Agricultural biotechnology in India: ethics, business and politics

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Abstract: This paper deals with the case of Bt cotton in Gujarat, India, as an illustration of how public policy chickens out when large-scale violation of ethical and scientific norms takes place with positive business outcomes. Entrepreneurial spirit has created a unique case of farmer participatory research whereon farm crosses are being made between Bt cotton varieties and other released varieties. New production cycles are being created by farmers who have extended the life of the crop from six months to nine months to reap advantage of continuous flowering and thus higher yield. All this has happened in an unauthorised manner, with full public knowledge and despite complaints of Monsanto and MAYHCO about Navbharat Seed Company having 'stolen' their Bt gene. Farmers are happy, politicians do not care and regulatory agencies are satisfied that sending a few committees to enquire is all that they needed to have done. This article presents a review of important studies in the context of the Bt adventure in Gujarat and discusses the findings obtained in a farmer survey on experience and perception of Bt cotton in Gujarat.

Keywords: biotechnology; Bt cotton; ethics; business; regulations; politics; Gujarat; farmer's varieties; IPM.

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1 Introduction

In a developing country with overflowing food grain stocks, a liberalising economy set on a growth path, and techno-bureaucracy willing to pursue new technologies with a reasonably open mind, the situation seems ripe for agricultural biotechnology. The investment in this sector is picking up and the private sector has been given a pivotal role along with synergistic public investment. Top Indian policy makers argue that biotechnology will provide food security to the hungry (Sharma, 2003) but do not explain as to why should hunger exist at all in India with its overflowing food stocks, if the issue was only supply! Activists also make a case for biotechnology so long as it increases productivity. The case of Bt cotton in Gujarat shows that this new technology indeed increases productivity, profits of the farmer and eliminates the need for excessive sprays of chemical pesticides.

Yet, when good economic returns follow a bad ethical practice in terms of technological change (respecting neither environmental regulation and monitoring, nor intellectual property rights), do ends justify the means? The answer begs for possible alternatives to Bt cotton:

- *The agro-chemical industry and conventional agriculture*: the chemical pesticide industry makes its living so to say, by heavy inputs in cotton (reportedly 40–50% of all the pesticides in India is consumed by hybrid cotton alone). It does not even educate workers and farmers about
    - safe ways of spraying (not even a single hoarding is there in the entire country on the subject though there are thousands of bill boards advertising the use of the chemical pesticides)
    - disposing pesticides containers (except in small print in the publications accompanying the pesticide bottles)
    - practicing integrated pest management – IPM-practices.
- *Ethical violations in chemical pesticide industry*: That are more conspicuous, have hazardous results and are more certain than other new technologies; in fact, consequences of excessive use of chemical pesticides on human and environmental conditions are well documented as against the environmental consequences of biotechnology which are still being probed. Yet, similar public debate does not ensue.
- *Integrated Pest Management* (IPM): Despite having achieved excellent results through publicly funded IPM, the investment on IPM in Gujarat remained static for the last three years – around 75000 US$ per annum that is less than 1% of the total agricultural budget in Gujarat. This is very likely to be the case at the countrywide level as ascertained in informal dialogues with senior policy makers in the Ministry of Agriculture. IPM offers an alternative to biotechnological solutions in pest control which is cheaper. But public policy support for IPM is quite weak.

Even though the adoption of Bt cotton in Gujarat has benefited farmers significantly, the public policy neglect of safer, cheaper and more affordable technological alternatives has obvious ethical implications too. The Department of Biotechnology (DBT) of the Government of India is aware of these alternatives and has hardly made any investment

in even fair comparative trials of Bt cotton with other competing technologies; not to mention the almost total absence of investment in public education about the likely hazards of taking up such large scale un-guarded, un-monitored and un-evaluated trials by farmers of the Bt crosses with local hybrids. Undoubtedly, the experience of Gujarat will be recalled in the history of biotechnology as one of the largest trials (with full public knowledge and without any responsible monitoring or evaluation by public agencies at similar scale) of an illegally released technology ever done by people themselves, oblivious of any environmental or other consequences.

2 The context for Bt adventure in Gujarat

Historical review of the introduction of Monsanto Bt cotton and the emergence of generic products of Bt cotton through Indian companies:

1990 Monsanto started negotiating the technology transfer agreement with the Government of India for its Bt cotton package.

1993 The talks failed, as agreement on financial terms of transfer was not reached.

1993 Monsanto started negotiating the technology transfer agreement with the MAHYCO for its Bt cotton package.

1995 DBT (Department of Biotechnology) approved MAHYCO to import 100 grams of cotton seeds containing Bt Cry 1 Ac gene. (Dhar, 2003)

1996 Approval by Central Government for import of the first Bt cotton variety US Cocker-312. This variety was crossed with the elite Indian varieties to produce locally adapted Bt cotton varieties with Cry1Ac gene.

