Farmers Suicides & Bt Cotton in India

The largest wave of suicides in history gathering storm as farmers are coerced into growing GM crops amid pro-GM cover-up based on false claims and "fudged" data contradicted by numerous independent studies all over the world; those intent on promoting GM crops to developing countries are committing a crime against humanity

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The Bt cotton killing fields

Within six weeks between July and August 2009 in the cotton-growing state of Andhra Pradesh in India, farmer suicides were reported almost every day. Officially the total number of suicides stood at 15, but opposition parties and farmers' groups said the true total was more than 150 [1]. Opposition leader N. Chandrababu claimed in a speech that he had the names and addresses of 165 farmers who ended their lives because of the distress caused by the drought.

In November 2009, similar reports came from another cotton growing state, Maharashtra. Farmers of Katpur village in Amravati district sowed Bt cotton four years ago. Instead of the promised miracle yields, huge debts have driven many to suicide, and even cattle have been reported dying after feeding on the plants [2] (see also [3] Mass Deaths in Sheep Grazing on Bt Cotton, *SiS* 30)..

The 5000-odd farmers of the Maharashtra village have decided to shun Bt cotton, and are now growing soybean instead. Some have also taken to organic farming.

"We were cheated by the seed companies. We did not get the yield promised by them, not eve half of it. And the expenditure involved was so high that we incurred huge debts. We have heard that the government is now planning commercial cultivation of Bt brinjal. But we do not want Bt seeds of any crop anymore," said farmer Sahebrao Yawiliker.

Successive studies in Maharashtra have concluded indebtedness was a major cause for suicides among farmers [4].

Within a week in November, two farmers in neighbouring villages in Wardha district killed themselves. Their Bt cotton crops were devastated by *lalya*, a disease that caused the cotton plants to redden and wilt [5]. The first farmer, 55 year old Laxman Chelpelviar in Mukutban, consumed the pesticide Endoulfan when the first picking from hs six acre farm returned a mere five quintals and an income of Rs15 000. His expenses were Rs50 000. The second farmer, 45 year old Daulat Majure, in Jhamkola, was discovered by his mother hanging dead from the ceiling. The cotton yield from his seven-acre farm was a miserable one quintal, worth Rs3 000.

Agricultural scientists said *lalya* point to a lack of micronutrients and moisture content in soils. A recent study by the MS Swaminathan Research Foundation was cited, which indicated that the soil in Wardha district was severely deficient in 18 micronutrients

Lalya unfolds with pest attacks, moisture stress and lack of micronutrients in the soil. The plant's chlorophyll decreases with nitrogen deficiency, resulting in another pigment, anthocyanin, which turns the foliage red. If reddening starts before boll formation, it results in a 25 percent drop in yield, said a scientist from the Central Institute of cotton Research at Nagpur, who wished to remain anonymous."*Lalya* is here to stay." He declared.

According to the agricultural scientists, the disease has its roots in the American Bt technology that India imported. Almost all the 500-plus Bt seed varieties sold in India in 2009 are of the same parentage, the American variety of Coker312 Bt Cotton, a top CICR scientist said. They are F1 hybrids, crossed with Indian variety.

The Coker-312 variety showed high susceptibility to attacks by sucking pests like jassids and thrips. The thrips disperse within plant cells, while jassids suck the sap as they multiply under a leaf's surface, forcing the plant to draw more nutrients from soil, aggravating the soil's nutritional deficiency.

Another characteristic of Bt cotton that worsens the soil is that the bolls come to fruition simultaneously, draining the soil all at once. In a region like Vidarbha, plants wilt in two or three days. "It is like drawing blood from anemic woman."

"If such a technology mismatch continues, soil health and farmers' economy will take a further hit, a top ICAR scientist with years of experience in cotton research was reported saying [5]. "The state needs to take up soil and water conservation efforst on a war footing in Vidarbha."

India has about ten million ha under hybrids and Bt cotton, much high than in China (6.3 m ha), US (3.8 m ha) and Pakistan (3.1 m ha). Unlike India, 79 other countries use self-seeding and non-Bt hybrids.

Cotton crisis and successive crop failures due to declining soil health goes hand in hand with the imported GM (genetic modification) technology, which is energy and input intensive, the report [5] concluded.

Other effects of Bt cotton the Indian scientists could have mentioned are the resurgence of secondary pests and especially the new exotic mealy bug pest introduced with the Bt cotton, as well as the reduced yields of other crops on land cultivated with Bt cotton [6] (see Mealy Bug Plagues Bt Cotton Fields in India and Pakistan, *SiS* 45).

After some respite in the post loan-waiver year of 2008, farmer suicides have begun to rise again [5]. The number of suicides in the six worst-affected western Vidarbha districts in 2009 was approaching 900. November saw 24 famers take their own lives in Yavatmal alone.

"Crop survival this year is only 44 percent in some blocks," said Sanjay Desmukh, Yavatmal collector. "Rains have been scanty."

