Bt Cotton in India
A COUNTRY PROFILE

ISAAA Series of Biotech Crop Profiles

Bt Cotton in India: A Country Profile

by

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July 2010

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Citation:

Choudhary, B. & Gaur, K. 2010. Bt Cotton in India: A Country Profile. ISAAA Series of Biotech Crop Profiles. ISAAA: Ithaca, NY.

ISBN: 978-1-892456-46-X

The authors gratefully acknowledge the support of ISAAA management and researchers at the ISAAA Centers in Kenya and the Philippines, and the staff of the Biotechnology Information Centers (BICs) located in 21 developing countries around the world in the preparation and the free distribution of the "Bt Cotton in India: A Country Profile" in developing countries. This volume is excerpted from the Global Status of Commercialized Biotech/GM Crops: 2009, ISAAA Brief 41, authored by Dr. Clive James. The purpose of "Bt Cotton in India: A Country Profile" is to provide information on the rapid adoption and impact of Bt cotton in India from 2002 to 2009. The purpose is also to share knowledge with the scientific community in India and global society and to facilitate a more informed and transparent discussion about its potential role in the agriculture sector, and its contribution to a more sustainable agriculture. The authors, not ISAAA, take full responsibility for the views expressed in this publication and for any errors of omission or misinterpretation.

Cover Picture:

Bt cotton hybrid MRC-7017 BG-II in the farmers' field ready for a rich harvest in Ban Sudhar village, Sirsa district of Haryana State, India.

Publication Orders:

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The remarkable success of Bt cotton in India

Remarkably, for the eighth consecutive year the hectarage, adoption rate and the number of farmers using Bt cotton hybrids in India in 2009, all continued to soar to record highs. In 2009, 5.6 million small and marginal resource-poor farmers in India planted and benefited from 8.381 (~8.4) million hectares of Bt cotton, equivalent to 87% of the 9.636 (~9.6) million hectare national cotton crop. Given that the adoption rate was already very high in 2008, when 5 million farmers planted 7.6 million hectares of Bt cotton, equivalent to 80% of the 9.4 million hectare national cotton crop, all the increases in 2009 are robust. The increase from 50,000 hectares in 2002, (when Bt cotton was first commercialized) to 8.4 million hectares in 2009 represents an unprecedented 168-fold increase in eight years. There were three notable developments in Bt cotton in India in 2009. First, there has been a consistent trend in India for increased adoption of multiple gene Bt cotton, over single gene products, since 2006, when multiple gene products were introduced. In 2009, for the first time, multiple gene Bt cotton occupied more hectares (57%) than single gene Bt cotton (43%); this reflects the superiority of the multiple gene products and farmer preference. Second, 2009 was the first year for an indigenous public sector bred Bt cotton variety (*Bikaneri Nerma*) and a hybrid (NHH-44) commercialized in India, thus redressing the balance between the role of the private and public sector in biotech crops in India. Third, was the approval to commercialize a new Bt cotton event, (bringing the total to six approved events) featuring a synthetic *cry1C* gene, developed by a private sector Indian company. The deployment of Bt cotton over the last eight years has resulted in India becoming the number one exporter of cotton globally as well as the second largest cotton producer in the world. Equally important, India is now poised to benefit from the continued productivity gains that biotech cotton hybrids and varieties offer for the short, medium and long term future. In summary, Bt cotton has literally revolutionized cotton production in India. In the short span of seven years, 2002 to 2008, Bt cotton has generated economic benefits for farmers valued at US$5.1 billion, halved insecticide requirements, contributed to the doubling of yield and transformed India from a cotton importer to a major exporter. Socio-economic surveys confirm that Bt cotton continues to deliver significant and multiple agronomic, economic, environmental and welfare benefits to farmers and society (James, 2009).

Land holdings, distribution and production of cotton in India

India, the largest democracy in the world, is highly dependent on agriculture. The performance of the agriculture sector continues to influence the growth of the economy – it is a major factor in driving India's national economy. In recent years, there has been a decline in the share of agriculture in the national economy from almost a quarter to 17.8% of its Gross Domestic Product (GDP). In contrast, there has been a very small decline in the workforce engaged in agriculture which still provides a means of survival to 52% of the population – more than half of India's population (Economic Survey, 2009). India is a nation of small resource-poor farmers, most of whom do not make enough income to cover their meager basic needs and expenditures. The latest National Sample Survey conducted in 2003, reported that 60.4% of rural households were engaged in farming indicating that there were 89.4 million farmer households in India (National Sample Survey, India, 2003). Sixty percent of the farming households own less than 1 hectare of land, and only 5% own more than 4 hectares. Only 5 million farming households (5% of 90 million) have an income that is greater than their expenditures. The

average income of farm households in India (based on 40 Rupees per US dollar) was US$50 per month and the average consumption expenditures was US$70. Thus, of the 90 million farmer households in India, approximately 85 million, which represent about 95% of all farmers, are small and resource-poor farmers who do not make enough money from the land to make ends meet – in the past, these included the vast majority of over 6 million Indian cotton farmers.

India has a larger area of cotton than any country in the world. Based on the latest estimate (Table 1), the Directorate of Cotton Development, Ministry of Agriculture reports that 6.3 million farmers planted cotton on 9.4 million hectares in 2008 with an average cotton holding of 1.5 ha (Ministry of Agriculture, India, 2007). In 2009, the total hectarage of cotton in India was estimated at 9.6 million hectares approximately 3% higher than the 9.4 million hectares in 2008, and farmed by 6.3 million farmers in 2008 and 2009. This increase is in contrast to the 2% decrease in cotton area globally in 2009 versus 2008. Comparing the distribution of cotton hectarage by States in India in 2008 (Table 1), Maharashtra, the largest cotton-growing State, had 2.15 million farmers growing cotton, which occupied approximately 34% of India's total cotton area; this was mostly cultivated on dry land. Gujarat had 1.30 million farmers, followed by 0.96 million in Andhra Pradesh, 0.45 million in Madhya Pradesh, 0.30 million in Rajasthan, 0.26 million in Haryana, 0.20 million farmers each in Punjab, Karnataka and Tamil Nadu and the balance in other states of India.

Whereas, India's cotton area represents 25% of the global area of cotton, in the past it produced only 12% of world production because Indian cotton yields were some of the lowest in the world; the advent of Bt cotton over the last 8 years has coincided with almost a doubling of yield from 308 kg per hectare in 2001 to 568 kg/ha in 2009, with 50% or more of the increase attributed directly to yield increases from Bt cotton.

Table 1. Land holdings distribution and production of cotton in India, 2008-2009

No.	State	Average Cotton Holding per Farm (Hectare)	Area of Cotton (Million Hectare)	Production (Million Bale)	Average Yield (Kg/ha)	No. of Cotton Farmers (Million)
1	Punjab	2.64	0.527	1.75	564	0.199
2	Haryana	1.72	0.456	1.40	522	0.265
3	Rajasthan	0.98	0.302	0.75	422	0.308
4	Gujarat	1.80	2.354	9.00	650	1.307
5	Maharashtra	1.46	3.142	6.20	3357	2.152
6	Madhya Pradesh	1.38	0.625	1.80	489	0.452
7	Andhra Pradesh	1.45	1.399	5.33	648	0.964
8	Karnataka	1.56	0.408	0.90	375	0.261
9	Tamil Nadu	0.52	0.109	0.50	780	0.209
10	Orissa	0.76	0.058	0.15	510	0.076
11	Others	0.30	0.026	1.250	-	0.086
	(Weighted Average) or Total	**1.50**	**9.406**	**29.03**	**524**	**6.279**

Source: Ministry of Agriculture, 2007 and Cotton Advisory Board, 2009.

The majority of the cotton in India is grown in ten States which are grouped into three different zones namely, Northern zone (Punjab, Haryana and Rajasthan), Central zone (Maharashtra, Madhya Pradesh, Gujarat and Orissa) and Southern zone (Andhra Pradesh, Karnataka and Tamil Nadu) (Table 2). Approximately 65% of India's cotton is produced on dry land and 35% on irrigated lands. Except for the Northern Zone, which is 100% irrigated, both Central and Southern cotton growing zones are predominantly rainfed. In 2009, of the total 9.6 million hectares, hybrids occupied 90% (8.6 million hectares) of the cotton area and only 10% (1.0 million hectares) were occupied by varieties. The percentage devoted to hybrids has increased significantly over the last few years, a trend that has been accentuated by the introduction in 2002 of high performance Bt cotton hybrids, which have out-performed conventional hybrids. Cotton is the major cash crop of India and accounts for 75% of the fiber used in the textile industry, which has 1,063 spinning mills, and accounts for 4% of GDP. Cotton impacts the lives of an estimated 60 million people in India, including farmers who cultivate the crop, and a legion of workers involved in the cotton industry from processing to trading. India is the only country to grow all four species of cultivated cotton *Gossypium arboreum* and *G. herbaceum* (Asian cottons), *G. barbadense* (Egyptian cotton) and *G. hirsutum* (American upland cotton). *Gossypium hirsutum* represents more than 90% of the hybrid cotton production in India and all the current Bt cotton hybrids are *G. hirsutum* (Table 2).

Table 2. Cotton growing zones in India, 2008-2009

Zones	North Zone	Central Zone	South Zone
States	Punjab, Haryana, Rajasthan	Maharashtra, Madhya Pradesh, Gujarat, Orissa	Andhra Pradesh, Karnataka, Tamil Nadu
Area	1.285 Million hectares	6.121 Million hectares	1.916 Million hectares
Production	3.9 Million bales	17.0 Million bales	6.7 Million bales
Productivity	516 kg/ha	472 kg/ha	594 kg/ha
Conditions	100% irrigated	Irrigated and rainfed	Irrigated and rainfed
Nature of Genotype	Hybrids and varieties	Hybrids and varieties	Hybrids and varieties
Species	G. *hirsutum*, G. *arboreum*	G. *hirsutum*, G. *arboreum*, Intra hirsutum, G. *Herbaceum*	G. *hirsutum*, G. *arboreum*, G. *herbaceum*, G. *barbadense*, Interspecific tetraploids (HB)
Insect/Pest	Heliothis, Whitefly, Jassids, Pink bollworm, Mealy bug	Heliothis, Whitefly, Jassids, Aphids, Pink bollworm, Mealy bug	Heliothis, Whitefly, Jassids, Aphids, Pink bollworm
Diseases	Leaf curl virus, Wilt	Wilt	Wilt, Foliar disease
Sowing Method	Drill Sown	Hand dibbling	Hand dibbling
Time of Sowing	April-June	June-July	July-August

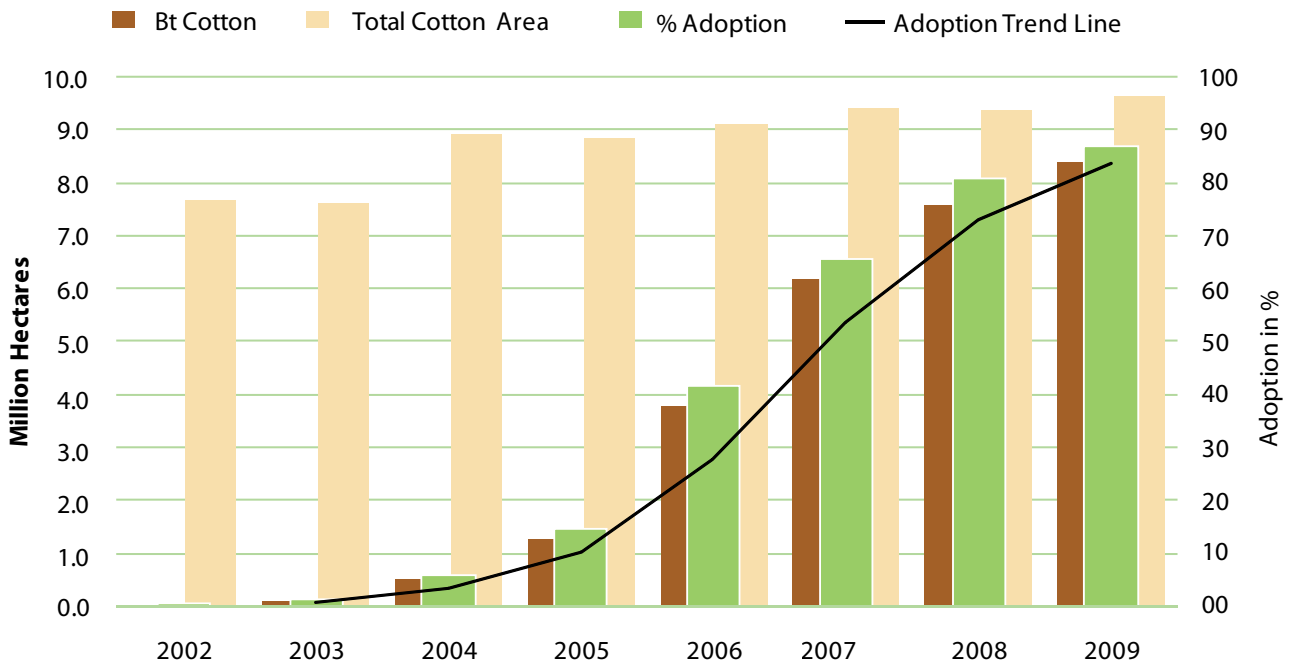
Source: Ministry of Agriculture, 2007 and Cotton Advisory Board, 2009.