1996 First trials of Bt cotton.

1997 Field trials permitted in five states viz., Andhra Pradesh, Karnataka, Tamil Nadu, Haryana and Maharashtra.

1998 Field trials extended to four more states viz., Madhya Pradesh, Rajasthan, Punjab and Gujarat.

1998 Monsanto acquired 26% stake in MAHYCO, which later became 50–50 joint venture MAHYCO-Monsanto Biotech (MMB).

1998 MMB received approval from Review Committee on Genetic Manipulation (RCGM) of DBT to conduct countrywide-field trials on 85 hectares, and to produce seeds on 150 hectares.

1999 RFSTE (Research Foundation for Science, Technology and Education), New Delhi files a Public Interest petition challenging 'legality' of RCGM (Review Committee of Genetic Manipulation) under DBT to approve field trials as it is not the concerned authority and also no bio-safety regulations were exercised (Krishnakumar, 2003).

2000 DBT allowed Mahyco to conduct extensive field trials, including seed production at 40 sites in six states based on the 'total confidential' data from small-scale trials.

2001 MMB approached GEAC (Genetic Engineering Advisory Committee) for commercial release of Bt cotton varieties.

2001 GEAC approved field trials for another year on 100 hectares in seven states.

2001 GEAC withheld environmental clearance of large-scale cultivation of transgenic Bt cotton in June 2001. Instead it called for fresh large-scale field trials under the direct supervision of committee set up by ICAR (Indian Council of Agricultural Research) with representatives from MOEF (Ministry of Environment and Forestry), DBT, Department of Agriculture and Cooperation and Ministry of Health through Advanced Varietal Trial programme (AVT) of All India Coordinated Cotton Improvement Project (The Economic Times of India, 2001). Besides these, the GEAC in the press release said 'MAHYCO may like to conduct field trials on farmer's field in an area of about 100 hectares under close supervision of GEAC and Monitoring and Evaluation committee.[1]' It also advised collection of complete evidences and data pertaining to impact of transgenic on human and animal food, spread of the cry protein resistant boll worm and impact on non-target soil microflora and other fauna.

October

2001 MMB discovered commercial cultivation of Bt cotton on over 10,000 acres (4000 hac.) in Gujarat, traced the sale of the seeds (Navbharat 151) to Hyderabad based Navbharat Seeds Pvt. Ltd. MMB also discovered that Navbharat has been in the business of selling the seeds for the previous three years and demanded punitive action against the company.

2001 Following this the GEAC ordered the Gujarat Biotechnology Coordination Committee to burn all illegal plantations.

2001 GEAC on insistence from the Gujarat Government ordered that the illegal cotton be procured at a suitable price. But the order was late as the produce was already in the market by that time.

November

2001 Case registered with Gujarat High Court against Navbharat for violating the *EPA* (Environmental Protection Act) rules.

January

2002 Secretary DBT announced that latest rounds of Bt cotton field trails were satisfactory, based on report from ICAR.

March

2002 Centre approved three-years commercialisation of three Bt cotton varieties – Bt MECH-12, Bt MECH-162 Bt and Bt MECH-184 with a set of conditions. It disapproved MECH 915 Bt cotton seeds.[2]

May

2002 Rasi Seeds Company Ltd., got a nod from DBT to conduct trials.[3]

August

2002 Karnataka government banned sale of Bt cotton seed temporarily.[4]

2.1 A brief literature review of the current Bt cotton debate in India

Technological change in tropical developing countries has been studied from institutional, socio-economic and cultural, policy and structural perspectives. Incentives for farmers, it has been realised, are the prime movers for technological change in most

cases. These incentives or benefits may sometime be high in short term, but may have low returns in the long term (as in the case of chemical intensive approach to agriculture). From the portfolio perspective, risk and return are two obvious determinants of this change. There can be four combinations – high risk, high return; high risk, low return; low risk, high return; and low risk, low return (Gupta, 1981). In the case of Bt, the risks associated with the technology are:

- Environmental: When the pest infestation goes down, the possibility of birds and other predators getting attracted goes down. To that extent, there is an impact on the avian biodiversity. Whether this effect is lesser or more than the pesticide sprayed cotton is a matter for further investigation. The possible effect on soil microorganisms, on other species, through diffusion of Bt gene including weeds are other environmental implications.
- Technological, i.e., resistance development of pests to the Bt gene: Such risks associated with resistance are being investigated. There does not seem to be any conclusive evidence. Some argue for precaution on this ground.
- Consumer health such as possible allergenic role of the food products (in this case, the oil of cottonseed): These risks have not been investigated adequately in the Indian context.
- Socio-economic: The socio-economic effect on labour by way of suspected decrease in demand, has recently been found to be offset by increased duration of the crop from six to nine months.[5] This increases the demand for labour used in picking cotton. The labour finds their productivity going up in Bt cotton compared to conventional hybrid cotton. Reportedly, the number of balls infested with pests being higher in the latter case makes the task of picking good quality cotton a bit tedious. The labour contractors also reportedly benefit because of the significantly higher volume of cotton being picked up by the labour everyday enhancing their own margins.
- Ethical: Implying doing things with inadequate information about right or wrong outcomes on various stakeholders, imposing in the process, costs on future generations. The ethical issues are extremely serious not only because of the decisions taken with inadequate information but also because of the possible hazards in natural eco-system. The constrained choice of future generations in terms of cotton varieties without Bt gene also involve a moral dilemma. Robinson recalls that every technological revolution in the past has had major impact on the perceptions of the public about right and wrong and consequently, the legitimacy of technological change (Robinson, 1999). The discourse on usefulness of genetic engineering will have to be guided by better science but also by a more widespread debate. Scientists cannot complain that their confidence in the technology is being questioned by people whose understanding of science is limited. In fact, the farmers who have crossed Bt cotton variety released illegally with the local hybrids, have found economically beneficial results and are paradoxically not worried about environmental implications. Most of the farmers we talked to, seemed to have faith in the ability of the scientists not only to monitor that but also to educate them as and when the situation warrants. The fact that scientists have delivered better hybrids in the past to overcome the resistance as well as other problems seems to assure the farmers that they would get the answers to any possible problem that transgenic

> cotton might create in future. The irony is that scientists themselves are not doing much systematic monitoring of the large-scale farmer participatory Bt research going on in Gujarat. For once, the scrutiny of science is not being matched with the popular faith in its capacity to deliver. The regulatory framework regarding biotechnology in India is summarised in Annexure one. It is a different matter that popular faith in this framework is not as strong as one would expect in a democratic society.

Regulatory efforts with regard to Bt cotton in India are proposed, but the officials of the Department of Biotechnology admitted their lack of knowledge regarding the long-term safety (Scoones, 2003). Scoones believes that by not engaging the critics in the science policy network, 'a sense of disengagement, distance and distrust within the regulatory process emerges.' Many agricultural and ecological scientists have felt excluded from the regulatory process. He quotes senior scientists involved with DBT about the doubt they have in the ability of DBT to enforce their own guidelines. He argues for some forms of accountability outside the science – industry – policy networks to make current discussion on biosafety regulations meaningful. Herring, though criticising the nature of dialogue between policy makers and the disadvantaged communities, nevertheless wonders whether scarce resources are to be spent in building a more strict, widespread and bureaucratic regulatory regime or, if these resources ought to go to public health, education or extension (Herring, 2003). Excessive caution, he suggests, may drain the resources required from alternative uses. He adds that insufficient caution might generate unanticipated harms.

Kinderlerer and Adcock (2003) raise the question of justice involving the introduction of new technologies and imply that if the poor benefit, then risk might be worth taking. In Gujarat, small and large farmers (with or without effective irrigation) seem to have voted for Bt, including the illegally marketed one, disregarding other consequences. Does it make it just? Do ends justify the means? Gupta and Sinha (2002) have asked this question in the context of environmental governance and have wondered whether the ethics of not investing in alternative ways of solving a problem make even more profitable outcomes from a particular approach, more legitimate and moral. Thus, if we ignore IPM and assume that Bt cotton gives more profit than IPM approach, will Bt approach become more ethical just on that ground, regardless of overall consequences for environment?

Bharathan (2000) believes that in the case of Bt cotton, the democratisation of knowledge, technology and discourse would require greater participation of the scientists from different disciplines. Venkateshwarlu (2003) had argued that despite general governmental sympathy for the farmers who violated GMO regulations, the real solutions lay in creating wider awareness about biosafety regulation rather than only making regulations stricter. In a recent report, Jishnu (2003) referred to seed industry estimates that nearly half of Gujarat's fields were planted with Bt cotton. She also looked at government figures about seed supply from public sources, and from legal channels, and the acreage under cotton to estimate the area under illegal Bt cotton.

Farmers in Gujarat have no qualms to say that the issue is not whether to grow Navbharat Bt or not, the issue is how to get all the seed that one needs one way or other. Seldom has a technology found so widespread approval from the users without any intervention of formal extension machinery. Undoubtedly, the politicians have supported it by expressing helplessness and claiming inability to get illegal cotton uprooted by paying compensation to the farmers. While Jishnu refers to the advantage of Navbharat

Bt cotton in terms of shorter duration, farmers have gone a step ahead and found that by extending the duration for about three months, they can almost double the yield with marginally extra cost. Navbharat Seed Company sources have maintained in personal communication (March 10, 2004) that they have not sold any seed for last two years. By implication, the entire diffusion of Navbharat 151 Bt cotton seed in Gujarat during the last two years has been achieved by farmers, traders and other seed companies, which have produced seed one way or the other incorporating the Bt gene from Navbharat 151 variety. What is even more interesting is that several postgraduate students of Gujarat Agricultural University have become entrepreneurs by developing the seed at their private farms and thus earning while learning. Whether their values will get so shaped in this process of illegal seed production that after twenty years when some of them would be head of the department or members of regulatory bodies, they would have perhaps less difficulty in living with legal or ethical violations, they might not even ask question about ethics in such situations.