Official records underestimate the real extent of suicides

According to Indian government records, 182 936 farmers committed suicide in India between 1997 and 2007 [7]. Nearly two-thirds occurred in five states, Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh and Chhattisgarh, with one-third of the country's population. The count has been rising even as the numbers of farmers are diminishing. As many as 8 million quit farming between 1991 and 2001, and the rate of quitting has only risen since.

These official figures tend to be huge underestimates. The records are collated by the National Criminal Records Bureau, a wing of the Ministry of home Affairs; but the numbers reported to the Bureau by the states are often massaged downwards. For example, women farmers are not normally accepted as farmers, as by custom, land is never in their names, although they do the bulk of the work in agriculture.

P. Sainath, the rural affairs editor of *The Hindu* and author of *Everybody Loves a Good Drought*, refers to the suicides as "the largest sustained wave of such deaths recorded in history", and attributes it to India's "embrace of the brave new world of neoliberalism."

The rate of farmers' suicides has worsened particularly after 2002 (the year GM crops were introduced to India, although Sainath does not say so). Between 1997 and 2001, the number of suicides was 78 737, or 15 747 a year on average. Between 2002 and 2006, the number was 87 567, or 17 513 a year on average.

Indebtedness the cause

Those who have taken their lives were deep in debt (as successive studies in Maharashtra confirmed [4]). Peasant households in debt nearly doubled in the first decade of the neoliberal "economic reforms" [7], from 26 percent of farm households to 48.6 percent, according to the National Sample Survey data. But in the worst states, the rate of indebtedness is far higher. For example, 82 percent of all farm households in Andhra Pradesh were in debt by 2001-02.

Furthermore, those who killed themselves were overwhelmingly cash crop farmers growing cotton, coffee, sugarcane, groundnut, pepper, and vanilla. Suicides were fewer among those that grow food crops such as rice, wheat, maize and pulses.

Giant seed companies have been displacing cheap hybrids and far cheaper and hardier traditional varieties with their own products. A cotton farmer buying Monsanto's genetically modified (GM) cotton would be paying far more for seed. Local varieties and hybrids were squeezed out with enthusiastic state support.

In 1991, farmers could buy a kilogram of local seed for as little as Rs7 or Rs9 in today's worst affected region of Vidarbha. By 2003, they would pay Rs350 (US$7) for a 450 gram bag of hybrid seed. By 2004, Monsanto's partners in India were marketing a 450 grams bag of Bt cotton seed for between Rs1 650 and Rs1 800 ($33 to $36). This price was brought down by government intervention overnight in Andhra Pradesh, where the government changed after the 2004 elections. The price dropped to around Rs900 ($18), still many times higher than 1991 or even 2003.

Health and food costs sky-rocketed while farmers' income crashed, and so did the price they got for their cash crops, thanks to subsidies to corporate and rich farmers in the US and EU. These subsidies on cotton alone destroyed cotton farmers not only in India but in African nations such as Burkina Faso, Benin, Mali and Chad.

As costs rose, credit dried up and debt went out of control, and the tides of suicides washed over India.

To add to the farmers' plight, the unsustainable farming practices are coming home to roost. More than 1 500 farmers in the state of Chhattisgarh committed suicide, driven into debt by crop failures due to falling water levels, which dropped from 40 feet to below 250 feet in just the past few years [8].

More "sinister" GM crops

But there is yet a more "sinister reason" for the mass suicides: GM crops, notably Bt cotton. Millions of Indian farmers had been promised undreamt of harvests by switching to planting GM seeds. They borrowed money to buy the exorbitant seeds, only to find their crops failing miserably, leaving them with spiralling debt from which the only exit is suicide. British journalist Andrew Malone writing for the *Mail* [9] reported an estimated 125 000 farmers had taken their own lives directly as the result of GM crops; the crisis being branded "GM genocide" by campaigners. It is perpetrated by powerful GM lobbyists and prominent politicians all over the world who persist in claiming that GM crops have transformed Indian agriculture and producing greater yields than ever before.

Malone described how he travelled to Maharashtra in the suicide belt to find out for himself who is telling the truth. There he witnessed the cremation of the body of the farmer in a cracked barren field near his home 100 miles from Nagpur in central India.

Death by insecticide

"As flames consumed the corpse, Ganjanan, 12, and Kalpana, 14, faced a grim future. While Shankara Mandauka had hoped his son and daughter would have a better life under India's economic boom, they now face working as slave labour for a few pence a day. Landless and homeless, they will be the lowest of the low." Malone wrote.

Shankara drank insecticide to end his life 24 hours earlier. He was in debt for two years' earnings and could see no other way out of his despair.

"There were still marks in the dust where he had writhed in agony. Other villagers looked on – they knew from experience that any intervention was pointless – as he lay doubled up on the ground, crying out in pain and vomiting."

Neighbours gathered to pray outside the family home. Nirmala Mandaukar told how she rushed back from the fields to find her husband dead. "He was a loving and caring man," she said, weeping.

Shankara's crop, Bt cotton, had failed twice. Like millions of other Indian farmers, he switched from traditional seeds to GM seeds, beguiled by the promise of bumper harvests and future riches. He borrowed money to buy the GM seeds. But when the harvests failed, he was left with mounting debts and no income.