Adoption of Bt cotton hybrids in India, 2002 to 2009

Bt cotton, which confers resistance to important insect pests of cotton, was first adopted in India as hybrids in 2002. There were 54,000 farmers which grew approximately 50,000 hectares of officially approved Bt cotton hybrids for the first

time in 2002 which doubled to approximately 100,000 hectares in 2003 (Figure 1). The Bt cotton area increased again four-fold in 2004 to reach half a million hectares. In 2005, the area planted to Bt cotton in India continued to climb reaching 1.3 million hectares, an increase of 160% over 2004. In 2006, the adoption percentage year-on-year growth for any country planting biotech crops in the world in 2006. Notably in 2006, India's Bt cotton area (3.8 million hectares) exceeded for the first time, that of China's 3.5 million hectares. In 2007, the Indian cotton sector continued to grow with a record increase of 63% in Bt cotton area from 3.8 to 6.2 million hectares, to become the largest hectarage of Bt cotton in any country in the world. In 2008, the Bt cotton area increased

Figure 1. Adoption of Bt cotton in India for the eight year period, 2002 to 2009



Source: Compiled by ISAAA, 2009.

Table 3. Adoption of Bt cotton in India, by major state, from 2002 to 2009 (thousand hectares)

State	2002	2003	2004	2005	2006	2007	2008	2009
Maharashtra	25	30	200	607	1,840	2,800	3,130	3,396
Andhra Pradesh	8	10	75	280	830	1,090	1,320	1,049
Gujarat	10	36	122	150	470	908	1,360	1,682
Madhya Pradesh	2	13	80	146	310	500	620	621
Northern Region*	-	-	-	60	215	682	840	1,243
Karnataka	3	4	18	30	85	145	240	273
Tamil Nadu	2	7	5	27	45	70	90	109
Others	-	-	-	-	5	5	5	8
Total	**50**	**100**	**500**	**1,300**	**3,800**	**6,200**	**7,605**	**8,381**

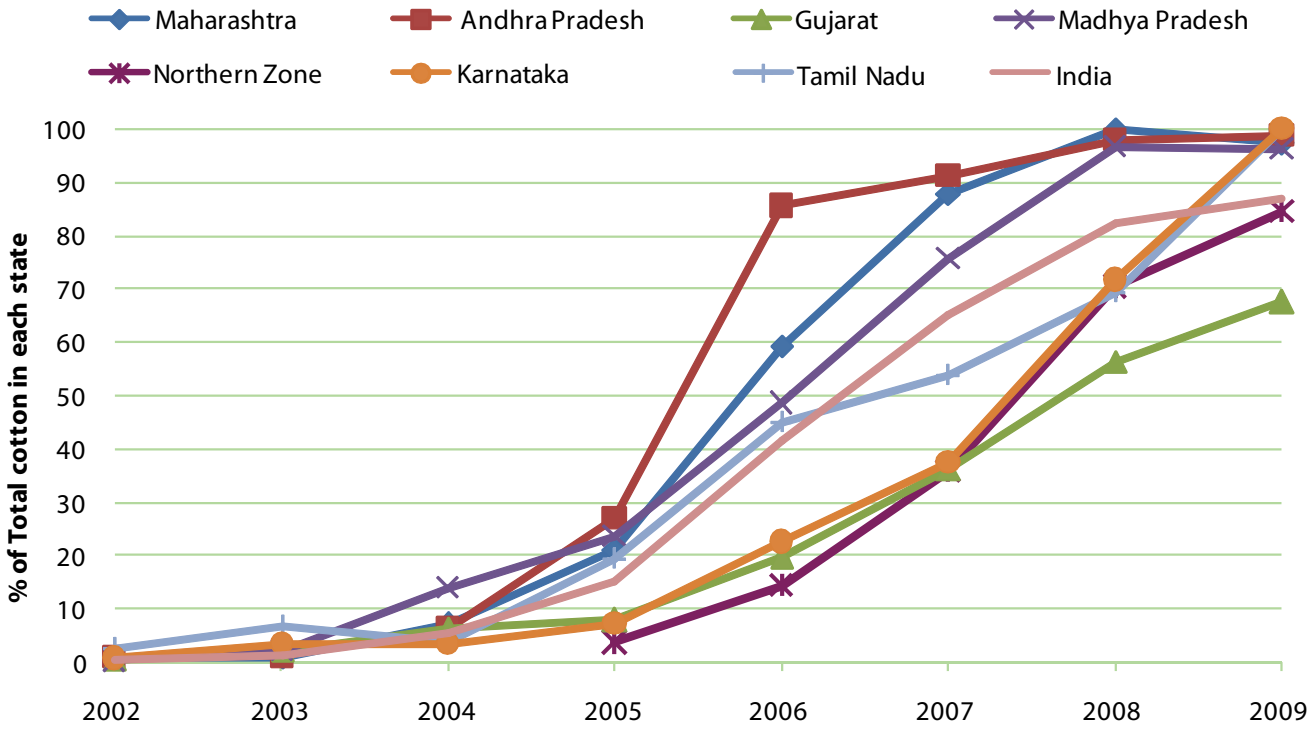
** Punjab, Haryana & Rajasthan*
Source: Compiled by ISAAA, 2009.

record increases which continued with almost a tripling of the area of Bt cotton to 3.8 million hectares. This tripling in area was the highest

yet again to a record 7.6 million hectares from 6.2 million hectares in 2007. Maintaining double digit growth, the Bt cotton area increased to 8.4 million hectares in 2009, over 7.6 million hectare in the previous year. Despite a very high level of adoption in 2008, 2009 was the fifth consecutive year for India to have the largest year-on-year percentage growth of all biotech cotton growing countries in the world; a 160% increase in 2005, followed by a 192% increase in 2006, a 63% increase in 2007, 23% increase in 2008 and a 11% increase in 2009 (Figure 2). In 2006-07, ISAAA reported that India overtook the USA to become the second largest cotton producing country in the world, after China (USDA/FAS, 2007).

Of the estimated 9.6 million hectares of cotton in India in 2009, 87% or 8.4 million hectares were Bt cotton hybrids – a remarkably high proportion in a fairly short period of eight years equivalent to an unprecedented 168-fold increase from 2002 to 2009. Of the 8.4 million hectares of hybrid Bt cotton grown in India in 2009, 35% was under irrigation and 65% rainfed.

Figure 2. Percent adoption of Bt cotton in India and in different states expressed as percentage adoption within states and nationally in India, 2002 to 2009



Source: Compiled by ISAAA, 2009.

A total of 522 Bt cotton hybrids (including a Bt cotton variety) were approved for planting in 2009 compared with 274 Bt cotton hybrids in 2008, 131 in 2007, 62 in 2006, 20 in 2005 and only 4 Bt cotton hybrids in 2004. Over the last eight years, India has greatly diversified deployment of Bt genes and genotypes, which are well-adapted to the different agro-ecological zones to ensure equitable distribution to small and resource-poor cotton farmers. The distribution of Bt cotton in the major growing states from 2002 to 2009 is shown in Table 3. The major states growing Bt cotton in 2009, listed in order of hectarage, were Maharashtra (3.39 million hectares) representing almost half, or 40%, of all Bt cotton in India in 2009, followed by Gujarat (1.68 million hectares or 20%), Andhra Pradesh (1.04 million hectares or 16%), Northern Zone (1.24 million hectares or 15%), Madhya Pradesh

(621,000 hectares or 8%), and the balance in Karnataka, Tamil Nadu and other states.

The area under single gene Bt cotton hybrids increased to 5.74 million hectares in 2007 and

Table 4. Adoption of single and multiple gene Bt cotton hybrids in India, 2006 to 2009 (in millions of hectares and percentage)

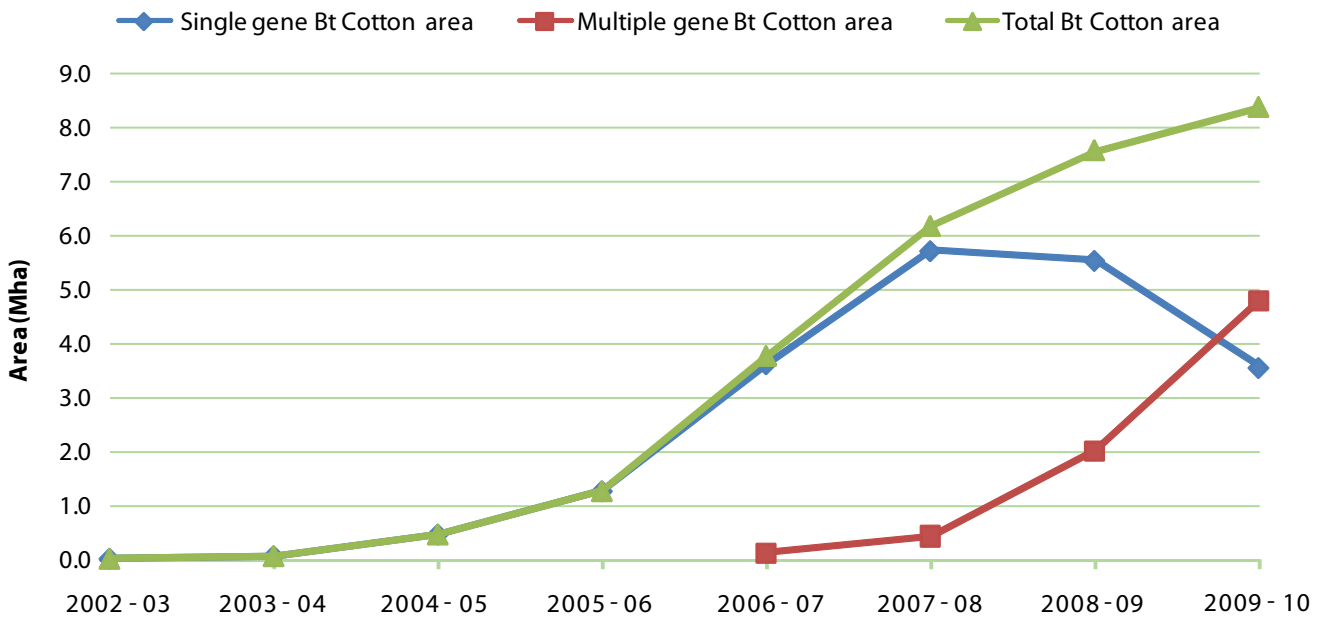
Number of Genes	2005	2006	2007	2008	2009
Multiple	-	0.15 (4%)	0.46 (8%)	2.04 (27%)	4.82 (57%)
Single	1.3 (100%)	3.65 (96%)	5.74 (92%)	5.56 (73%)	3.58 (43%)
Total	**1.3 (100%)**	**3.80 (100%)**	**6.20 (100%)**	**7.60 (100%)**	**8.40 (100%)**

Source: Compiled by ISAAA, 2009.

In recent years, there has been an increasing trend to adopt multiple gene (mostly two genes) Bt cotton hybrids by cotton farmers in India (Table 4 and Figure 3). The first two-gene event MON15985, commonly known as Bollgard®II (BG®II) was developed by Mahyco and sourced from Monsanto, featured the two genes *cry1Ac* and *cry2Ab*, and was approved for sale for the first time in 2006 – four years after the approval of the single gene event MON531 Bt cotton hybrids in 2002-03. In the first year 2006-07, the multiple gene Bt cotton hybrids were planted on 0.15 million hectares whilst single gene Bt

then registered a decline of 5.56 million hectares in 2008 and 3.58 million hectares in 2009. During the same time, multiple gene Bt cotton area grew rapidly to 0.46 million hectares in 2007 to 2.04 million hectare in 2008. In 2009, the multiple gene Bt cotton hybrids were planted for the first time on more area (57%) than single gene Bt cotton hybrids occupying 4.82 million hectares as compared to 3.58 million (43%) occupied by single gene Bt cotton hybrids. It is projected that the multiple gene Bt cotton hybrids will occupy approximately 90% of total Bt cotton area in 2010.

Figure 3. Adoption of single and multiple gene Bt cotton hybrids from 2002 to 2009



Source: Compiled by ISAAA, 2009.

cotton hybrids occupied 3.65 million hectares equivalent to 96% of all the Bt cotton planted.