The discourse on Bt cotton is being outpaced by the fast changing ground realities. Sahai (2003) referred to the paper by Quaim and Zilberman (2003), which created lot of controversy. It stated that the genetically modified cotton having Bt gene had shown higher yields in the experimental plots in India. Sahai (1997) argued that the failure of Bt cotton in Maharashtra and Andhra Pradesh contradicted, 'the exuberant projections of two foreign scientists publishing from a US university….' She argued that the motivations of the editorial committee of *Science,* a very reputed journal, could be considered suspect. We are worried that if such be the logic, would widespread satisfaction with Bt cotton in Gujarat during last two years vindicate the decision of editorial board of *Science?* It is a different matter that farmers have found Mahyco Mansanto Biotech (MMB) cotton yielding higher than Navbharat 151 seed but their preference still remains for the latter because of its ability to yield for longer duration, earliness in flowering and almost one-fourth the seed cost (MMB seed costs about 35 USD per 450 grams whereas Navbharat costs nine to twelve dollars for the same quantity).

3 The field survey

3.1 Survey outline and methodology

A survey of 363 farmers from various parts of Gujarat except Kutch was undertaken to collect data about their experience with Bt cotton during 2001–2002, the year when Navbharat 151 seed was formally sold by the Navbharat seeds Ltd. During last two years, the seed has not been sold by this company. But the seed has been multiplied by the farmers or other private agencies as mentioned above. The sample survey had been organised on the basis of source of seed in terms of a location and producer.

The respondents were selected at random from 75 villages from 10 major cotton-growing districts of Gujarat state. The villages were selected on the basis of diffusion/spread of the technology to capture as much of agro-ecological diversity as possible. The respondents were interviewed by the PostGraduate students of Gujarat Agricultural University pursuing their Masters Degree in Plant Breeding and Genetics, Agril. instead of Entomology, Agronomy and Agril. Economics. The respondents were visited at their farms and pre-designed and tested questionnaires were used to elicit their

opinions. Since the survey was based on recall data and that too with a lag of one year, there is a possibility of some loss of information. The data pertains to the year 2002. The information collected from the respondent farmers was crosschecked by asking the neighbouring farmers about their views relating to the BT cotton crop of the respondent farmer. Several farmers were hesitant in giving their names since they knew that their cultivation of Bt cotton was illegal. Once assured of anonymity, they agreed to cooperate in the survey.

3.2 Field survey results

In Table 1, we provide brief information about the sample of farmers who bought seed from distant locations, local shops, other sources within their region and those who have made it on their own. There was not much difference among these groups with regard to age composition or education. The largest proportion of farmers in all land size groups bought seeds from distant sources signifying a distinct preference for the BT seeds even from far off places. The main difference was that small and large farmers had sizeable section which purchased seeds from shops (which had highest productivity and were thus perhaps of best quality). The key contrast was that while majority of marginal landholders had only less than one-fourth area under irrigation, compared to those who had bought from shops and from distant places having much larger area under irrigation. Among those who had procured seeds from shops and distant places, majority had irrigated holding signifying their ability to provide better production environment to good quality seeds. In Table 2, the sample characteristics are on the basis of seed producers (companies or farmers themselves). Age and education did not make much difference to seed buying behaviour. However, if we look at the ratio of branded to non-branded seed purchase behaviour, the ratio was 3:2 among marginal land holders while it was about 2:1 in the larger land holding farmers. If the land holding is a proxy for better economic power, those who could afford, did go for better seeds. What is interesting though is that even among these more opportunistic buyers, a significantly higher proportion went for illegal Navbharat seeds rather than Monsanto's legally released Bt seeds. Poorer farmers relied much more on low quality F_2[6] seeds compared to the rest. A discriminant analysis among the four groups also revealed the average yield to be lower among growers of own seed or F_2 seed by about 10 to 25%. The on-farm characteristics of different kinds of seeds are described in Table 3. Compared to normal cotton, both MMB and Navbharat flowered earlier, took lesser days to maturity, were slightly dwarf and had higher number of balls per plant. The trend was similar in the case of farmers' own seeds as well as the F_2. The average yield was highest in the case of MMB followed by Navbharat, farmers crossed and F_2. When one looks at the source in terms of location (Table 4), the seeds obtained from shops apparently performed the best followed by the ones bought from distant sources, from other farmers, and the minimum yield was from own seeds. The experience with different pesticides was on an average better in the case of Navbharat seed than in case of MMB or other sources. When one looks at the composition of sources, locationwise and producerwise, among all the producers, the seed of Navbharat was obtained by largest number of people from far off places indicating maximum demand and minimum availability from the shops. In terms of farmers, crossed F_2, pattern was similar except that shop was not an important source of farmers crossed or F_2 seed. There was not much difference in terms of the incidence of different pests.