Official figures from the Indian Ministry of Agriculture do indeed confirm the huge humanitarian crisis: more than 1000 farmers kill themselves in the country each month. "Simple, rural people, they are dying slow, agonizing deaths. Most swallow insecticide – a pricey substance they were promised they would not need when they were coerced into growing expensive GM crops." Malone wrote. "Pro-GM experts claim that it is rural poverty, alcoholism, drought and 'agrarian distress' that is the real reason for the horrific toll. But as I discovered during a four-day journey through the epicentre of the disaster, that is not the full story."

In one village, he found 18 farmers had committed suicide after being "sucked" into GM debt. Village after village, families told how they had fallen into debt on being persuaded to buy GM seeds. Famers paid £10 for 100 g of GM seeds, a thousand times the cost of traditional seeds. The GM salesmen and government officials promised farmers that these were 'magic seed' that yield better crops without parasites and insects.

Far from being magic seeds, the GM crops were devastated by bollworms. They also required double the amount of water.

When rains failed for the past two years, many GM crops simply withered and died.

In the past when crops failed, farmers could still save seeds and replant them the following year. But with GM hybrid seeds, they have been unable to do that.

Suresh Bhalasa was another farmer cremated the same week, leaving a wife and two children. His family had no doubt that their troubles began the moment they were encouraged to buy Monsanto's Bt cotton.

"We are ruined now," said the 38-year-old wife of the deceased. "We bought 100 grams of Bt cotton. Our crop failed twice. My husband had become depressed. He went out to the field, lay down in the cotton and swallowed insecticide."

Monsanto admitted that soaring debt was a "factor in this tragedy," but said that cotton production had doubled in the past seven years. A spokesman blamed other reasons for the recent crisis, such as "untimely rain" or drought, and that suicides have always been part of the rural Indian life.

Malone's findings on GM cotton and farmers suicides confirm what we reported in 2006 [10] (Indian Cotton Farmers Betrayed, *SiS* 29); when organic cotton was already providing

farmers a lifeline [11] (Message from Andra Predesh:Return to organic cotton & avoid the Bt cotton trap, *SiS* 29; see also [12] Stem Farmers' Suicides with Organic Farming, *SiS* 32).

Yield 'jump' due to Bt cotton?

However, the findings by journalists and activists working on the ground were contradicted by a discussion paper [13] of the International Food Policy Research Institute (IFPRI) of the CGIAR (Consultative Group on International Agricultural Research). The CGIAR describes itself [14] as a "strategic partnership" of 64 members supporting 15 international centres working in collaboration with many hundred of government and civil society organizations as well as private businesses around the world.

Based on the analysis of information from a variety of official and unofficial sources, published and unpublished studies, the IFPRI paper [13] concluded that "there is no evidence of a "resurgence" of farmer suicides in India in the last five years, and that Bt cotton technology has been "very effective overall in India."

It stated that Bt cotton is "neither a necessary nor a sufficient condition for the occurrence of farmer suicides." Nevertheless, "in specific regions and years, where Bt cotton may have indirectly contributed to farmer indebtedness, leading to suicides, its failure was mainly the result of the context or environment in which it was planted."

These conclusions absolve Bt cotton from having played *any* part in the farmers suicides, laying practically all the blame on inappropriate rainfall and drought, with no mention of the exorbitant price of GM seeds compared with traditional seeds; nor of failed harvests or of pesticide use.

Actually, the data presented showed that the two states with the largest planted areas of Bt cotton, Maharashtra (1 840 000 ha) and Andhra Pradesh (830 000) in 2006 (Table 7 of IFPRI paper) were also the ones with the highest suicide rates that year.

The following year's harvest in Maharashtra was no better despite the hype of a 'bumper crop' by the state government suspected of intending to boost the image of Bt cotton and to depress the price [15]. Farmers were reporting huge losses. One Bt cotton farmer harvested 80 quintals (1 quintal = 100 kg) in 45 acres and expected to harvest a further 80 quintals at most. As cotton seed is about one-third lint, the actual lint yield was less than 12 kg/acre or 32.5 kg/ha. The state had projected a total production of 7 000 000 bales (1 bale = 170kg), but the Divisional Commissioner of Amravati said it would not exceed 4 000 000 bales. In the end, the official record on the Indian Government's Cotton Corporation of India database was 5 000 000 bales [16].

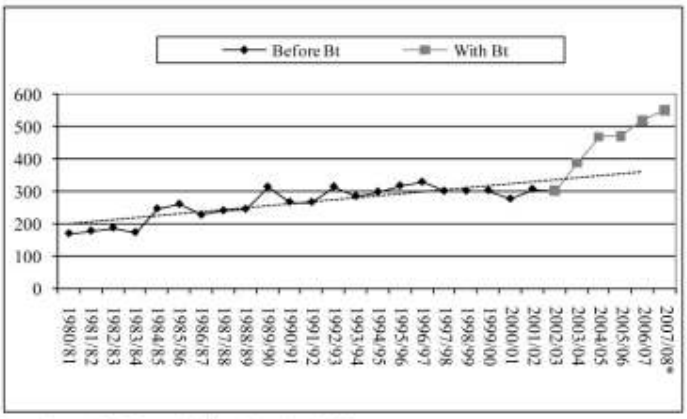
The most dubious claim in the IFPRI paper [13] was in a graph showing that the average yield of cotton for all India shot up from about 300 kg/ha to 500 kg/ha in the five years after Bt cotton was introduced in 2002, an increase attributed largely to Bt cotton. But when the average cotton yields by region were plotted, no such jump was evident; and even less so when the average yields by states were plotted (see Figure 1). Maharashtra, the state with the largest area of Bt cotton, had the lowest yields.