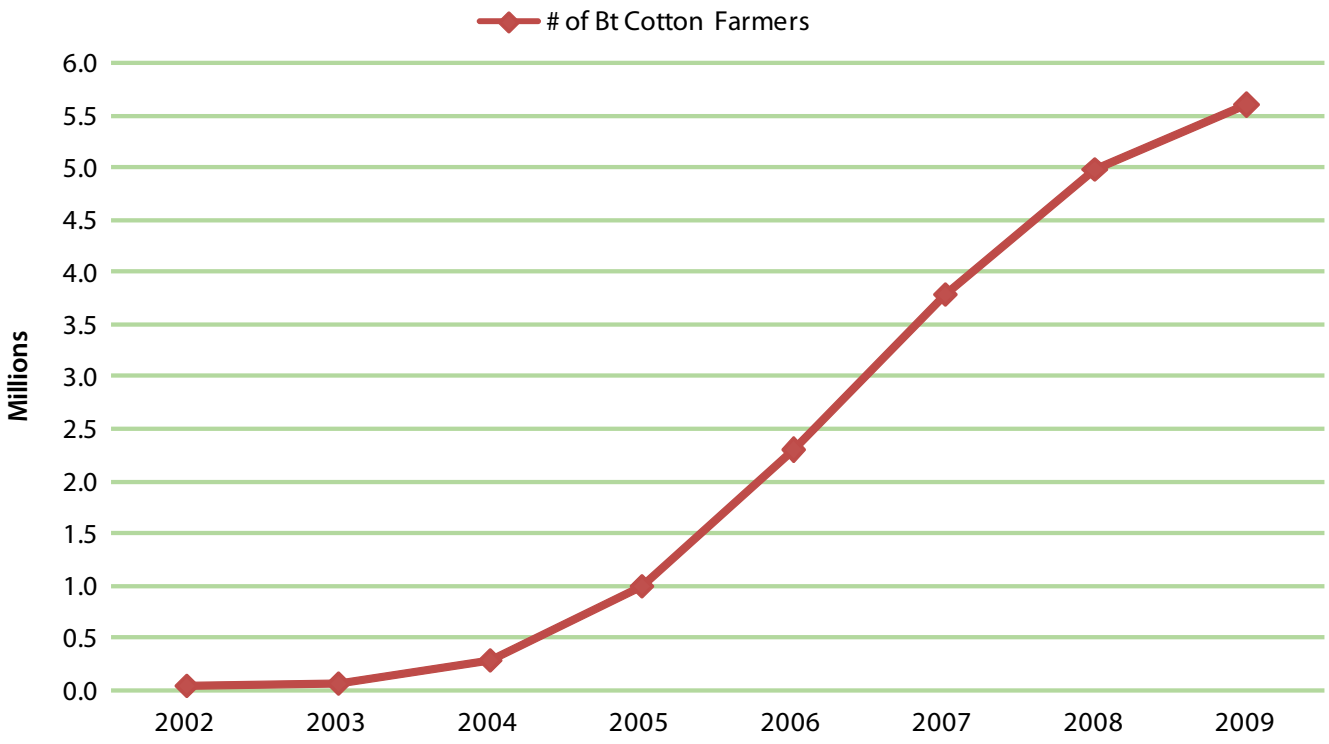
Farmers prefer multiple genes over a single gene Bt cotton hybrids because multiple gene

Bt cotton hybrids provide additional protection to *Spodopetra* (a leaf eating tobacco caterpillar) while it also increases efficacy of protection to both American bollworm, Pink bollworm and Spotted bollworm. It is reported that multiple gene Bt cotton farmers earn higher profit through cost savings associated with fewer sprays for *Spodopetra* control as well as increasing yield by 8-10% over single gene Bt cotton hybrids.

Number of farmers growing Bt cotton hybrids in India, 2002 to 2009

Based on the latest official data the average cotton holding per farm in India is 1.5 hectares (Table 1) and thus it is estimated that approximately 5.6 million small and resource-poor farmers planted Bt cotton hybrids in 2009, up from 5.0 million in 2008 and 3.8 million farmers in 2007 (Figure 4). Thus, remarkably the number of farmers growing Bt cotton hybrids in India has increased from 50,000 in 2002 to 100,000 in 2003, 300,000 small farmers in 2004, to 1 million in 2005, with over a two-fold increase of 2.3 million farmers in 2006, 3.8 million farmers in 2007, 5 million in 2008 and 5.6 million farmers in 2009. This is the largest increase in number of farmers planting biotech crops in any country in 2009. The 5.6 million small and resource-poor farmers who planted and benefited significantly from Bt cotton hybrids in 2009 represented approximately 88% of the total number of 6.4 million farmers who grew cotton in India in 2009. Given that only 90% of the cotton area is planted to hybrid cotton, the percentage adoption for the 8.4 million hybrid hectares alone in 2009 was 94%. This is approximately the same high level of adoption for biotech cotton in the mature biotech cotton markets of the USA and Australia. It is notable that the first indigenous, publicly-bred Bt variety *Bikaneri Nerma* (BN) and hybrid NHH-44Bt (expressing event BNLA-601)

Figure 4. Number of small farmers adopting Bt cotton hybrids in India, 2002 to 2009



Source: Compiled by ISAAA, 2009.

were commercialized for the first time in 2009. They are unique because they are the first Bt cotton hybrid and variety to be bred by a group of Indian public sector institutes which include the Central Institute for Cotton Research (CICR), Nagpur and National Research Centre for Plant Biotechnology (NRCPB), New Delhi of the Indian Council of Agricultural Research (ICAR) in partnership with the University of Agricultural Sciences (UAS), Dharwad. NHH-44Bt was planted on approximately 1,000 hectares in three different states including Maharashtra and Gujarat in Central cotton zone and Andhra Pradesh in Southern cotton growing zone, whilst the variety BN Bt was planted on approximately 9,000 hectares. It is likely that the Bt variety BN will be planted in India in 2010 on most of the remaining 10% of cotton hectarage that will not be occupied by hybrids (Kranthi, 2009).

Some of the critics opposed to Bt cotton in India have, without presenting supporting evidence, alleged that Bt cotton has contributed to farmer suicides in India. An important paper (IFPRI, 2008) published by the International Food Policy Research Institute, based in the USA, could not find evidence to support the views of the critics. On the contrary, the paper concludes that:

"In this paper, we provide a comprehensive review of evidence on Bt cotton and farmer suicides, taking into account information from published official and unofficial reports, peer-reviewed journal articles, published studies, media news clips, magazine articles, and radio broadcasts from India, Asia, and international sources from 2002 to 2007. The review is used to evaluate a set of hypotheses on whether or not there has been a resurgence of farmer suicides, and the potential relationship suicide may have with the use of Bt cotton.

We first show that there is no evidence in available data of a "resurgence" of farmer suicides in India in the last five years. Second, we find that Bt cotton technology has been very effective overall in India. However, the context in which Bt cotton was introduced has generated disappointing results in some particular districts and seasons. Third, our analysis clearly shows that Bt cotton is neither a necessary nor a sufficient condition for the occurrence of farmer suicides. In contrast, many other factors have likely played a prominent role" (IFPRI, 2008).

Savings of insecticides due to Bt cotton

Traditionally, cotton consumed more insecticides than any other crop in India and was a significant proportion of the total pesticide (insecticides, fungicides and herbicides) market for all crops. For example, of the total pesticide market in India in 1998 valued at US$770 million (Table 5), 30% was for cotton insecticides only, which were equal to 42% of the total insecticide market for all crops in India (Chemical Industry, 2007). Subsequent to the introduction of Bt cotton, cotton consumed only 18% of the total pesticide market, in 2006, valued at US$900 million as compared to a much higher 30% in 1998. Similarly, the market share for cotton insecticides as a percentage of total insecticides declined from 42% in 1998 to 28% in 2006. This saving in insecticides between 1998 and 2006 coincided with the introduction of Bt cotton which occupied 3.8 million hectares equivalent to 42% of the hectarage of the cotton crop in 2006. More specifically, the sharpest decline in insecticides occurred in the bollworm market in cotton, which declined from US$147 million in 1998 to US$65 million in 2006 – a 56% decrease, equivalent to a saving of US$82 million in the use of insecticides to control cotton bollworm in 2006. Thus, insecticide use for control of bollworm dropped by half at the same time when approximately half the cotton area (3.8 million hectares) was benefiting from controlling bollworm with Bt cotton.

The trends in decreased use of insecticides on cotton noted by the chemical industry in India (Chemical Industry, 2007), based on the value of confirmed savings from Bt cotton, are similar to the trend noted and supported by the data from the Indian Ministry of Agriculture based on consumption of pesticides (active ingredient in metric tons) during the period 2001 to 2006 (Table 6). Since the introduction of Bt cotton in 2002, the consumption of pesticides as measured in active ingredient, has exhibited a consistent downward trend as adoption of Bt cotton has increased at unprecedented rates to reach 87% of all cotton hectarage in India in 2009. The data in Table 6 confirms a consistent downward trend of pesticide consumption from 48,350 metric tons in 2002, the year Bt cotton was first introduced to 37,959 metric tons in 2006 when 3.8 million hectares occupied 42% of the total hectarage of cotton in India. The decrease in pesticide usage is equivalent to a 22% reduction over only a short period of five years. Pesticide usage statistics for India for 2007, 2008 and 2009 are not yet published but based on the steep decline between 2001 and 2006 the downward trend would be expected to continue as percentage adoption of Bt cotton has steadily increased to reach 87% of all cotton in 2009. It is noteworthy that the decline in pesticide usage between 1998 and 2006 (Table 5) has occurred when the total hectarage of cotton in India has actually increased slightly from 8.7 million hectares in 1998 to 9.2 million hectares in 2006.

Table 5. Value of the total pesticide market in India in 1998 and 2006 relative to the value of the cotton insecticide market

Item/Year	1998	2006
Total pesticide market (in million US$)	US$770 million	US$900 million
Cotton insecticides as % of total pesticide market	30%	18%
Cotton insecticides as % of total insecticide market	42%	28%
Value in US$ millions of cotton bollworm market & (savings due to Bt cotton) in 2006 over 1998	US$147 million	US$65 million (Savings of US$82 million, or 56%, compared with 1998)

Source: Chemical Industry, 2007.

In summary, the adoption of Bt cotton in 2002 in India has led to a significant decrease in insecticide usage for the control of cotton bollworm, which in 2006 was estimated at a minimal 20% reduction of approximately 9,000 tons of active ingredient valued at approximately US$80 million in 2006.

Table 6. Consumption of pesticides in India, 2001 to 2006 (metric tons of technical grade or active ingredient)

Year	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Total Pesticide	47,020	48,350	41,020	40,672	39,773	37,959

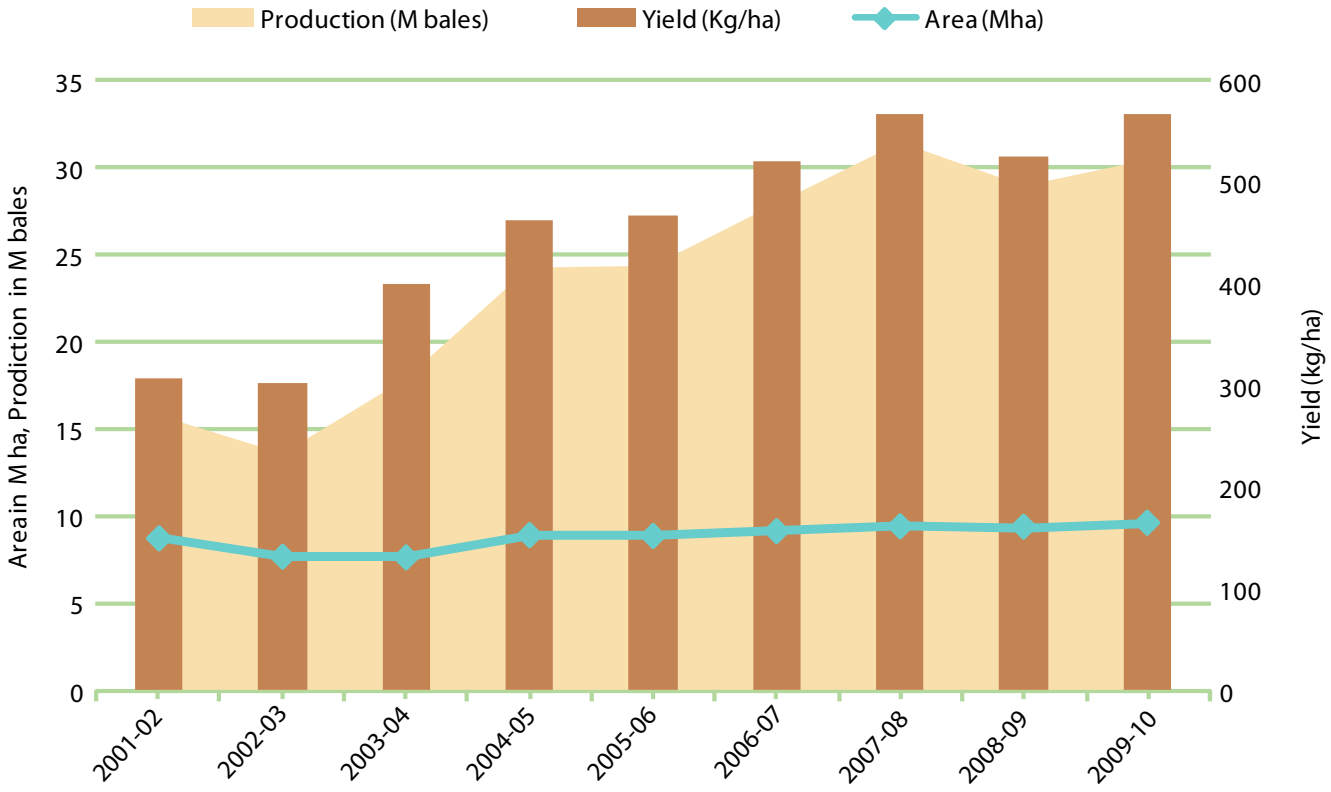
Source: Central Insecticides Board and Registration Committee, Ministry of Agriculture, 2008.