The survey by and large, reveals that farmers growing MMB have achieved marginally higher yield but at higher costs (since as mentioned earlier, MMB seeds cost about 35 USD per 450 gms, whereas Navbharat seeds bought from shop cost about USD 9–10). In case of Navbharat seeds or its derivatives, they have still managed much higher yields than the normal hybrids at much lesser cost. From the risk perspective, what is most remarkable (see Table 3) is the higher Standard Deviation (SD) in case of Bt cotton compared to the normal hybrids.

Higher risk and higher return would make the technological choice attractive for entrepreneurial farmers but for the others, it might be inhibitory. Given the fact that the survey is based on recall data and that too with a lag of one year, there is possibility of some loss of information. We are planning to repeat this survey among the same farmers for the current year's performance. What has been demonstrated unambiguously is that in the current year a very significant number of farmers have decided to irrigate the crop even after normal season and elongate the life by about three months with very attractive returns. Normally farmers grow potato in some parts after cotton but this year they decided to continue with the cotton, particularly the Navbharat seeds and its derivatives.

Table 1 Some characteristics of farmers using Bt seeds from different sources

Sl.	*Variable*		*Distant (206)*	*Shop (108)*	*Others (26)*	*Own (17)*
1	Age	Up to 30	20 (9.71)	7 (6.48)	2 (7.69)	1(5.88)
		31–60	166 (80.58)	88 (81.48)	20 (76.92)	14(82.35)
		> 61	10 (4.85)	3 (2.78)	2 (7.69)	1(5.88)
2	Education	Illiterate	9 (4.37)	2 (1.85)	3(11.54)	0(0.00)
		Primary	72 (34.95)	28 (25.93)	5(19.23)	3(17.65)
		High school	86 (41.75)	41 (37.96)	11(42.31)	8(47.06)
		Graduate and above	20 (9.71)	20 (18.52)	3(11.54)	4(23.53)
3	Land holding	Marginal farmers (< 2 ha.)	32 (15.53)	8 (7.41)	8(30.77)	4(23.53)
		Small farmers (2–4 ha.)	99 (48.06)	49 (45.37)	6(20.08)	8(47.06)
		Large farmers (> 4 ha.)	71 (34.47)	42 (38.89)	10(38.46)	5(29.41)
4	Per cent irrigated holding	< 25 %	18 (8.74)	4 (3.70)	1 (3.85)	1 (5.88)
		25–50 %	42 (20.39)	12 (11.11)	2 (7.69)	2 (11.77)
		51–75 %	47 (22.82)	16 (14.82)	6 (23.08)	4 (23.53)
		> 76 %	95 (46.12)	67 (62.04)	15 (57.69)	10 (58.82)
		Missing	4	9	2	0

* Per cent values are worked out from total respondents as mentioned on top of the table

4 Policy implications

From a simple efficiency point of view, sufficient availability of F_1 seed duly authenticated from the shops would achieve the highest profits for the farmers. However, this possibility depends on the government's ability to screen Navbharat seed Ltd., for its environmental safety and other regulatory requirements and thus make its seeds available legitimately at 25% of the MMB seed. Dr. Desai, MD of Navbharat Seeds in a personal

interview said, 'When government has already tested the biosafety and environmental safety of Cry 1Ac gene, and it has concluded that Navbharat 151 contains that gene, then why should we be prevented from commercialisation of the variety, where is the risk?' He states that they collected the germplasm from the farmers' fields in Maharashtra. This seed collected from farmers' fields apparently contained the Cry 1 Ac gene. Navbharat Seeds Ltd. crossed it with Guj. Cot 10, a selection from the Bikaner Lerma, a local variety that has a wide adaptability and is very suitable for Indian conditions. So far as the intellectual property right issues are concerned, the conflict between Monsanto and Navbharat will have to be resolved in the courts but on the face of it, there does not seem to be a case against Navbharat from the facts available so far (since India does not permit gene patents). Dr. Desai, the proprietor of Navbharat Seeds, acknowledged that their company did not have the facilities for producing genetically engineered seeds. They made crosses with Guj. Cot. 10 in the normal process in which the Bt gene got incorporated. The choice of parents was apparently much better in the case of Navbharat than was the case with MMB. Smaller companies are generally closer to the ground and thus can respond to the farmers' needs more efficiently. However, when the seed in case is Bt which is not yet protected as per the Indian laws, the case for its incorporation in other varieties in an unauthorised manner, falls in the realm of morality rather than law.