Without a proper statistical analysis, it is impossible to tell if the trend before and after the introduction of Bt is different; furthermore, there is no evidence Bt cotton is responsible for any yield 'jump'.

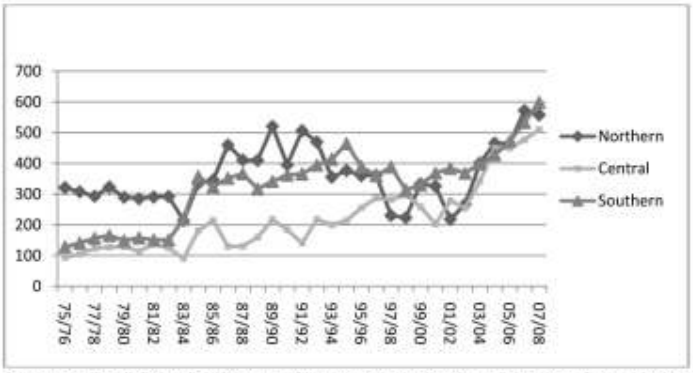
The official Indian Government data [17] do not present yields from Bt cotton separately from those of non-Bt cotton. The IFPRI paper [13] provided some information on the number of hectares planted with Bt cotton in its Table 7 for the years 2002 to 2006. In 2004, 500 000 ha

were planted with Bt, representing 5.69 percent of the total 8 786 000 ha of cotton land. If Bt cotton were solely responsible for the increase in yield to 470 kg/ha reported that year, the 5.69 percent of land planted with Bt cotton would have had to yield a miraculous 2460.5 kg/ha, because the extrapolated yield without Bt cotton, according to the old curve would have been only 350 kg/ha. Clearly other factors were responsible for the increase in yield that apply to cotton crops in general, Bt and non-Bt, as was pointed out by a researcher of the Coalition for a GM-Free India [18]: an enormous increase in irrigation, good rainfall (for rain fed crops), increase in use of fertilizers and hybrid seeds (including Bt hybrids with indigenous varieties) and lack of pests.

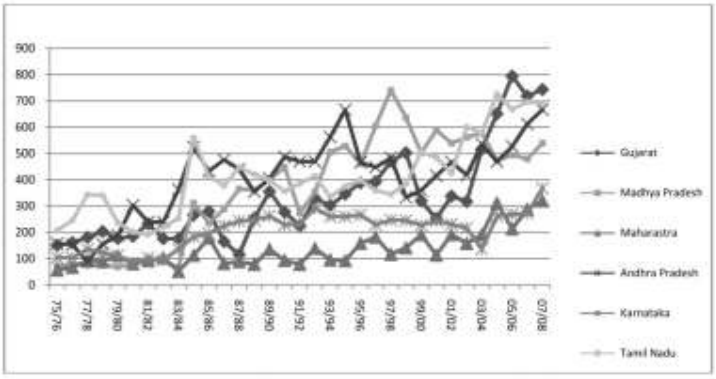
But are the reported increases in yields reliable?



Source: International Cotton Advisory Committee (2008).
Note: Data for 2007/08 is an estimate.



Source: Directorate of Cotton Development, Government of India (2008); East India Cotton Association.(2008).



Source: Data provided by Directorate of Cotton Development, Government of India (2008); East India Cotton Association (2008).

Figure 1 Yield jump due to Bt cotton. Top, average cotton yields for all India 1980-2007; middle, average cotton yields for different regions 1975-2007; bottom, average cotton yields for states, 1975-2007 (redrawn from [13])

Questionable reliability of data

The reliability of the Indian Government's database [16] is open to question. For example, the production of the whole of India for 2008 was recorded at 31 500 000 bales, giving an average yield of 567 kg/ha. But according to the later estimate by American agencies, the 2008 production was 23 000 000 bales [17], or an average yield of only 414 kg/ha. Data from other

countries such as the United States and China also showed that yields of cotton have stagnated since the introduction of Bt cotton.

Massive failures of Bt cotton crops in the states of Madhya Pradesh and Maharashtra were widely reported in the first year of introduction [18-21] (Bt cotton fails in India, Science in Society 16). The Khargone district in Madhya Pradesh facing a severe drought reported 100 percent Bt cotton failures compared with 20 percent failures of non-Bt cotton. The Vidharbha cotton belt in the adjoining state of Maharashtra report more than 30 000 ha damaged by root rot with over 70 percent of the crop areas affected. Farmers in both areas were demanding compensation.