Cotton production, yield and imports/exports, 2002 to 2009

Coincidental with the steep increase in adoption of Bt cotton between 2002 and 2009, the average

yield of cotton in India, which used to have one of the lowest yields in the world, increased from 308 kg per hectare in 2001-02, to 526 kg per hectare in 2008-09 and projected to increase to 568 kg per hectare in the 2009-10 season, with 50% or more of the increase in yield, attributed to Bt cotton (Figure 5). Thus, at a national level, Bt cotton is a major factor contributing to higher cotton production which increased from 15.8 million bales in 2001-02, to 24.4 million bales in 2005-06, 28 million bales in 2006-07, and 31.5 million bales in 2007-08, which was a record cotton crop for India (Cotton Advisory Board, 2008). The Cotton Advisory Board projects 30.5 million bales of production in 2009-10 despite the fact that there was a delayed monsoon with erratic rainfall and flooding at the time of boll maturity and cotton picking in the Central and Southern cotton growing zones which contribute over 80% of cotton production in the country. This quantum leap in cotton production since 2002-03 has been triggered by improved seeds and particularly the ever-increasing plantings of improved Bt cotton in the ten cotton-growing states (Cotton Advisory Board, 2009). While the public sector continues to play a dominant role in production and distribution of low-value high volume seeds like cereals, pulses and oilseeds, the private seed sector is focusing on high-value, low-volume segments like vegetables, horticultural and cash crops like cotton. The private seed industry's role in promoting genetically modified (Bt) cotton has been particularly significant. India is now a mega cotton producing country as noted in the Economic Survey of 2006-07. The Annual Economic Survey 2007-08 of the Ministry of Finance also reports an increase in production and productivity of cotton during the Tenth Five Year Plan (2002-2007), which coincides with the introduction of Bt cotton in India in 2002 (Ministry of Finance, 2008).

Figure 5. Cotton hectarage, production and yield in India, 2001 to 2009

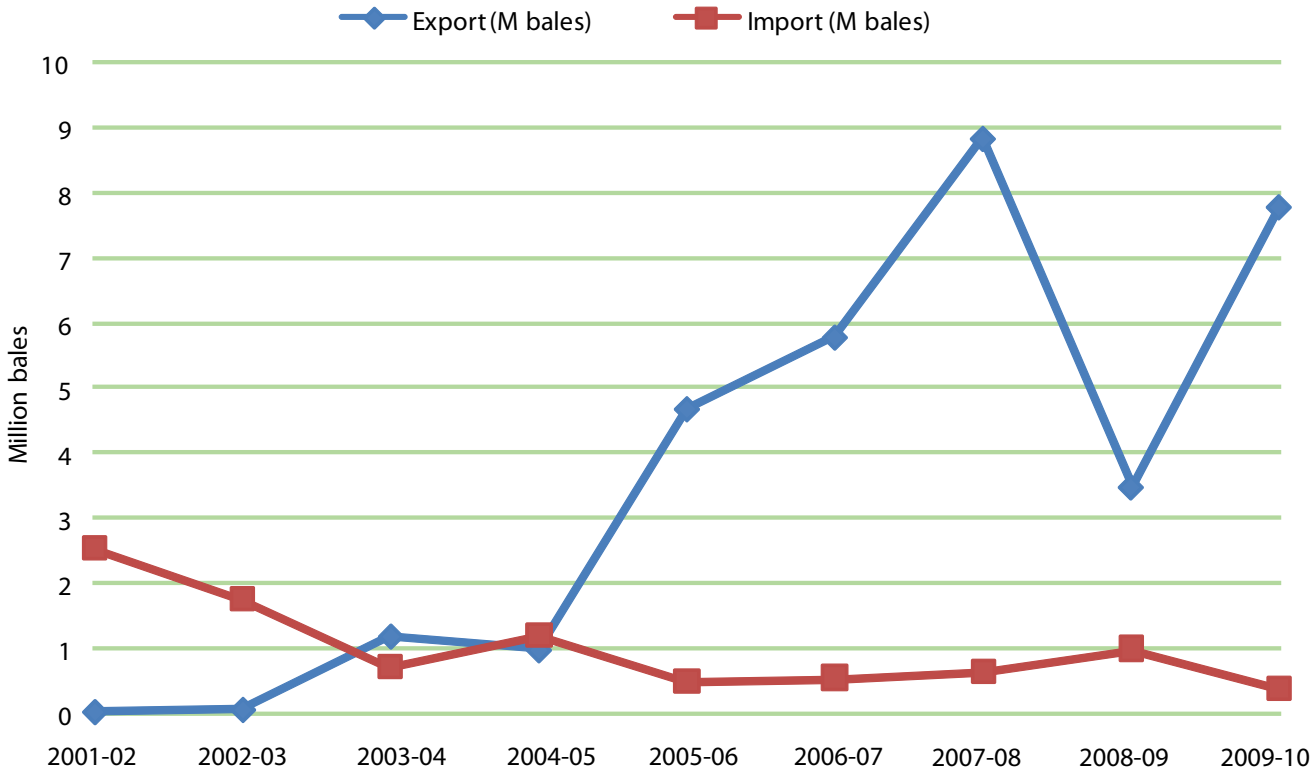


1 bale = 170 kg

Source: Cotton Advisory Board, 2009.

With the boom in cotton production in the last eight years, India has become transformed from a net importer to a net exporter of cotton. Exports of cotton have registered a sharp increase from a meager 0.05 million bales in 2001-02 to 5.8 million bales in 2006-07 before touching a high of 8.8 million bales in 2007-08. In 2008-09, raw cotton export recorded a modest 3.5 million bales. Cotton industry sources expect the cotton export to rebound to 7.8 million bales in 2009-2010 with imports decreasing to 0.39 million bales (Figure 6).

Figure 6. Export and import of cotton in India (2001 to 2009)



1 bale = 170 kg
Source: Cotton Corporation of India, 2009.

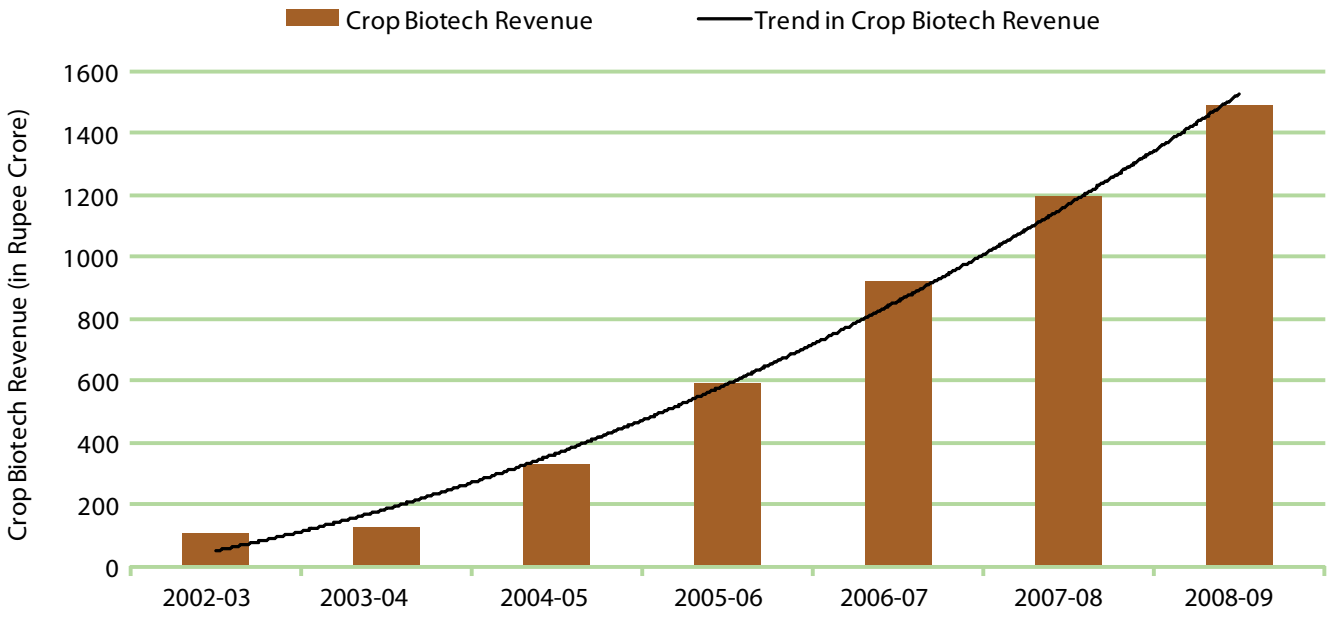
Bt cotton hybrids market in India, 2002 to 2008

Concurrent with the boom in cotton production, the Indian biotech and seed industry has also been growing at an unprecedented rate with high year-on-year growth because of the high adoption of Bt cotton by Indian farmers. In 2008-09, the Indian biotechnology industry registered an 18% growth in Rupee terms, with record revenue of Rs. 12,137 crore (US$2.7) billion (based on Rupees 45 per US$) from 10,234 crore (US$2.3 billion) in 2007-08. According to the survey conducted by BioSpectrum-ABLE (Biospectrum, India, 2009) in 2008-09 (Figure 7), the biotech crop sector grew by a quarter (24%) to Rs. 1,494 crore (US$332 million), registering the second largest growth among various segments of biotech sector in India. Notably, Bt cotton is the only biotech crop product that continues to grow with increasing adoption of Bt cotton hybrids by farmers in India. During the last seven years (2002-2008), Bt cotton sustained growth of the biotech crop segment in the Indian biotech industry. In 2008, the share of the crop biotech segment increased to 12.31% compared to a previous 11.70% of the Indian biotech sector revenue – a trend that has continued since the introduction of Bt cotton hybrids in 2002. More specifically, the biotech crop revenues grew continuously at a double

digit rate of 24% in 2008-09, 30% in 2007-08, 54.9% in 2006-07, 95% in 2005-06; it increased fourteen-fold from Rs. 110 crore (US$25 million) in 2002-2003 to Rs. 1,494 crore (US$332 million) in 2008-09. In 2008, the biopharma segment continued to account for the largest share, 64.95%, of the biotech industry revenues

to 522 (including a Bt variety) from 274 hybrids in 2008 – a doubling of the number of hybrids from 131 in 2007. Importantly, this increase in number of hybrids has provided much more choice in 2009 than in previous years to farmers in the North, Central and Southern regions, where specific hybrids have been approved

Figure 7. Bt cotton hybrids market in India (in rupee crore), 2002 to 2008



(1 Crore = 10 Million Rupees)
Source: BioSpectrum India, 2009.

followed by 16.99% for bioservices, 12.31% for biotech crop, 3.94% for bioindustrial and the remaining 1.81% for the bioinformatics sector. The survey projects doubling of the Indian biotech industry revenue in the next two years when it is estimated to reach US$5 billion in 2010 compared with US$2.7 billion in 2008 (Based on 45 Rupees per US$).

Approval of events and Bt cotton hybrids in India

The number of events, as well as the number of Bt cotton hybrids and companies marketing approved hybrids have all increased significantly from 2002, the first year of commercialization of Bt cotton in India. In 2009, the number of Bt cotton hybrids increased by more than two-fold

for cultivation in specific regions (Annex-1 and Figure 8). In 2009, a total of six events were approved for incorporation in a total of 522 hybrids with a fifth event incorporated in both the Bt cotton variety, *Bikaneri Nerma* (BN), approved in 2008 and the publicly-bred Bt cotton hybrid NHH-44 which was approved for commercial cultivation in 2009. The sixth event MLS-9124 was approved for the first time in 2009 (Table 7).

The first event, MON531, Bollgard®I (BG®I), featuring the *cry1Ac* gene was developed by Maharashtra Hybrid Seeds Company Ltd. (Mahyco), sourced from Monsanto, and approved for sale in 2009, for the eighth consecutive year, in a total of 180 hybrids for use in the North, Central and South zones – this

compares with 141 BG®I hybrids in 2008, 96 BG®I hybrids in 2007 and 48 BG®I hybrids in 2006.