Table 2 Preliminary characteristics of farmers growing/using seeds of different varieties of Bt cotton

Sl.	*Variable*	*Classes*	*Navbharat (133)*	*Monsanto (106)*	*Farmer Crossed (77)*	*F2 (41)*
1	Age	<30	10 (7.52)	11 (10.38)	7 (9.09)	4 (9.76)
		30–60	108 (81.2)	82 (77.36)	65 (84.42)	33 (80.49)
		>61	8 (6.02)	2 (1.84)	3 (3.90)	1 (2.44)
2	Education	Illiterate	7 (5.26)	3 (2.83)	2 (2.60)	2 (4.88)
		Primary	44 (33.08)	26 (26.53)	28 (36.36)	10 (24.39)
		High school	49 (36.84)	49 (46.23)	32 (41.56)	16 (39.07)
		Graduate and above	17 (17.78)	12 (11.23)	11 (19.29)	7 (17.39)
3	Land holding	Marginal (< 2 ha.)	21 (15.79)	9 (8.49)	12 (15.58)	10 (24.39)
		Small farmer (2–4 ha.)	60 (45.11)	39 (36.79)	33 (42.86)	20 (48.78)
		Large farmer (> 4 ha.)	47 (35.34)	42 (29.62)	30 (38.96)	9 (21.95)
4	Per cent irrigated holding	< 25 %	10 (7.52)	5 (4.72)	6 (7.79)	3 (7.32)
		25–50%	23 (17.29)	16 (15.09)	12 (15.84)	7 (17.07)
		51–75%	26 (19.55)	23 (21.70)	18 (23.38)	6 (14.63)
		> 76%	69 (51.87)	56 (52.83)	39 (50.65)	23 (56.10)
		Missing	5	06	2	02

* Per cent values are worked out from total respondents as mentioned on top in the table

The critics have argued that regulatory processes were compromised in the case of MMB to ensure its early release. Moral issues are involved in such compromises too. Critics have also argued that wider participation of civil society and multi-disciplinary scientists has not taken place adequately. What is even more disturbing is that after the widespread

diffusion of Navbharat seed through entirely illegal channels, no systematic monitoring, data analysis and feedback system has been put in place[7].

Which is lesser evil? Subject Navbharat Seed to as stringent environmental regulatory tests as necessary and then make it possible for farmers to obtain proper F_1 seed so that responsibility, if any, for the adverse consequences can be fixed on the company? Or to live with the situation where almost every farmer who can afford to grow Bt cotton wants to grow it and generally with Navbharat seed obtained one way or the other?

Are we trying to make virtue of a vice? Do two wrongs make one right? Because MMB is reported to have been pushed with very poor results in some states and reasonable results in other states, without adequate public debate, Navbharat Seed Company should be allowed to have the similar advantage. After all, the farmers do not seem to be complaining at all about Navbharat seeds.

Table 3 Characterwise performance of various Bt crop varieties in comparison to normal cotton

		BT		*Normal*		*BT*		*Normal*	
SI.	*Character*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
		Navbharat F_1 (133)				*Monsanto F_1 (106)*			
1	Days to 50% flowering	76.96	11.52	95.39	14.72	75.95	18.79	88.92	23.53
2	Days to maturity	151.52	24.71	181.87	32.15	158.48	24.96	178.51	28.04
3	Plant height (feet)	5.08	0.99	5.85	0.88	5.44	1.01	5.78	0.96
4	Number of balls per plant	95.35	23.64	66.65	20.15	89.80	23.38	70.89	16.63
5	Flower shedding/plant	59.73	14.32	69.88	17.77	60.52	13.31	62.75	15.30
6	Yield (kg/acre)	1229.51	520.90	800.73	304.31	1327.83	635.97	936.63	376.79
		Farmer Crossed (77)				*F_2 (41)*			
1	Days to 50% flowering	75.25	12.94	95.32	12.31	76.94	1057	91.77	19.09
2	Days to maturity	155.52	22.63	188.01	22.63	157.44	25.08	187.65	33.06
3	Plant height (feet)	4.86	0.95	6.23	0.99	4.79	1.07	5.74	0.79
4	Number of balls per plant	98.62	26.93	66.32	16.94	91.67	18.50	71.32	15.34
5	Flower shedding/plant	59.33	17.43	70.46	16.28	59.62	13.70	66.76	17.33
6	Yield (kg/acre)	1198.83	400.32	775.87	219.70	1169.27	401.77	868.00	246.40

We believe that markets without morals only create circulation of short-term goodies which cost the society much more in the long term. Once a society learns to be comfortable with the notion of, 'ends justifying the means', the ability of the society to appreciate the merit of 'means justifying the ends' goes down. Slowly, everybody cuts the corners and opportunism undermines sustainability.