In 2005, in advance of a deadline for a decision on license renewal, Greenpeace India and the Sarvodaya Youth Organization released two versions of a report on Bt cotton prepared by the Joint Director of Agriculture of Warangal District, Andhra Pradesh (AP). The data in the original report, commissioned under a memorandum of understanding between the AP government and Monsanto-Mahyco, revealed a comprehensive failure of Bt cotton in AP. The second visibly tampered-with version exaggerated the yields, thereby substantially reducing Monsanto's compensation to farmers [22] (India's Bt Cotton Fraud, *SiS* 26).

Local scientists and farmers accused the State Agriculture department scientists of "fudging data" on Bt cotton performance [23]. "For example, 4 is made into 14 quintals yield, and figures are similarly concocted to show reduced pesticide use."

Monsanto commissioned a study using a market research agency for the 2004 season (see below), which claimed that Bt cotton yield was up by 58 percent on a country wide basis, resulting in a 60 percent increase in farmers' incomes; and in Andhra Pradesh, a 46 percent yield increase and a 65 percent reduction in pesticide costs gave a 42 percent increase in income to farmers. Every one of those claims was directly contradicted by independent research on the ground [24].

A notorious paper by Martin Qaim (University of Bonn) and David Zilberman (University of California, Berkeley) was published in the top journal *Science*, claiming outstanding (80 percent) yield increases from Monsanto's GM cotton; and projected the results as relevant to farmers throughout the developing world [25]. The paper drew a storm of protest, as it derived all its data from Monsanto, and its findings were completely at odds with the reports coming from Indian farmers. Dr. Devinder Sharma, a food policy expert, called Qaim and Zilberman's paper a "scientific fairytale" [26].

These Bt fantasies were contradicted by independent studies.

Independent studies contradict claims of Bt yield jump

Agricultural scientists Dr Abdul Qayum and Kiran Sakkhari conducted an independent study on Bt cotton on a season-long basis for three years in 87 villages of the major cotton growing districts of AP - Warangal, Nalgonda, Adilabad and Kurnool - and found against Bt cotton on all counts [27].

- Bollgard (Monsanto's Bt cotton) failed miserably for small farmers in terms of yields; non-Bt cotton surpassed Bt in yield by nearly 30 percent with 10 percent less expense
- Bollgard did not significantly reduce pesticide use; over the three years, Bt farmers spent Rs 2 571 on pesticides on average, while the non-Bt farmers spent Rs2 766
- Bollgard did not bring profit to farmers; over the three years, the non-Bt farmers earned on average 60 percent *more* than Bt farmers

- Bollgard did not reduce the cost of cultivation; on an average, the Bt farmers had incurred 12 percent more costs than non-Bt farmers
- Bollgard did not result in a healthier environment; researchers found a special kind of root rot spread by Bollgard cotton, infecting the soil so that other crops would not grow.

Another report*, The story of Bt cotton in Andhra Pradesh: Erratic processes and results* [28] published by the Centre for Sustainable Agriculture (CSA), documented the controversial events surrounding the failures of Bt cotton during its first three years of commercial cultivation in Andhra Pradesh.

In the first year (2002-2003), the popular non-Bt hybrid yielded on average 276 kg/ha compared with 180 kg/ha from Bt-cotton (an increase of 53 percent). The average net return for non-Bt farmers was Rs2 147 compared with Rs518 for Bt farmers, an increase of 314 percent. Some 71 percent of farmers on Bt cotton suffered a net loss compared with only 18 percent of farmers who planted non-Bt cotton. Similar surveys carried out in Maharashtra and Andhra Pradesh by New Delhi based Research Foundation for Science, Technology and Ecology confirmed the dismal results of Bt cotton; farmers who planted Bt cotton suffered a net loss of Rs 3300 per acre, whereas those growing non Bt hybrids and Desi varieties (indigenous non Bt cotton) gained RS10 750 and Rs 8250 respectively. These trends were confirmed in a third study by non-government organization, Gene Campaign.

Monsanto-Mahyco, however, conducted its own survey, which presented positive findings for Bt cotton.

In the second year (2003-2004), Monsanto-Mahyco commissioned a survey by a market research agency A C Nielson, which came up with the appropriately positive report. However, a season-long monitoring by Deccan Development Society, Permaculture Association of India and Andhra Pradesh Coalition in Defence of Diversity (APCIDD) returned quite different findings. It showed that Bt crops did not significantly reduce the cost of pesticides, they required more insecticide sprays for controlling sucking pests than non-Bt crops, and Bt crops led to a 9 percent reduction in net profit for farmers (see Table 1).

Table 1. Monsanto Commissioned study vs independent study

State	Bollworm Reduction	Pesticide Usage Reduction		Yield increase		Increase in Net Profit
Andhra Pradesh	%	Rs	%	Quintals / Acre	%	Rs / Acre
Monsanto Study	58%	1856/-	24%	1.98	92	5138/-
Andhra Pradesh APCIDD Study	14%	321/-	2%	-0.09	(-)9	(-) 750/-

In the third year, the areas planted with Bt expanded again, to 6 times the previous year, as conditional approval was granted by the GEAC for commercial release for RCH2 Bt, a Bt hybrid with an indigenous variety of Rasi Seeds, for South and Central India.