The second event, MON15985, Bollgard®II (BG®II) was also developed by Mahyco and sourced from Monsanto, featured the two genes *cry1Ac* and *cry2Ab*, and was approved for sale for the first time in 2006 in a total of seven hybrids for use in the Central and South zones. This event was approved for commercial cultivation for the first time in the Northern zone in 2007 and the number of hybrids for sale increased from 7 in 2006, 21 in 2007, 94 in 2008 and further increased significantly to 248 BG®II cotton hybrids in 2009 in the North, Central and South zones.

The third event, known as Event-1 was developed by JK Seeds featuring the *cry1Ac* gene, sourced from IIT Kharagpur, India. The event was approved for sale for the first time in 2006 in a total of four hybrids for use in the North, Central and South zones. Whereas this event was approved in only four hybrids in 2006, in 2008 it quadrupled to 15 hybrids and again doubled to 27 in 2009.

The fourth event is the GFM event which was developed by Nath Seeds, sourced from China, and features the fused genes *cry2Ab* and *cry1Ac*. It was approved for sale for the first time in a total of three hybrids in 2006, one in each of the three regions of India. In 2009, the number of hybrids for sale increased three-fold from 24 to 63 in 3 zones.

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 Nerma*(BN) expressing the *cry1Ac* gene. It was approved for commercial release in the North, Central and South cotton growing zones in India during Kharif, 2008. In 2009, a publicly-bred Bt cotton hybrid NHH-44 was also released for commercialization based on event BNLA-601 expressing the *cry1Ac* gene. This is the first indigenous Bt cotton event developed by the Central Institute of Cotton Research (CICR) – one of the premier public sector institute of the Indian Council of Agricultural Research (ICAR) – along with University of Agricultural Sciences, Dharwad, Karnataka. The approval of the Bt cotton variety BN will help farmers in varietal growing areas which were previously disadvantaged because they were unable to benefit from the insect resistant Bt cotton hybrids cultivated widely across all three cotton growing zones.

The sixth new event, MLS-9124, was developed indigenously by Metahelix Life Sciences and features a synthetic *cry1C* gene. In 2009, two Bt cotton hybrids namely MH-5125 and MH-5174

Table 7. Commercial release of different Bt cotton events in India, 2002 to 2009

No	Crop	Event	Developer	Status	Date of Approval
1	Cotton*	MON-531	Mahyco/Monsanto	Commercialized	2002
2	Cotton*	MON-15985	Mahyco/Monsanto	Commercialized	2006
3	Cotton*	Event-1	JK Agri-Genetics	Commercialized	2006
4	Cotton*	GFM Event	Nath Seeds	Commercialized	2006
5	Cotton**	BNLA-601	CICR (ICAR) & UAS, Dharwad	Commercialized	2008
6	Cotton*	MLS-9124	Metahelix Life Sciences	Commercialized	2009

**Bt cotton hybrid; ** Bt cotton variety and Bt cotton hybrid*
Source: Compiled by ISAAA, 2009.

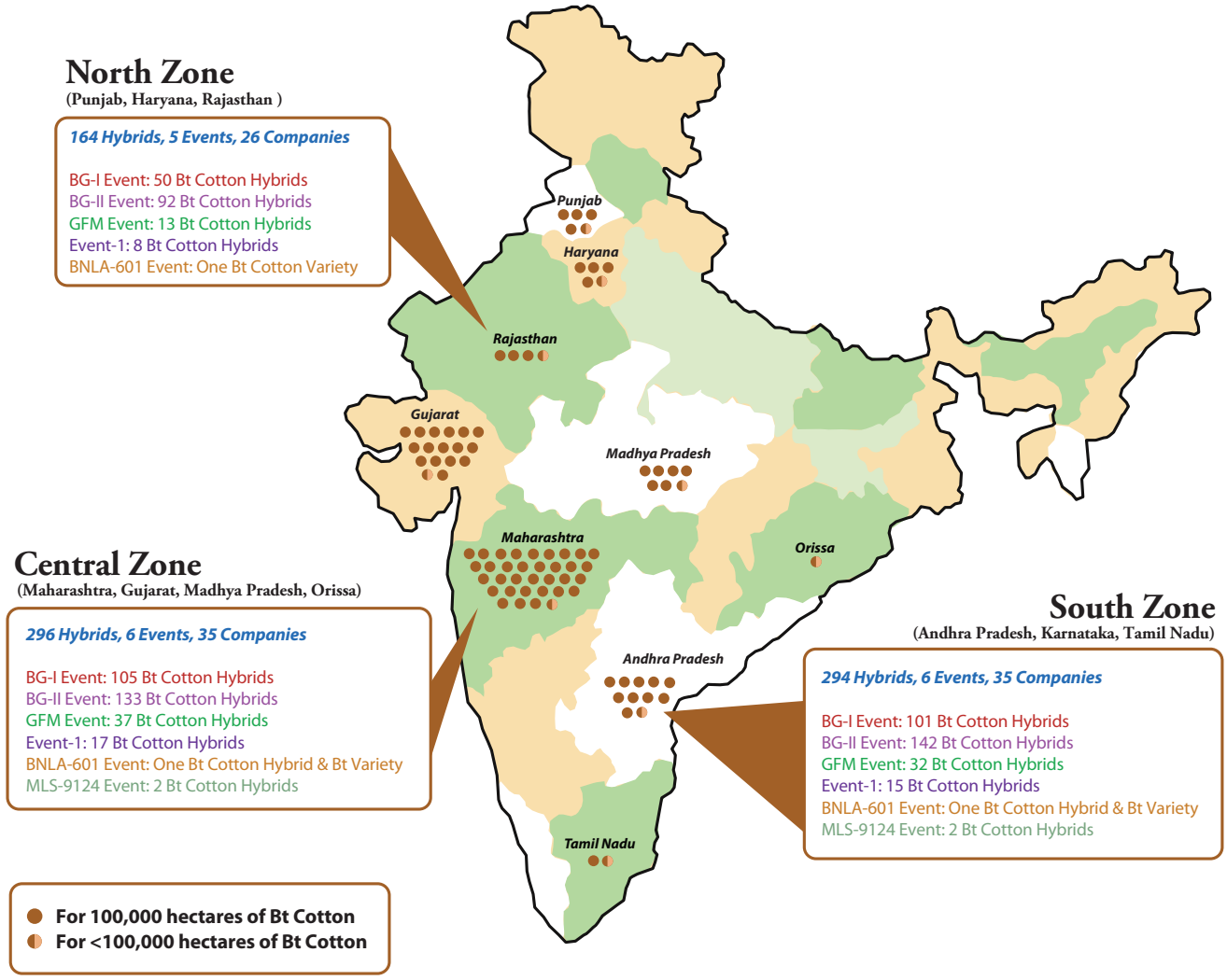
expressing the synthetic *cry1C* gene (MLS-9124) were approved for commercial sale for Central and Southern zones.

The commercial deployment of these five events in hybrids and sixth event in both variety and hybrids in India is summarized in Table 8, and their regional distribution is detailed in

Sciences (UAS), Dharwad, and approved for planting in Central and South cotton growing zones in 2009.

The number of Bt cotton hybrids as well as the number of companies offering Bt cotton hybrids in India has increased dramatically over the last 8 years since the first commercialization

Figure 8. Approval of events and Bt cotton variety & hybrids in India, 2009



Source: Compiled by ISAAA, 2009.

Table 9. The variety *Bikaneri Nerma* was approved in 2008 and commercialized by CICR, Nagpur and the University of Agricultural Sciences (UAS), Dharwad in the three zones of North, Central and South India. In addition, NHH-44 Bt cotton hybrids was commercialized by CICR, Nagpur and University of Agricultural

in 2002. In 2009, the number of Bt cotton hybrids doubled to 522 (including one variety) from 274 in 2008 and 131 in 2007 with 34 companies and one public sector undertaking marketing those hybrids and variety in three cotton-growing zones in 2009. By contrast in 2008, only 30 companies offered 274 hybrids,

up from 24 companies offering 131 hybrids in 2007. The following 34 indigenous seed companies and one public sector institution from India, listed alphabetically, offered the 522 hybrids and one variety for sale in 2009; Ajeet Seeds Ltd., Amar Biotech Ltd., Ankur Seeds Pvt., Bayer Biosciences Ltd., Bioseeds Research India Pvt. Ltd., Ganga Kaveri Seeds Pvt. Ltd., Green Gold Pvt. Ltd., J. K. Agri Genetics Ltd., Kaveri Seeds Pvt. Ltd., Krishidhan Seeds Ltd., Mahyco, Metahelix Life Sciences, Monsanto Holdings Pvt. Ltd., Namdhari Seeds Pvt. Ltd., Nandi Seeds Pvt. Ltd., Nath Seeds Ltd., Navkar Hybrid Seeds Pvt. Ltd., Nuziveedu Seeds Ltd., Palamoor Seeds Pvt. Ltd., Prabhat Agri Biotech Ltd., Pravardhan Seeds Ltd., Rasi Seeds Ltd, RJ Biotech Pvt. Ltd., Safal Seeds and Biotech Ltd., Seed Works India Pvt. Ltd., Solar Agrotech Pvt. Ltd., Super Seeds Pvt. Ltd., Tulasi Seeds Pvt. Ltd., Uniphos Enterprises Ltd., Vibha Agrotech Ltd., Vikki Agrotech, Vikram Seeds Ltd., Yashoda Hybrid Seeds Pvt. Ltd., Zuari Seeds Ltd., CICR (Nagpur) and UAS Dharwad.

The deployment of the four events in 522 hybrids in 2009 is summarized in Table 8 and Table 9, as well as the corresponding distribution of hybrids in 2002, 2003, 2004, 2005, 2006, 2007 and 2008. In 2009, the Genetic Engineering Approval Committee (GEAC) approved 248 new Bt cotton hybrids for commercial cultivation in the 2009 season, in addition to the 274 Bt cotton hybrids approved for sale in 2008, for a total of 522 hybrids. This provided farmers in India's three cotton-growing zones significantly more choice of hybrids for cultivation in 2009.

Table 8. Deployment of approved Bt cotton events/hybrids/variety by region in India in 2009

Event	North (N)	Central (C)	South (S)	North/ Central (N/C)	North/ South (N/S)	Central/ South (C/S)	N/C/S	Total Hybrids
BG-I[1]	34	39	40	6	1	51	9	180
BG-II[2]	63	40	47	3	5	69	21	248
Event-I[3]	7	5	3	0	0	11	1	27
GFM Event[4]	12	19	14	0	0	17	1	63
BNLA-601[5]	0	0	0	0	0	1	1*	2
MLS-9124[6]	0	0	0	0	0	2	0	2
Total	**116**	**103**	**104**	**9**	**6**	**151**	**33**	**522**

**Bt cotton variety, [1],[2] Mahyco [3] JK Seeds [4] Nath Seeds [5]CICR (ICAR) and [6]Metahelix*
Source: Compiled by ISAAA, 2009.

Of the 522 Bt cotton hybrids approved for commercial cultivation, 164 hybrids featuring five events were sold by 26 companies in the Northern zone, 296 hybrids featuring six events were sold by 35 companies in the Central zone, and 294 hybrids featuring six events were sold by 35 companies in the Southern zone (Table 9 and Figure 9).

As described in the earlier section, there has been a substantial increase in the area and number of hybrids with two genes for pest resistance, the BG®II event, in 2009. The BG®II cotton hybrids more than doubled to 248 in 2009 from 94 in 2008 and only 21 hybrids in 2007. This trend is due to the multiple benefits that double genes offered in terms of more effective control of more than one insect pest. For this reason, the BG®II hybrids are preferred by farmers across all three different cotton-growing zones. The BG®II hybrids protect cotton crops from both *Helicoverpa armigera* and *Spodoptera* insects and offer an effective tool in insect resistance management to Indian cotton farmers.

Similarly, the distribution of the 522 hybrids approved for 2009 is summarized in Table 9 as well as 274 hybrids approved for 2008, 131 hybrids approved for 2007, the 62 hybrids approved for 2006, the 20 hybrids approved for 2005, the four hybrids offered for sale in 2004 and the three hybrids approved for both 2003 and 2002. In 2002, Mahyco was the first to receive approval for three Bt cotton hybrids, i.e. MECH 12, MECH 162 and MECH 184, for commercial cultivation in the Central and Southern cotton growing zones in India. The rapid deployment of hybrids during the period 2002 to 2008 reaching 522 Bt cotton hybrids in 2009 as well as their respective events in the three regions is summarized in Annex-1 and illustrated in the map in Figure 8.

