles. It was the private sector (MMB in particular) which was responsible for the advent as well as the spread of GM cotton in the country. The powerful commercial sector was not deterred by the adversities and hardships posed by the environment. In order to conquer complex debates, sometimes, moral and ethical values were also compromised. All the efforts and strategies ranging from simple marketing tactics to unprincipled approaches were utilized to propel the technology in the market. This resulted in a bad name for the product in many cases and further complicated the issues. But despite all the problems, the technology promoters became successful in achieving penetration in the market. The legal and political environment of the country acted as a friend and a foe at the same time. Laws regarding the technology regulation did not exist at a very advanced stage. The legal scenario at the national level was further complicated due to the presence of highly diverse set of practices adopted at state levels.

All the elements of the marketing mix- product, price, place, and promotion acted cohesively and spelled success in the marketplace. These elements were duly customized according to various stages of the product life cycle. The marketing strategy elements were adapted according to the laws of the country, economic conditions of its potential adopters, geographic conditions of local areas, and the extent of competition generated by the market. The study further concludes that GM cotton is at the maturity stage in our economy. The market for GM cotton in our country has reached a near saturation, with 89% of the total area being covered by it.

Table 6. 4 P's Strategies at Various Stages of the PLC

Stages of PLC	Product	Price	Place	Promotion
Introduction	Basic version	Skimming pricing with higher technology fee.	Launched in Central and Southern zones only. Leveraging the existing distribution setup of Mahyco.	Aggressive advertisements and political lobbying.
Growth	Better adapted and effective products like Bollgard II and number of events approved reached four.	Reduction in the price across all the zones in 2006. In 2007, there was a uniform rate of pricing made applicable across all the zones.	Distribution and reach of Bt cotton increased with the approval for its launch granted for the Northern zone.	Promotion efforts included a lot of political support in certain areas along with high decibel advertisements.
Maturity	The number of events approved reached six. One indigenous variety and hybrid was developed by CICR.	Prices further reduced in 2008-09 and rose by a margin in 2011-12.	Area under Bt cotton grew in 2008- 2011 but declined in 2011-12 due to the fact that the demand of Bt seeds exceeded the supply in some states.	A number of public relation initiatives and advertorials in addition to regular promos. Monsanto was surrounded by controversies like paid editorials and was asked by the regulator to drop false claims from its advertisements in 2012.

The present controversies, if not handled in time, as indicated by the study, point towards its decline in the future. It is the time for the whole industry to settle the issues that may lead to this undesired path.

Research Implications, Limitations of the Study, and Scope for Further Research

The analysis done in this paper has managerial implications for the biotechnology industry. The promoters of the technology should use caution while formulating and implementing the marketing strategy elements. They must be aware of the thin line difference between being ethical and unethical. As mentioned in this paper, unethical strategies led to a lot of criticism and sowed the seeds of discontent among many stakeholders across all stages of the PLC of Bt cotton.

The organizations involved in the trade of Bt cotton seeds must realize that with 92% (in 2012-13) of the total area under cotton penetrated by Bt, the market has reached near saturation. Hence, the marketers must make further plans to elongate the maturity stage or avoid the decline phase. The findings of this study can also be generalized by other innovative technologies endeavoring to make their mark. They can use this marketing voyage of biotechnology in our country and improve their marketing strategies. They can utilize this analysis to plan effectively and avoid mistakes.

Further research could be carried out to find out the marketing strategies and tactics which can help GM cotton promoters in preventing its decline and achieving further growth. A study of consumer perceptions can be helpful in providing insights into the same. The study is theoretical in nature and ignores the consumer's side of the situation. It needs to be supported by consumer research to widen its applicability.

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