Mass Bt crop failures were detected early in the season in Warangal district. The government had sent out 50 teams of experts to visit the fields and compile a report, but no information was forthcoming. By November 2004, the agricultural officials in Warangal admitted that out of 20 000 ha of Bt cotton grown in the district 65 percent was damaged by wilt,

where the flowers, bolls, and the plants dried up resulting in very low yields. In contrast, only 15 percent of the non-Bt crops were damaged.

Qayum and Sakhari continued a fourth successive year of study on Bt cotton in Andhra Pradesh for the APCIDD, the Deccan Development society and the Permaculture Association of India [23]. They compared the performance of Bt cotton with non-Bt cotton, and organic (NPM, non-pesticide management) cotton and the corresponding economic returns to farmers.

The previous report [28] from 2002-2005 covered the Bt cotton hybrids MCH162 and MCH184 introduced by Mahyco-Monsanto. These hybrids were found to have "failed miserably" as small farmers could neither reduce pesticide use nor cost of cultivation, and some diseases similar to Rhizotaria root rot and bacterial leaf flight had widely spread first in Bt hybrid cotton, which later infected the non-Bt hybrids. As a result of the report and extended agitation by farmers in the region, GEAC and the Government of Andhra Pradesh imposed a ban on the cultivation of Mahyco-Monsanto hybrids in the state during 2005-2006.

Between 2004 and 2006, a number of new hybrids were released for cultivation in Andhra Pradesh. These include RCH 20, ProAgro368, Bunny and Mallika, in addition to Raasi's RCH-2. So the study for 2005-2006 analysed the performance of all the Bt hybrids in nine villages in three districts, Warangal, Adilabad and Nalgonda.

The results showed that NPM cotton and non-Bt cotton cost less than Bt cotton by 22.83 percent and 16.66 percent respectively and resulted in better net economic return by 35.35 percent and 8.81 percent respectively. There were only slight differences in yields with Bt cotton hybrids ahead of non-Bt and NPM cotton by 6.09 and 6.6 percent respectively. The greatest savings were in the cost of seeds. Bt-hybrid seeds cost Rs1 750 per acre compared with Rs481.8 for non-Bt hybrid seeds, and Rs473.7 NPM-hybrid seeds.

Incidentally, the average yield over the five years 2002-2006 for Andhra Pradesh according to state record was 328 kg/ha [25]. But the figures from the government database [16] gave an average of 485 over the same period, an inflation of 48 percent.

While the incidence of American bollworm – the pest that Bt cotton protects against – was low throughout the study area irrespective of whether Bt, non-Bt or NPM cotton was grown, other important pests, the sucking pests, were rampant. The incidence was higher in Bt cotton fields and extended to longer duration, so Bt farmers had to spray once or twice more than non-Bt farmers, while NPM farmers did not have to use insecticides at all. These findings confirmed results obtained earlier, which we reported in detail [30] (Organic Cotton Beats Bt Cotton in India, *SiS* 27).

In 2007, a study on Bt cotton in Vidarbha documented that it has failed iin the region [31]. Suman Suhai, director of Gene Campaign, told *The Hindu* that despite knowing that Bt cotton would not work in rainfed areas, the government had introduced it in Vidarbha, and as a result the high input costs of Bt cotton had increased indebtedness in an area already heavily indebted. The study showed that 70 percent of small farmers had already lost their landholdings as collateral for loans that they could never repay.

Suhai said seed dealers encouraged farmers to buy far more fertilizer and pesticide than was needed, raising their input costs. They promised farmers 12 to 15 quintals per acre when the actual harvest was in the range of three to 5 quintals per acre. At the same time cotton price came down with the import of Chinese cotton. On average, farmers who adopted Bt cotton lost Rs1 725 per acre.

The study further revealed that many farmers adopted Bt cotton because they believed it was a "government seed", instead of being privately produced and marketed. They also adopted

it because the government was activity promoting it. Local officials like the Agriculture Commissioner of Amravati were aware of the failures of Bt cotton, but the state agriculture department continued to promote it.

The study also collected evidence of other effects of Bt cotton on plants and animals: cattle deaths in areas where they grazed in harvested Bt cotton fields [2] (Mass Deaths in Sheep Grazing on Bt Cotton, *SiS* 30). Women working in cotton fields had complained of rashes (see [32] (More Illnesses Linked to Bt Crops, *SiS* 30), and mango trees that were not flowering. But the government has turned a deaf ear to those reports.

Vandana Shiva has roundly condemned the IFPRI paper in her critique [33], exposing all its false claims. More recent field studies in Vidarbha carried out by her organization Navdanya showed a 13-fold increase in pesticide use by farmers since Bt cotton was introduced in 2004.

A 2008 survey comparing Bt cotton with organic cotton showed that organic producers earned on average Rs6 287/acre, nearly ten times as much as the Rs714/acre income of Bt cotton farmers.

These problems with Bt cotton are not unique to India. We reviewed GM cotton failures around the world at the beginning of 2005 [34] (GM Cotton Fiascos Around the World, *SiS* 26), notably Indonesia, China, The United States.