Table 9. Deployment of approved Bt cotton events/hybrids/variety by companies/institutions in India, 2002 to 2009

Event	2002	2003	2004	2005	2006	2007	2008	2009
NORTH ZONE Haryana Punjab Rajasthan				6 Hybrids 1 Event 3 Companies	14 Hybrids 3 Events 6 Companies	32 Hybrids 4 Events 14 Companies	62 Hybrids 4 Events 15 Companies	164 Hybrids 5 Events 26 Companies
CENTRAL ZONE Gujarat Madhya Pradesh Maharashtra	3 Hybrids	3 Hybrids	4 Hybrids	12 hybrids 1 Event 4 Companies	36 Hybrids 4 Events 15 Companies	84 Hybrids 4 Events 23 Companies	148 Hybrids 4 Events 27 Companies	296 Hybrids 6 Events 35 Companies
SOUTH ZONE Andhra Pradesh Karnataka Tamil Nadu	3 Hybrids	3 Hybrids	4 Hybrids	9 Hybrids 1 Event 3 Companies	31 hybrids 4 Events 13 Companies	70 Hybrids 4 Events 22 Companies	149 Hybrids 4 Events 27 Companies	294 Hybrids 6 Events 35 Companies
Summary Total no. of hybrids Total no. of events Total no. of companies	3 1 1	3 1 1	4 1 1	20 1 3	62 4 15	131 4 24	274 4 30	522* 6 35

** Some of the 522 hybrids including a variety are being grown in multiple regions (see Figure 8)*
Source: Compiled by ISAAA, 2009.

The approval and adoption of Bt cotton by the two most populous countries in the world, India (1.1 billion people) and China (1.3 billion people), can greatly influence the approval, adoption and acceptance of biotech crops in other countries throughout the world, particularly in developing countries. It is noteworthy that both countries elected to pursue a similar strategy by first exploring the potential benefits of crop biotechnology with a fiber crop, Bt cotton, which has already generated significant and consistent benefits in China, with the same pattern evident in India, the largest grower of cotton in the world. In 2009, India had more biotech cotton under cultivation (8.4 million hectares) than China (3.8 million hectares) whereas the number of farmers benefiting from Bt cotton was higher in China (7.0 million) than India (5.6 million) because the average cotton holding per farm in China (0.6 hectare) is smaller than in India (1.5 hectare).

Benefits from Bt cotton in India

The global study of benefits generated by biotech crops conducted by Brookes and Barfoot (2010), estimates that India enhanced farm income from Bt cotton by US$5.1 billion in the period 2002 to 2008 and US$1.8 billion in 2008 alone.

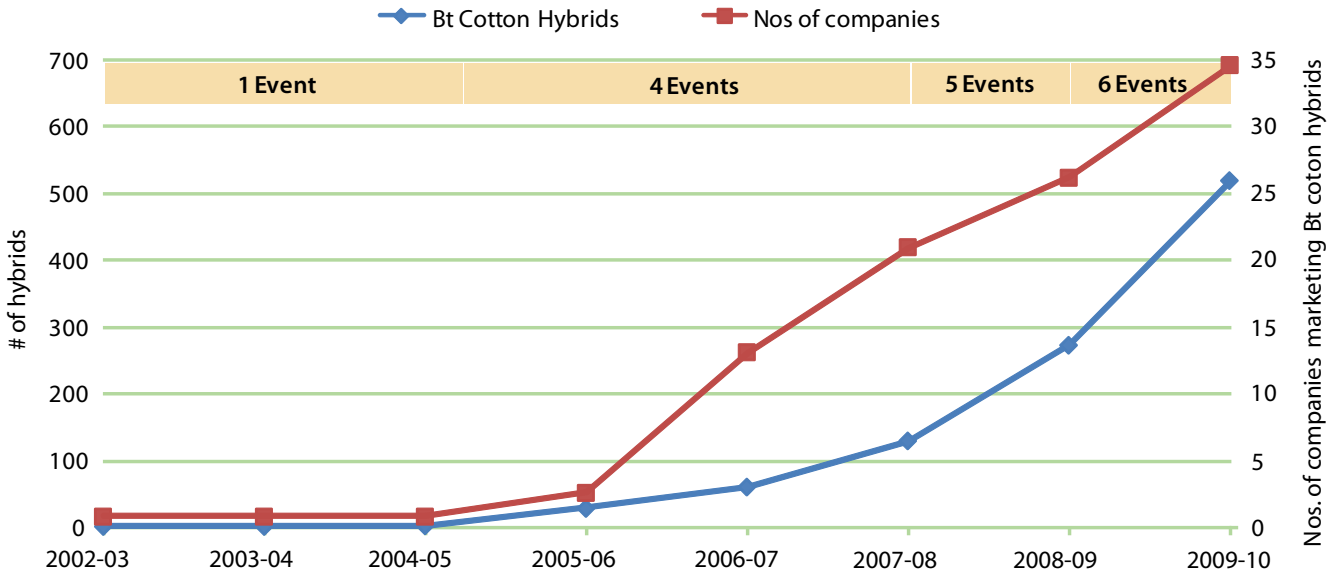
A sample of eleven economic studies on the

impact of Bt cotton, all conducted by public sector institutes over the period 1998 to 2009, covering both pre and post-commercialization of Bt cotton are referenced chronologically in Table 10. The first three studies were based on two sets of data to estimate the overall economic advantage of cotton including a field trial data set for 1998/99 to 2000/01 from the Department of Biotechnology analyzed by Naik (2001) and the second set was an ICAR field trial data set for 2001-2002 analyzed and published by ICAR (2002) and Qaim (2006). The other eight studies/ surveys were conducted on large numbers of Bt cotton farmers' fields between 2002 to 2007, by different public sector institutions listed in Table 20. The studies have consistently confirmed 50 to 110% increase in profits from Bt cotton, equivalent to a range of US$76 to US$250 per hectare. These profits have accrued to small and resource-poor cotton farmers in the various cotton growing states of India. The yield increases ranged usually from 30 to 60% and the reduction in number of insecticide sprays averaged around 50%. It is noteworthy that the benefits recorded in pre-commercialization field trials are consistent with the actual experience of farmers commercializing Bt cotton during the eight year period 2002 to 2009.

Pre-commercialization Bt cotton data analysed by Naik (2001) indicated that the overall economic advantage of Bt cotton in 1998/99 ranged from US$76 to US$236 per hectare, equivalent to an average 77% gain, compared with conventional cotton. Naik reported a 38% yield increase and 75% reduction in numbers of insecticides spray on Bt cotton over non-Bt counterparts.

The ICAR (2002) data set from large scale field trials in 2001 reported that the economic advantages for three Bt cotton hybrids (MECH-12, MECH-162 and MECH-184) tested under the All India Coordinated Cotton Improvement Project (AICCIP) from 1998/99 to 2000/01 was relatively high due to severe pest infestations confirming efficacy of Bt technology for targeted insect pests. The overall economic advantages of the three Bt hybrids ranged from US$96 to US$210 per hectare – a 29% to 86% increase compared to conventional cotton. Qaim (2006) analyzed multi-location field trials

Figure 9. Release of Bt cotton hybrids in India, 2002 to 2009



Source: Compiled by ISAAA, 2009.

data generated by Mahyco and showed similar economic benefits – a 50% reduction in number of sprays, 34% yield increase resulting in a net profit of US$118 per hectare. The magnitude of the economic advantages reported by Qaim 2006 was of the same order of magnitude as the 1998/99 data set analyzed by Naik (2001), and ICAR field trials data (2002). These pre-commercialization studies confirmed that Bt cotton resulted in a major economic advantage to cotton farmers by substantially increasing yield, reducing insecticide sprays and reduction in labour costs.

The first on-farm study by Bennett *et al.* (2006) confirmed that the principal gain from Bt cotton in India was the significant yield gains estimated at 45% in 2002, and 63% in 2001, for an average of 54% over the two years. Taking into account the decrease in application of insecticides for bollworm control, which translates into a saving of 2.5 sprays, and the increased cost of Bt cotton seed, Brookes and Barfoot (2009) estimated that the net economic benefits for Bt cotton farmers in India were US$139 per hectare in 2002, US$324 per hectare in 2003, US$171 per hectare in 2004, and US$260 per hectare in 2005, for a four year average of approximately US$225 per hectare. The benefits at the farmer level translated to a national gain of US$2.0 billion in 2007 and accumulatively US$3.2 billion for the period 2002 to 2007. Other studies reported a similar range of benefits, acknowledging that benefits will vary from year to year due to varying levels of bollworm infestations. The study by Gandhi and Namboodiri (2006), reported a yield gain of 31%, a significant reduction in the number of pesticide sprays by 39%, and an 88% increase in profit or an increase of US$250 per hectare for the 2004 cotton growing season.

A Front Line Demonstration (FLD) study on cotton for 2005-06 released by the Indian Council of Agricultural Research (ICAR, 2006) reconfirms a net 30.9% increase in seed yield of Bt cotton hybrids over non-Bt hybrids and a 66.3% increase over open-pollinated cotton varieties (OPV). Data in the study covered 1,200 demonstration and farmers' plots in 11 cotton-growing states in India. In the demonstration plots, the Bt cotton hybrids proved to be highly productive with an average yield of 2,329 kg/ha of seed cotton compared to the non-Bt cotton hybrids (1,742 kg/ha) and varieties (1,340 kg/ha). Similarly, the average yield of Bt cotton hybrids was higher in farmers' plots at 1,783 kg/ha compared to non-Bt cotton hybrids (1,362 kg/ha) and OPV in farmers' field (1,072 kg/ha).

A study in 2005 by University of Andhra (2006) concluded that Bt cotton farmers earned three times more than non-Bt cotton farmers in Guntur district and eight times more in Warangal district of Andhra Pradesh, India. The Government of Andhra Pradesh commissioned the study three years ago to examine the advantages, disadvantages, cost of cultivation and net return to Bt cotton as compared to other cotton varieties in selected districts. The study confirmed that the average Bt farmer had a 46% higher yield and applied 55% less pesticides than the non-Bt cotton farmer in Guntur district. Bt cotton farmers in Warangal district applied 16% less pesticides and reaped 47% more cotton as compared to non-Bt farmers. Farmers noted that Bt cotton allowed earlier picking due to less pest susceptibility, and the boll color was superior.

A 2007 study "Socioeconomic impact of Bt cotton", conducted by the Centre for Economic and Social Studies (CESS), Hyderabad concluded that the Bt cotton technology was superior to the conventional cotton hybrids in terms of yield and net returns. The study was carried out in four districts; Warangal, Nalgonda, Guntur and Kurnool in Andhra Pradesh representing the four agro-climatic zones in 2004-2005 and 2005-2006 and sponsored by the Andhra Pradesh Netherlands Biotechnology Programme

Table 10. Eleven studies conducted by public institutes on the benefits of Bt cotton in India for the years, 1998 to 2009

Publication	[1]Naik 2001	[2]ICAR field trials 2002	[3]Qaim 2006	[4]Bennet 2006	[5]IIMA 2006	[6]ICAR FLD 2006	[7]Andhra University 2006	[8]CESS 2007	[9]Subramanian & Qaim 2009	[10]Sadashivappa & Qaim 2009	[11]Qaim *et. al* 2009
Period studied	1998-99 & 00-01	2001	2001 & 2002	2002 & 2003	2004	2005	2006	2004 & 2005	2004 & 2005	2006 & 2007	1998 to 2006
Yield increase	38%	60-90%	34%	45-63%	31%	30.9%	46%	32%	30-40%	43%	37%
Reduction in no. of spray	4 to 1 (75%)	5-6 to 1 spray (70%)	6.8 to 4.2 (50%)	3 to 1	39%	–	55%	25%	50%	21%	41%
Increased profit	77%	68%	69%	50% or more gross margins	88%	–	110%	83%	-	70%	89%
Average increase in profit/ hectare	$76 to $236/ hectare	$96 to $210/ hectare	$118/ hectare	–	$250/ hectare	–	$223/ hectare	$225/ hectare	$156/ hectare or more	$148 / hectare or more	$131/ hectare or more

Sources:

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11. Qaim M, A Subramanian and P Sadashivappa. 2009. Commercialized GM crops and yield, Correspondence, Nature Biotechnology. 27 (9) (Sept 2009).

(APNBP) now known as Agri Biotechnology Foundation – a part of Seventh Framework Programme of the European Union. Whereas the absolute cost of production for Bt cotton was 17% higher, the study reported that the expenditures on insecticides decreased by 18% (from 12 sprays on non-Bt cotton to 9 sprays) yield increased by 32% resulting in the overall cost of cotton per quintal decreasing by 11%. Thus, as a result of higher yield and reduced pesticide sprays, Bt cotton farmers improved their net income by 83% over non-Bt cotton. The study confirmed that Bt cotton generated 21% higher labour employment than non-Bt

cotton of which female laborers were the major beneficiaries among casual laborers. The study concluded that small farmers elected to plant Bt cotton, rather than conventional because it was more profitable and allowed them and their families to enjoy improved living standards.