The situation regarding the Bt cotton controversy in India with particular reference to Gujarat, has assumed very different dimensions because of the large-scale dispersal of illegal seeds all over the country. Regulatory agencies were aware of the illegal transportation and did very little, if anything at all. The problem was allowed to become so widespread that no political system could have afforded to annoy such a large farming community benefiting from a technology. There are two historical analogues of this

problem. In the irrigation command area projects in which a large area is supposed to be irrigated through canals drawn from a reservoir, the secondary and tertiary canals always took longer time to be constructed than the primary canal. Farmers in the upper reaches of the primary canal got used to getting water for three seasons of paddy or other such crops whereas the tail enders did not get enough water even for dryland crops. Subsequently, when the secondary and tertiary canals got built for distribution in the lower reaches, the farmers in the upper reaches created political pressure, violated the law and continued to get as much advantage as they could get. The second example also from the irrigation sector is that of setting up lift irrigation cooperatives along the canal by lifting water from the canal. Farmers use pump sets and lift water from canal flowing on gravity principles and start irrigating their holdings through lift canal. Such a practice is illegal and affects the interests of the farmers of the lower reaches adversely who depend upon the water in main canal flowing on gravity basis only. However, in both the cases, politics prevailed over ethics.

Table 4 Characterwise performance of various Bt crop varieties from different sources in comparison to normal cotton

		BT		*Normal*		*BT*		*Normal*	
Sl.	*Character*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
		Other (26)				*Shops (108)*			
1	Days to 50% flowering	78.37	17.04	78.40	9.97	72.00	20.61	85.49	27.59
2	Days to maturity	153.46	26.67	188.25	35.11	155.71	28.99	168.20	25.68
3	Plant height (feet)	4.88	0.98	6.18	0.79	5.62	0.87	5.52	0.89
4	Number of flowers/plant	258.46	95.07	288.12	93.84	206.86	81.62	200.16	85.95
5	Number of balls per plant	93.84	25.23	64.79	17.47	92.17	23.44	71.01	11.15
6	Flower shedding/plant	62.42	11.74	72.37	17.04	55.66	13.45	56.53	13.45
7	Yield (kg/acre)	1117.69	337.92	855.42	290.28	1393.38	562.91	953.98	349.51
		Own (17)				*Distant (206)*			
1	Days to 50% flowering	74.68	13.35	94.66	13.94	78.03	10.50	95.76	11.56
2	Days to maturity	155.29	26.36	176.56	30.64	155.04	21.67	189.86	29.77
3	Plant height (feet)	4.97	1.19	5.75	0.70	4.9	1.00	6.06	0.94
4	Number of flowers/plant	262.05	69.95	254.06	72.55	270.88	87.52	275.27	90.14
5	Number of balls per plant	85.58	20.60	71.87	25.29	95.61	24.25	67.27	19.87
6	Flower shedding/plant	62.75	15.72	66.46	16.90	61.38	15.14	72.47	15.97
7	Yield (kg/acre)	930.59	283.12	780.31	304.33	1209.42	519.36	789.42	281.77

The question in case of Bt cotton is, whether politics facilitated by markets will entirely ignore ethics irrespective of who has violated how much ethics. We contend that to simply ignore ethics in the face of opportunities offered by one single technology is not a very healthy or reasonable position when other alternatives for pest control in cotton or other crops are available such as IPM or herbal pesticides. The ethics of not giving a fair trial to low cost, farmer-innovation based pest management strategies (see Honey Bee database at www.sristi.org) has remained totally out of national and international discourse on Bt cotton.

The very fact that Honey Bee Network has documented thousands of innovations in this regard over last fifteen years has been ignored by those who feel very concerned about morality, justice and fairness in public discourse[8]. Hundreds of examples are available for the last several years at http://www.sristi.org/index.php for the purpose. National Innovation Foundation (NIF) has built a huge database of grassroots innovations and traditional knowledge (www.nifindia.org) which has been ignored by the critics of Bt cotton as steadfastly as by the supporters of the Bt cotton. Of course, both may do it for different reasons. If herbal pesticides or agronomic means of pest control can reduce the costs of the farmers and thereby avoid the need for endangering environmental security, why not? But Department of Biotechnology of the Government of India must be held as much accountable for the mess that we are in, as anybody else responsible for regulating the technology. Such is the case when several hundred farmers have committed suicide in the last few years because they could not pay back the loans taken for growing cotton with the help of chemical pesticide. We wrote to the Chief Ministers of Andhra Pradesh and Karnataka few years ago when large scale suicide deaths were reported. We sent non-chemical pest control innovations to them suggesting a fair trial of these options to help farmers. They did not care to respond. The biotechnology on the other hand, has received tremendously positive response from the same Chief Ministers and Central government officials. Is it the nature of control that corporations exercise, which makes dispensation of influence so much easier for the powers that be? Or is it the genuine advantage that biotechnology offers over other means of achieving the same results in agriculture that warrants such a policy response?