Independent study in US confirms Bt cotton failures

A 4-year study [35] by researchers at the University of Georgia and the US Department of Agriculture confirms that the use of GM cotton did not provide increased return to farmers in the United States. On the contrary, it may decrease income by up to 40 percent [36] (Transgenic Cotton Offers No Advantage, *SiS* 38).

The researchers grew a number of different cultivars of cotton at two locations in the state of Georgia. The transgenic varieties consisted of two main traits, herbicide tolerance and Bt biopesticides, alone and variously combined (stacked); they were

1. Bollgard (B), expressing the Bt toxin Cry1Ac from soil bacterium *Bacillus thuringiensis* to control the cotton bollworm
2. Bollgard II (B2) expressing two different Bt toxins, Cry1Ac and Cry2Ab, to delay the evolution of pest resistance
3. Roundup Ready (RR), tolerant to glyphosate herbicide;
4. Bollgard/Roundup Ready (BR)
5. BollgardII/Roundup Ready (B2R)
6. Liberty Link (LL), tolerant to herbicide glufosinate

Five different non-transgenic cotton cultivars were also grown. Each cultivar, whether transgenic or not, was managed to maximise profit, as consistent with practices recommended by the University of Georgia.

The results showed that “no transgenic technology system produced significantly greater returns than a non-transgenic system in any year or location.” The returns are dominated by yields, and could be reduced by 30-40 percent. In 2004 at one of the two locations, the non-transgenic variety produced a return of $1274.81 per ha compared with $858.73 for BR, $737.41 for B2R, and $876.14 for LL.

The researchers remarked that the high investment for transgenic crops before any yield is realised is a predicament for growers, one shared by farmers in India and elsewhere.

It is a pity that the researchers have not included organically managed cotton in their study, because it is clearly a much better option.

Bt cotton does not protect against cotton bollworms as intended and worse

Bt cotton is supposed to protect against cotton bollworms on account of one or more genes coding for a family of proteins from the soil bacterium *Bacillus thuringiensis* that are specifically toxic to them.

However, farmers have found that Bt cotton did not always live up to expectations. In the first year of its introduction in India, Bt cotton crops in the Bhavanagar, Surendranagar, and Rajkot districts of Gujarat were reported to be attacked by bollworm, despite being initially resistant in the early phases of plant growth [21]. A later study in Vidarbha [31] confirmed that the Bt cotton gene worked only for the first 90 days in a 160 days growth period for Indian cotton, leaving the cotton unprotected during the most crucial time.

By 2005, scientific studies from several countries backed up farmers' experience. Scientists in India, China and the United States found that the levels of Bt toxin produced by Bt crops vary substantially in different parts of the plant and in the course of the growing season, and are often insufficient to kill the targeted pests. This could lead to greater use of pesticides, and accelerate the evolution of pest resistance to the Bt toxin [37] (Scientists Confirm Failures of Bt-Crops, *SiS* 28).

Scientists at the Central Institute of Cotton Research found that the amount of Cry1Ac protein varied across the Bt varieties and between different plant parts [38]. The leaves had the highest levels; whereas the levels in the boll-rind, square bud and ovary of flowers were clearly inadequate to fully protect the fruiting parts producing the cotton bolls. Increasing numbers of armyworm (*Helicopverpa armigera*) larvae survived as toxin levels dropped below 1.8 µg/g wet weight of the plant parts. Thus, a critical level of 1.9 µg/g was needed to kill *all* the pests. Regardless of plant varieties, the level of toxin decreased with the age of the plant, though the decrease was more rapid in some hybrids than in others. By 110 days, Cry1Ac expression decreased to less than 0.47µg/g in all Bt hybrids.

In a separate study, scientists at the same institute tested the susceptibility of an insect pest from different regions in India to Bt toxin [39]. The LC_{50} - the concentration killing 50 percent of the larvae – of Cry1Ac ranged from 0.006 to 0.105 µg/ml. There was a 17.5 fold overall variability in susceptibility among the districts. The highest variability of 17.5 fold was recorded from districts of South India. The variability in pest susceptibility, like the variable expression of the Cry1A proteins in Bt crops, will reduce the efficacy of Bt pest control.

At the Institute of Plant Protection, Chinese Academy of Agricultural Sciences in Beijing researcher found that the toxin content in the Bt cotton varieties changed significantly over time, depending on the part of the plant, the growth stage and the variety. Generally, the toxin protein was expressed at high levels during the early stages of growth, declined in mid-season, and rebounded late in the season. In line with the study in India, the scientists found that the toxin content in leaf, square, petal and stamens were generally much high than those in the ovule and the boll [40].

From the beginning, scientists have predicted another problem, that the bollworm would develop resistance to Bt toxin, and hence a general recommendation was that 20 percent of the land should be set aside for planting non-Bt crops to act as 'refugia' to slow the development of Bt resistance; and the pro-GM lobby has been congratulating itself at how Bt resistance has not developed [41]. But as pointed out by Prof. Joe Cummins of ISIS [42] (No Bt Resistance? *SiS* 20), the 'refugia' were fictitious, as the US Department of Agriculture had recommended insecticide sprays on both non-Bt crops in the refugia and Bt crops.