A recent paper "Village-wide effects of agricultural biotechnology: The case of Bt cotton in India", featured a case study by Subramanian *et al.* (2009). The study analyzed the economy-wide effects of Bt cotton for rural households in semi-arid India. The study showed that Bt cotton technology increased yield between 30-40% and reduced insecticide quantities by about 50% on average, thus generating an additional income of US$156 per hectare or more. More specifically, Bt cotton was associated with a substantial overall generation of rural employment with important gender implications. They concluded by noting that Bt technology generated more employment for females than males, ***"The aggregation of total wage income showed that females earned much more from Bt cotton than males. This was due to the fact that cotton harvesting is largely carried out by hired female laborers, whose employment opportunities and returns to labor improve remarkably. Pest control, on the other hand, is often the responsibility of male family members, so that Bt technology reduced their employment in cotton production. On average, the saved family labor could be reemployed efficiently in alternative agricultural and non-agricultural activities, so that the overall returns to labor increased, including for males."*** Similarly, studies published by Sadashivappa *et al.* (2009) (which analyzed Bt technology performance over the first five years of adoption, using panel data with three rounds of observations) concluded that on average, Bt adopting farmers realized pesticide reductions of roughly 40%, and yield advantages of 30-40% resulting in a higher net profit of 70% or US$148 per hectare, or more.

Moreover, the recent studies by Qaim *et al.* (2009) analyzed the socio-economic effects of Bt cotton in India and demonstrated spillover effects of Bt cotton benefits for rural households in semi-arid states – Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. The pre and post commercialization farm surveys conducted by Qaim *et al*, revealed that farmers adopting Bt cotton used 41% less pesticides and obtained 37% higher yields, resulting in an 89% or US$135 per hectare gain in cotton profits. In spite of seasonal and regional variation, these advantages have been sustainable over time. These direct benefits of Bt cotton technology have also been reported by other farm surveys conducted by public sector institutions during the period 1998 to 2006. For the first time in a systematic survey, Qaim *et al.* (2009), demonstrated the indirect benefits of Bt technology in India. For instance, higher cotton yields provided more employment opportunities for agricultural laborers and a boost to rural transport and trading businesses. Income gains among farmers and farm workers resulted in more demand for food and non-food items, inducing growth and household income increases in other sectors locally. Their research noted that each dollar of direct benefits was associated with over US$0.80 cents of additional indirect benefits in the local economy. In terms of income distribution, all types of households benefited, including those below the poverty line. Sixty percent of the gains accrued to the extremely and moderately poor. Bt cotton also generated increased net employment, with important gender implications. Compared to conventional cotton, Bt increased aggregated returns to labor by 42%, whereas the returns for hired female agricultural workers increased by 55%. This is largely due to additional labor employed for picking cotton, which is primarily a female activity in India. As is known, women's income has a particularly positive effect for child nutrition and welfare. These studies concluded that ***"In this case, at least, there is***

strong evidence that the trait in this crop is already contributing to poverty reduction in the subcontinent."

The only published impact studies of Bt cotton in 2008/09 was conducted by IMRB International (IMRB, 2009) which focused on the agronomic and economic benefits. The only published study specifically on the social impact of Bt cotton was conducted by Indicus Analytics in 2007 (Indicus, 2007).

The IMRB study "Samiksha-09" sampled 4863 farmers selected from 400 villages from 27 districts in six States and interviewed 4,860 farmers representing both BG-I®, BG-II® and non-Bt cotton farmers based on 2008 cotton cultivation. The IMRB study compared the economic benefits of BG-I® and BG-II® cotton hybrids versus non-Bt cotton hybrids. The study reported a 38% incremental yield for BG-I® hybrids and 46% incremental yield with BG-II® cotton hybrids over conventional cotton hybrids in 2008. Similarly, the study reported higher saving on the cost of pesticide sprays of Rs. 1,635 per hectare (US$36) for BG-II® hybrids and Rs. 909 (US$20) for BG-I® cotton hybrids over conventional cotton. As a result, BG-II® cotton farmers earned Rs. 23,374 per hectare (US$520) and Rs. 17,082 (US$378) for BG-I® cotton farmers over conventional cotton farmers. It is noteworthy that on average BG-II® cotton farmers earned an additional net income of Rs. 6,292 (US$140) over BG-I® cotton farmers. This is consistent with the trend for farmers to increasingly adopt BG-II® cotton hybrids over BG-I® cotton hybrids in 2008 and 2009 and it is expected that BG-II® cotton hybrids will replace BG-I® cotton hybrids in the near term. On a cost benefit analysis, the study showed that BG-II® cotton hybrids offered 194% return on investment compared with 158% for BG-I® cotton hybrids and only 93% for non-Bt cotton hybrids. The study also revealed that 90% and 91% of BG-I® and BG-II® cotton farmers, respectively, were satisfied with the performance of Bt cotton technology cutting irrespective of whether they were large, medium, or small and marginal farmers. The IMRB estimates for the 2008 season were higher than estimates for the previous years (2002 to 2007) due to higher prices of cotton, the higher value of the Indian Rupee versus the US dollar. The IMRB study estimated that in 2008 Bt cotton technology helped farmers to increase cotton production nationally by 72 million quintals of seed cotton (42 million bales of lint), reduced pesticide usages by Rs. 1,813 crore (US$403 million) and earned additional income of Rs. 16,215 crore (US$3.6 billion).

The latest parallel study to the IMRB studies, conducted by Indicus Analytics (Indicus, 2007) focused on Bt cotton in India in 2006 – it was the first study to focus entirely on the social impact as opposed to the economic impact. The study involved 9,300 households growing Bt cotton and non-Bt cotton in 465 villages. The study reported that villages growing Bt cotton had more social benefits than villages growing non-Bt cotton. More specifically, compared with non-Bt cotton villages, Bt cotton villages had more access to permanent markets (44% versus 35%), and banking facilities (34% versus 28%). Bt cotton farmers also benefit more from visits of government and private sector extension workers and are more likely to adopt recommended practices such as improved rotation, and change in the use of the first generation Bt cotton hybrids for improved second generation Bt cotton hybrids. Notably, there was also a consistent difference between Bt cotton households and non-Bt cotton households in terms of access and utilization of various services. More specifically compared with non-Bt cotton household, women in Bt cotton households had a higher usage of antenatal check ups, more and higher use of professionals to assist with births at home. Similarly, children from Bt cotton households

had a higher proportion, which had benefitted from vaccination (67% versus 62%) and they were more likely to be enrolled in school. It is noteworthy that the socio-economic advantages enjoyed by Bt cotton households are already evident despite the fact that the first Bt cotton was only adopted in 2002. Thus, the economic benefits associated with Bt cotton is already starting to have a welfare impact that provides a better quality of life for Bt cotton farmers and their families in India.

The 2008 ISAAA Report (James, 2008) projected that the adoption rate of Bt cotton in India in 2009 would reach more than 80%, whereas the actual level in 2009 was 87%. Given the significant and multiple agronomic, economic and welfare benefits that farmers derive from Bt cotton in India, the adoption of approved Bt cotton hybrids and varieties in India is expected to continue to increase modestly in 2010 since the current level of adoption at 87% is close to optimal. Despite the unprecedented high adoption of Bt cotton by 5.6 million farmers, the majority of whom have first-hand experience of up to eight years of the significant benefits it offers, and the consistent high performance of Bt cotton compared with conventional, anti-biotech groups still continue to vigorously campaign against biotech in India, using all means to try and discredit the technology, including filing public interest writ petitions in the Supreme Court contesting the biosafety of biotech products.

Annex 1. Listing of events, Bt cotton variety and hybrids in India, 2009

Zone	BG-I Hybrids	BG-II Hybrids	GFM/Event-I/MLS-9124/BNLA-601
North Zone (164 Hybrids 5 Events, 26 Companies)	ABCH-3083 Bt, ABCH-3483 Bt, ABCH-1857 Bt, ABCH-172 Bt, ABCH-173 Bt, ABCH-174 Bt, ABCH-177 Bt, ABCH-178 Bt, Ankur 3028 Bt, Ankur 8120 Bt, Ankur-651, Ankur-2226, Ankur-2534, GK-206, IT-905, Jai Bt, KDCHH-507 BG-I, KDCHH-9810, MRC-6025, MRC-6029, MRC-6301, MRC-6304, NAMCOT-402, NCS-138, NCS-913, NCS-950, NCS-901 Bt, NCS-902 Bt, NCS-903 Bt, NCS-904 Bt, NCS-905 Bt, Ole, PCH 401 Bt, PCH 402 Bt, PCH 403 Bt, PCH-406 Bt, RCH-134, RCH-308, RCH-314, RCH-317, SDS-9, SDS-1368, Shakti-9 Bt, Sigma, SP 7007 B1, VBCH-1006 BG, VBCH-1008 BG, VICH-11 BG, 6317 Bt, 6488 Bt	ABCH-1299 Bt (BG-II), ABCH-2099 Bt (BG-II), ABCH-4899 Bt (BG-II), ABCH-7399 Bt (BG-II), ABCH-143 Bt (BG-II), ABCH-146 Bt (BG-II), ABCH-181 Bt (BG-II), ABCH-182 Bt (BG-II), ABCH-191 Bt (BG-II), ABCH-192 Bt (BG-II), ACH 33-2, Ankur 3028 BG-II, ANKUR-5642, ANKUR-8120, GK-212, Jai BG-II, Jassi, KCH-36 BG-II, KCH999 BG-II, KCH-14K59 BGII, KCH-15K39 BGII, KCH-100 BG-II, KCH-172 BG-II, KCH-189 BG-II, KCH-311 BG-II, KCH-707 Bt, KDCHH-541 BGII, KDCHH-441, MRC-7361 BG II, MRC-7365 BG-II, MRC-7017, MRC-7031, MRC-7041, MRC-7045, NAMCOT-616 BGII, NAMCOT-617 BGII, NCS-855 Bt2, NCS-856 Bt2, NCS-857 Bt2, NCS-858 Bt2, NCS-145 (Bunny), PCH-876 Bt2, PCH-877 Bt2, PCH-878 Bt2, PCH-879 Bt2, RCH-602 BGII, RCH-605 BGII, RCH-314 BGII, RCH-134, PRCH-302, PRCH-333, SDS-27 BG II, SDS-6003 BGII, SDS-234 BGII, SDS-9, SDS-36, SOLAR-56 BG-II, SOLAR-64 BG-II, SOLAR-65 BG-II, SOLAR-72 BG II, SOLAR-75 BG-II, SOLAR-76 BG-II, SOLAR-77 BG-II, SO7H878 BGII, SP1169B2, SP 7010B2, SWCH-4707 BG-II, SWCH-4711 BG-II, SWCH-2 BG-II, SWCH-4704 BG-II, SWCH-4713 BG-II, Tulasi-162 BG II, Tulasi-225 BG-II, Tulasi-4, Tulasi-45, VBCH 1515 BGII, VBCH 1516 BGII,VBCH 1517 BGII, VBCH 1518 BGII, VBCH-1501, VBCH-1504, VICH-307 BG-II, VICH-308 BG-II, VICH-309 BG-II, VICH-310 BG-II, VICH-9, VICH-11, 569, 6488- 2, 2510-2, 2113-2	Navkar-5 Bt, NCEH-6R, NCEH-26 Bt, NCEH-31 Bt, NCH-1005 Bt, NCH-1085 Bt, NCH-1163 Bt, NCH-1177 Bt, UPLHH- 12 Bt, UPLHH- 271 Bt, UPLHH- 342 Bt, UPLHH- 350 Bt, ZCH-193 Bt, UPLHH-1, ***JKCH-1950 Bt, JKCH-99 Bt, JKCH-1145 Bt, JKCH-1923 Bt, JKCH-1945 Bt, JKCH-1947, JK-1050, JKCH-226 Bt***, **BNBt (Variety)**
Central Zone (296 Hybrids, 6 Events, 35 Companies)	ABCH-3083 Bt, ABCH-3483 Bt, ABCH-1857 Bt, ABCH-172 Bt, ABCH-173 Bt, ABCH-174 Bt, ABCH-177 Bt, ABCH-178 Bt, ABCH-1165, ABCH-1220, ACH 33-1, ACH 155-1, ACH-177-1, Akka, Ankur 3042 Bt, Ankur-9, Ankur-651, Ankur-3032 Bt, Ankur HxB-1950 Bt, Brahma, Dyna, GK-204, GK-205, Jai Bt, KCH-135, KCH-707, KDCHB-407 BG-I, KDCHH-507 BG-I, KDCHH-786, KDCHH-9632, KDCHH-9810, KDCHH-9821, Mahasangram BG, MECH-12, MECH-162, MECH-184, MRC-6301, NCS-906 Bt, NCS-907 Bt, NCS-908 Bt, NCS-909 Bt, NCS-910 Bt, NCS-138, NCS-145 (Bunny), NCS-207 (Mallika), NCS-913, NCS-929, NCS- 950, NCS-954, NCS-955, NCHB-991, NCHB-992, NPH-2171, NSPL-36, NSPL-405, NSPL-999, PCH-404 Bt, PCH-405 Bt, PCH-407 Bt, PCH-408 Bt, PCH-409 Bt, PCH-115, PCH-207 (PCH-205), PCH-923, PCH-930, PRCHB- 405 BG-I, PRCH-102, PRCH-31, Rudra, RCH-2, RCH-118, RCH-138, RCH-144, RCH-377, RCH-386, RCH-395 Bt, Sarju-BG, Sigma, SP 1136 B1, SP-499, SP-503, SP-504 (Dhanno), SP-904, SP-923, SWCH-4428 Bt, SWCH-4531 Bt, SWCH-4314 Bt, Tulasi-4, Tulasi-5 Bt, Tulasi-9, Tulasi-117, VBCH-101, VBCH-1006,VBCH-1009, VBCH-1010, VBCH-1016, VBCH-1017,VCH-111, VICH-5, VICH-9, VICH-15, 322 Bt, 110 Bt, 6188 Bt, 563 Bt , 311 Bt	ABCH-1299 Bt (BG-II), ABCH-2099 Bt (BG-II), ABCH-4899 Bt (BG-II), ABCH-7399 Bt (BG-II), ABCH-1020 Bt (BG-II), ABCH-143 Bt (BG-II), ABCH-146 Bt (BG-II), ABCH-181 Bt (BG-II), ABCH-182 Bt (BG-II), ABCH-191 Bt (BG-II), ABCH-192 Bt (BG-II), ACH-111-2, ACH-177-2 , Ajeet-11-2, Ajeet-155-2, Akka, Amar-1065 Bt, Ankur-3028 BG-II, Ankur-3034 BG II, Ankur- 216 BG II, Ankur- 257 BG II , Ankur- 3070 BG II, Ankur HB 2104 BG-II, Atal, Brahma BGII, GK-218 BGII, GK-221 BGII , GK-224 BGII , GK-231 BGII , GK-235 BGII , GK-205, Jai BG-II, KCH-14K59 BG-II, KCH-15K39 BG-II, KCH-36 BG-II, KCH-999 BGII, KCH-707, KCH-135, KDCHH-541 BGII, KDCHB-407 BG-II, KDCHH-441, KDCHH-621, KDCHH-9632, Krishna BGII, MLBCH6 BGII, MLCH-317, MRC-7373 BG II, MRC-7383 BGII, MRC-7301, MRC-7326, MRC-7347, MRC-7351, MRC- 7918, NAMCOT 614 BGII, NAMCOT 615 BGII, NAMCOT 603 BGII, NAMCOT 605 BGII, NCS-859 Bt2, NCS-860 Bt2, NCS-861 Bt2, NCS-862Bt2 , NCS-853Bt2, NCS-145 Bt 2, NCS-207 (Mallika), NCS-854 Bt 2, NCHB-945 Bt, NSPL-333 BGII, NSPL-432 BGII, NSPL-666 BGII, NSPL-36, NSPL-405, NSPL-999, Paras Lakshmi, PCH-115 Bt2, PCH-881 Bt2, PCH-882 Bt2, PCH-2171 Bt 2, PCH-205 Bt 2, PRCH-331 Bt II, PRCH-333 Bt II, PRCH-504, PRCH-505, RCH-608 BGII, RCH-377 BGII, RCH-530 BG-II, RCH-2, RCH-515, RCH-578, RCH-584, SARJU BG-II, SOLAR-66 BG-II, SOLAR-60 BG-II, SP 904B2, SP 1016 B2, SP 1170 B2, SP-504 , Super-5 BG-II, Sudarshan BG-II, SWCH-2 BG-II, SWCH-4708 BG-II, SWCH-4715 BG-II, SWCH-1 BG-II, SWCH-5017, SWCH-5011, Tulasi- 135 BG-II, Tulasi- 144 BG-II, Tulasi- 162 BG-II, Tulasi- 117 BG-II, Tulasi-4, Tulasi-9, Tulasi-118, VBCH- 1511, VBCH-1516, VBCH- 1519, VBCH- 1520, VBCH- 1521, VBCHB-1525, VBCHB-1526, VICH-311 BG-II, VBCH-1501, VBCH-1503 , VBCH-1505, VICH-312 BG-II, VICH-313 BG-II, VICH-314 BG-II, VICH-5 Bt, VICH-15, 311-2, 557-2 , 110-2, 111-2, 195-2	ACH 1050 Bt, ACH 1151 Bt, ACH 1171 Bt, ACH-1019, Dhruv Bt, Kashinath, GBCH-07 Bt, GBCH-09 Bt, GBCH-01, Monsoon Bt, Navkar-5, NCEH-2R, NCEH-3R, NCEH-21, NCEH-23, NCEH-14, NCEH-34 Bt, SBCH-286 Bt (Raka Bt), TPHCN07-015 Bt, TPHCN07-005 Bt, TPHCN07-009 Bt, UPLHH-271 Bt, UPLHH-17 Bt, UPLHH-12 Bt, UPLHH-189 Bt, UPLHH-352 Bt, UPLHH-13 Bt,UPLHH-1Bt, UPLHH-10 Bt, UPLHH-2Bt, YRCH-4 Bt, YRCH-9 Bt, YRCH-13 Bt, YRCH-31 Bt, YRCH-45 Bt, YRCH-54 Bt, ZCH-50005, ZCH-50072 Bt, ***JK-Chamundi Bt, JK-Gowri Bt, JKCH-2245 Bt, JKCHB-229 Bt, JK-Ishwar (JKCH-634 Bt), JKCH-99, JKCH-226, JKCH-666, JK-Durga Bt, JK- Indra Bt, JK-Varuna, PCH-99 Bt, PCH-77 Bt, PRCH-712 Bt, PRCH-713 Bt, PRCH-714 Bt, PRCH-715 Bt,*** **MH-5125Bt, MH-5174Bt, BN Bt (Variety)**