In the absence of empirical trials of chemical pesticide based cotton along side the Bt cotton and the IPM cotton, it will be difficult to make any scientific inference, one way or the other. But the lack of evidence does not deter either the critics or the supporters of Bt technology to make their case. And this to us, is the core of the current tragedy not only in India but all over the world. Ethics will indeed become efficient if the nature of discourse and rules of determining the valid evidence in scientific arguments change.

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Notes

1 Press Release by GEAC from www.poptel.org.uk/panap/latest/gepress.htm.

2 Bt Cotton: Conditional approval, but doubts persist from www.kisanwatch.org/eng/special_reports/feb2002/spr_bt_controversy.htm.

3 Rasi seeds gets nod to conduct Bt Cotton trials from www.kisanwatch.org.

4 Karnataka Bans Monsanto's Bt Cotton Seeds, AgBioIndia 11aug02 from www.mindfully.org/GE/GE4/Karnataka-Bans-Monsanto11aug02.htm.

5 Author's own observation in field.

6 F_1 refers to filial one seeds. That is when two different parent lines (whether pure lines or otherwise) are crossed, the first generation is called F_1. When the same seed is grown again, (and in cross pollinated crop like cotton, has chances of inert breeding with in the population) is called F_2. The same seed when grown in third generation is called F_3 and in fourth generation, F_4.

7 NBRI, NBRI Newsletter, Volume XXX, No. 3, Sept, 2003. The situation becomes more complex when public sector research institutes like National Botanical Research Institute (NBRI), Lucknow, have also licenced the Bt technology to seven companies based on indigenously identified/synthesised Bt gene. These new genes will have to go through the same regulatory process before these become available to farmers.

8 The Honey Bee network is fifteen-year-old network of farmers, scientists, activists, individual volunteers and professionals, etc., who are trying to link creative and innovative farmers across different language, regional and cultural barriers through local language newsletters and other ICT applications, *Shodh Yatras* (walk through the villages) and other means akin to cross pollination by honey bees. The Honey Bee network also ensures that creative people do not remain anonymous and their IPRs on their knowledge are protected. For details visit www.honeybee.org or www.sristi.org.

Appendix one: regulatory reforms in biotechnology

These rules are applicable for manufacture, use, import, export and storage of hazardous microorganisms and genetically engineered organisms or cells and also correspondingly to any substances and products and food stuffs, of which such cells, organisms or tissues hereof form part.

Competent authorities and their functions:

Recombinant DNA Advisory Committee: Responsible to review the developments that take place in the field of biotechnology at national and international levels and recommend safety regulations for India.

Review Committee on Genetic Manipulation: To monitor safety related aspects of ongoing research projects and activities involving genetic engineered organisms/hazardous microorganisms. It also has to lay down the procedures restricting or prohibiting sale importation and use of genetically engineered organisms.

Institutional Biosafety Committee: Will look at the experiments for the purpose of education outside the laboratory areas.

Genetic Engineering Approval Committee: Responsible for approval of large-scale use, release, production and experimental field trials of hazardous microorganisms and recombinants in research and industrial production from the environmental angle.

State Biotechnology Coordination Committee: It is functional at state level wherever necessary. It has the powers to inspect, investigate and take punitive action in case of violations of statutory provisions.

District Level Committee: To monitor the safety regulations in installations engaged in the use of genetically modified organisms/hazardous microorganisms and its applications in the environment.

Various provisions of the guidelines:

- No person can procure and use or sell any hazardous microorganisms of genetically engineered organisms/substances or cells except with the approval of the GEAC.
- Use of the material shall only be allowed in laboratories or inside laboratory area notified by the MoEF under EP Act, 1986.
- GEAC shall give the occupier the directions or take measures concerning the discharge of microorganisms/ genetically engineered organisms/substances or cells.
- Any person operating must obtain the licence issued by the GEAC.
- GEAC may in special cases give approval of deliberate release.
- Any person applying for the approval shall submit information and make examinations or cause examinations to be made to eradicate the case, including examinations and on-site experimentation plan according to specific directions and at specific laboratories.
- Approvals by the GEAC shall be for specific period not exceeding four years at the first instance renewable for two years at a time.
- The approval can be revoked in case:

- of any new information as to the harmful effects of the approved organisms
- if the approved organisms cause damage of environment, nature or health
- non-compliance with conditions stipulated by GEAC.

The supervision will be carried out through GEAC through SBCC and State Pollution Control Board.

In case of immediate intervention by the SBCC or DLC to prevent the damage to nature, environment and health they may take the action without issuing the order on the expense to be incurred by the person responsible for the damage.

It is the responsibility of the DLC to prepare an off-site emergency plan detailing how emergencies relating to a possible major accident at a site will be dealt with and in preparing the plan.

The GEAC may fix fees to cover, in whole or in part, the expenses incurred by the authorities in connection with approvals, examinations, supervisions and control.

Any appeal against the decision of GEAC may be made in 30 days from the date the decision was communicated.

Source: DBT, Government of India, http://dbtindia.nic.in/policy/rules.html.