But by 2005, Bt resistance in bollworms had indeed emerged in Australia [37]. A population of the Australian cotton bollworm, *Helicoverpa armigera* – the most important agricultural pest in Australia as well as China, India and Africa - has developed resistance to Cry1Ac at 275-times the level that would have killed the non-resistant insect [43]. Some 70 percent of the resistant larvae were able to survive on Bt cotton expressing Cry1Ac (Ingard), which has been grown in Australia since 1996.

A new variety of Bt cotton containing both Cry1Ac and Cry2Ab was commercially released in late 2003. Resistance monitoring in Australia and China had suggested that pest susceptibility to Cry1Ac was declining in the field. In 2001, a strain of cotton bollworm was isolated from the survivors in the New South Wales and Queensland monitoring programme that appeared to be resistant to Cry1Ac. The researchers have now confirmed the findings, and attributed the high level of resistance to a 3- to 12-fold over-expression of an enzyme, serine protease, which binds avidly to Cry1Ac toxin, preventing it from acting, and possibly, detoxifying it by breaking it down.

Another problem more serious than Bt resistance in the targeted pest is the emergence of secondary pests. And this has happened first in China and then in India and Pakistan [6].

China was initially held up as the success story on Bt cotton [34]. It first granted permission to Monsanto to grow the crop in 1997, and for the first several years reported great reductions in the use of pesticides. Early warnings appeared in a study published in 2002 by researchers at an institute funded by China's Environmental protection Agency. It found that although Bt cotton was effective in controlling bollworm, it had adverse impacts on the bollworm's natural enemies and was not effective in controlling many secondary pests. A second study published in October 2004 found that Bt cotton did not reduce the total numbers of insecticide sprays because additional sprays were needed against sucking pests. A study of 481 Chinese farmers by researchers at the Cornell University released in 2006 reported that after seven years, populations of other insects such as mirids have increased so much that farmers have had to spray their crops up to 20 times a growing season [44].

One of the researchers, Per Pinstrup-Anderson, well known GM supporter and professor. of Food, Nutrition and Public Policy at Cornell said: "These results should send a very strong signal to researchers and government that they need to come up with remedial actions for the Bt-cotton farmers. Otherwise farmers will stop using Bt cotton, and that would be very unfortunate."

The study found that farmers in the survey who had planted Bt cotton were doing well initially, and by year three, cut pesticides by 70 percent and earned 36 percent more than farmers planting non-Bt cotton. By 2004, however, they had to spary just as much, resulting in a net average income eight percent less than conventional cotton farmers because Bt seed costs three times as much as conventional seed.

The other researchers were Shenghui Wang, Cornell Ph.D. now an economist at the World Bank, and Cornell professor David R. Just. They stress that secondary pest problems could become a major threat in countries where Bt cotton has been widely planted.

Undaunted, the supporters of GM continue their positive spin. In the abstract of a paper published in *Science* in 2008 [45] the authors wrote: "Our data suggest that Bt cotton not only controls *H. armigera* on transgenic cotton designed to resist this pest but also may reduce its presence on other host crops and may decrease the need for insecticide sprays in general."

In the full paper, however, the authors reported that mirids, podsucking bugs that used to be controlled by spraying and by competition with the bollworm, have now become key pests of

cotton in China. They conclude their paper with the statement: "Therefore, despite its value, Bt cotton should be considered only one component in the overall management of insect pests in the diversified cropping systems common throughout China."

Grassroots researcher Ram Kalaspurker based in Yavatmal, Maharashtra in India, was among the first to document (with video and photography) the emergence of secondary pests and even a totally new exotic pest, giant mealy bugs that have infested Bt cotton plants, and spreading to near-by plants [46] (Deadly gift from Monsanto to India, *SiS* 38). The problem is so serious that a special combined session of entomology and pathology groups was convened in the entomology panel meeting on 10 April 2008. It stated [47] "All the participant entomologists were unanimous in expressing their concern on the emergence of new insect pests over the past 4 years, particularly after the introduction of Bt-cotton. Severe infestation of mealy bugs, mirid bugs and thrips was recorded in several parts of the country. Mealy bugs in Gujarat and mirid bugs in Karnataka were reported to have caused significant economic damage." An arsenal of deadly insecticides has been suggested by some entomologists to deal with these secondary pests as well as with resistant bollworms.

Scientific consensus for organic non-GM agriculture

There is a developing scientific consensus that organic non-GM agriculture and localized food (and energy) systems are what the world needs for food security that would also save the climate [48] (Food Futures Now: *Organic *Sustainable *Fossil Fuel Free , ISIS publication).

Prince Charles was so distressed by the plight of the suicide farmers that he set up a charity, the Bhumi Vardaan Foundation [49], to help those affected, and to promote organic Indian crops instead of GM.

The planting of GM cropOs in India must end. The plight of Indian farmers serves as a dire warning against adopting GM crops; and those who insist on promoting GM crops for farmers in the developing world [50] (Beware the New "Doubly Green Revolution", *SiS* 37) are perpetrating a crime against humanity.

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