South Zone (294 Hybrids, 6 Events, 35 Companies)	ABCH-172 Bt, ABCH-173 Bt, ABCH-174 Bt, ABCH-177 Bt, ABCH-178 Bt, ABCH-3083 Bt, ABCH-3483 Bt, ABCH-1165, ABCH-1220, ACHB-901-1 Bt, ACH-1 Bt, ACH 21-1, ACH 33-1, ACH 155-1, Akka, Ankur-238 Bt, Ankur-3082 Bt, Ankur HB 1024 Bt, Ankur-3042 Bt, Ankur HB-1902 Bt, Ankur HB-1976 Bt, Brahma, Dyna, GK-207, GK-209, Jai Bt, KCH-135, KCH-707, Mahasangram BG, KDCHH-507 BG-I, KDCHB-407, KDCHH-9632, KDCHH-9810, MECH-162*, MECH-184*, MRC-6322, MRC-6918, NCS-1911 Bt, NCS-1912 Bt, NCS-1913, NCS-1914 Bt, NCS-145 (Bunny), NCS-207 (Mallika), NCS-913, NCS-929, NCS-950, NCS-954, NCS-906 Bt, NCS-907 Bt, NCS-908 Bt, NCS-909 Bt, NCS-910 Bt, NCHB-940 Bt, NCHB-945 Bt, NCHB-990, NCHB-992, NPH-2171, NSPL-9, NSPL-36, NSPL-603, NSPL-666, NSPL-405, NSPL-999, Ole, PCH-1410 Bt, PCH 1411 Bt, PCH 1412 Bt, PCH-1413 Bt, PCH-115, PCH-207 (PCH 205), PCH-409 Bt, PCH-930, PCH-2270, PRCHB-405, RCH-2, RCH-20, RCH-111, RCH-371, RCH-368, RCHB-708, Rudra, Sigma, SP 1170 B1, SP1016 B1, SP911B1, SP-503, SP-504 (Dhanno), SP-700, SWCH-4428 Bt, SWCH-4531 Bt, SWCH-4314 Bt, Tulasi-9 Bt, Tulasi-4, Tulasi-45 Bt,Tulasi-117, Tulasi-118 Bt, VBCHB-1010 BG, VBCH-1016 Bt,VBCH-1018 Bt, VBCHB-1203,VICH-5, VICH-9, VCH-111, 118 Bt, 340 Bt, 6188 Bt.	ABCH-143 Bt BG-II, ABCH-146 Bt BG-II, ABCH-147 Bt BG-II, ABCH-148 Bt BG-II, ABCH-1299 Bt BG-II, ABCH-7399 Bt BG-II, ABCH-181 Bt BG-II, ABCH-182 Bt BG-II, ABCH-191 Bt BG-II, ABCH-192 Bt BG-II, ABCH-1065 Bt, ABCH-1020 Bt, ACH-33-2, ACH-177-2, ACH-155-2, Akka, Ankur-3028 BG-II, Ankur-3034 BG-II, Ankur-257 BG-II, Ankur-356 BG-II, Ankur-3066 BG-II, Ankur HB 2110 BG-II, Ankur-5642, Ankur-10122, Atal BGII, Brahma, GK-218 BGII, GK-221 BGII, GK-223 BGII, GK-224 BGII, GK-231 BGII, GK-235 BGII, GK-217, Jai BG-II, KCH-707 BGII, KCH-14K59 BGII, KCH-15K39 BGII, KCH-36 BGII, KCH-999 BGII, KCH-135 Bt, KDCHH-541 BGII, KDCHB-407 BG-II, KDCHH-441, KDCHH-621, KDCHH-9632, MLBCH6 BGII, MLCH-318, MRC-7373 BGII, MRC-7383 BGII, MRC-7160, MRC-7918, MRC-7201, MRC-7347, MRC-7351, MRC-7929, NAMCOT-612, NAMCOT-607, NAMCOT-604 BG-II, NAMCOT-605 BG-II, NAMCOT-614 BG-II, NAMCOT-615 BG-II, NCS-854, NCS-207, NCS-145 (Bunny), NSPL-432 BGII, NSPL-333 BGII, NSPL-405, NSPL-999, PCH-884 Bt2, PCH-887 Bt2, PCH-888 Bt2, PCH-115 Bt2, PCH-881 Bt2, PCH-882 Bt2, PCH-885 Bt2, PCH-886 Bt2, PCH-205 Bt2, PCH-2171 Bt2, PCH-2270, PCH-105, PRCH-331 BG-II, PRCH-333 BG-II, PRCH-504, PRCH-505, RCH-20 BG-II, RCH-2, RCH-530, RCH-533, RCH-596, SARJU BG-II, SOLAR-66 BG-II, SOLAR-60 BG-II, SP-1171 B2, SP 504 B2 (Dhanno) BG II, SP911B2, SP904B2, SP-1037, Sudarshan BGII, Super-5 BG-II, SWCH-2 BG-II, SWCH-4708 BG-II, SWCH-4703 BG-II, SWCH-4715 BG-II, SWCH-4720 BG-II, SWCH-5017 BG-II, SWCH-5011 BG-II,Tulasi-135 BG-II, Tulasi-144 BG-II, Tulasi-252 BG-II, Tulasi-4 BG-II, Tulasi-45 BG-II, Tulasi-117 BG-II, Tulasi-333 BG-II, Tulasi-7, Tulasi-9, Tulasi-118, VBCHB-1525 BG-II, VBCHB-1526 BG-II, VBCH-1511 BG-II, VBCH-1516 BG-II, VBCH-1519 BG-II, VBCH-1520 BG-II, VBCH-1521 BG-II, VBCH-1501, VBCH-1505, VBCH-1506, VICH-301 BG-II, VICH-303 BG-II, VICH-304 BG-II, VICH-311 BG-II, VICH-312 BG-II, VICH-313 BG-II, VICH-314 BG-II, VICH-5 Bt,VICH-15 Bt, 110-2, 118-2, 61888-2, 322-2, 113-2, 340-2.	Dhruv Bt, GBCH-04Bt, GBCH-07 Bt, Kashinath, Monsoon Bt, NCEH-2R, NCEH-3R, NCEH-13 Bt, NCEH-34 Bt, SBCH-310 Bt, SBCH-292 Bt, TPHCN07-015 Bt, TPHCN07-005 Bt, TPHCN07-009 Bt, UPLHH-189 Bt, UPLHH-7 Bt, UPLHH-295 Bt, UPLHH-355 Bt, UPLHH-358 Bt, UPLHH-360 Bt, UPLHH-347 Bt, UPLHH-265 Bt, UPLHH-271 Bt, UPLHH-10 Bt, YRCH- 4 Bt, YRCH-9 Bt, YRCH- 13 Bt, YRCH-31 Bt, YRCH-45 Bt,YRCH- 54 Bt, UPLHH-12 Bt, UPLHH-5 Bt, ZCH-50072 Bt, ***JKCH-1305 Bt, JKCHB-229 Bt, JK-Durga, JKCH-99, JKCH-634 (JK-Iswar), JKCH-2245 Bt, JK Chamundi Bt, JK-Indra Bt, JK- Gowri Bt, PCH-99 Bt, PCH-77 Bt, PRCH-712 Bt, PRCH-713 Bt, PRCH-714 Bt, PRCH-715 Bt,*** **MH-5125Bt, MH-5174Bt, BN Bt (Variety)**

Source: Compiled by ISAAA, 2009.

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