CHAPTER-7
PROBLEMS AND PROSPECTS OF GM CROPS IN INDIA
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7.1 Problems of GM Crops:

A new technology represents both its positive and negative sides. But it is always better to minimize harmful effects and improve welfare of the technology. Any farmer in the world would continue to grow, save and breed the transgenic and non-transgenic crops that provide benefits to them. The similar situations are being seen in the cultivation of Bt cotton in India. “The political debates in New Delhi have no impact on farmers since they will embrace a technology if it is suitable regardless of the controversy. Farmers will not wait for all regulators to say yes to the product, they will start using it if they find that these products are beneficial to them,” said Dr. Pakki Reddy (International Food Policy Research Institute And Research And Information System For Developing Countries, 2007). He added, “I came from Andhra Pradesh, where we grow vegetables, and marginal farmers only use hybrid tomatoes, and with new varieties coming, we just adopt them. We are very happy with that.”

Genetically-modified foods have the potential to solve many of the world’s hunger and malnutrition problems, and to help, protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides. Yet, there are many challenges ahead for governments, especially in the areas of safety testing, regulation, international policy and food labeling. Many people feel that genetic engineering is the inevitable motive of the future and that we cannot afford to ignore a technology that has such enormous potential benefits. However, we must proceed with caution to avoid causing unintended harm to human health and the environment from this powerful technology (WHO/EURO, 2000).

For understanding the importance of modern genetic modification methods for accelerating the improvement of crop varieties, is better to remember that crossbreeding methods have been generally used in crop improvement for at least a century to transfer new or improved traits from
distantly related plant breeding stock into varieties that are especially useful for crop production. This now well established use of breeding stock from wild plant varieties that in itself, has in the past saved the world in wheat supply from devastating fungal disease, and has been the source of semi-dwarf rice traits that powered the Green Revolution in Asia, and has enabled new highly productive rice varieties to be created by breeders. Now it is useless for efficient food production. It is meant that new technology is not short term process. It takes more than century years to come into existence and provides benefits to the world. It has been found that farmers prefer to test agricultural biotechnology on small part of their land; if works, they will adopt it. Today in India Bt cotton area has increased to 10 million acres (James C., 2007)\(^3\) and this means it is successful technology.

The perceived negative forms and problems of the new technology in India may be grouped in the following categories:

(i) Illegal seeds, illiteracy and lack of awareness of the Bt technology;
(ii) Lack of regulatory system in India;
(iii) Terminator seeds;
(iv) Refuge problems in India;
(v) Lack of Infrastructure;
(vi) Difference in expenditure of private sector and public sector
(vii) Food and human safety problems;
(viii) Problems of safe genetically modified food;
(ix) Religious factor in GM food; and
(x) Problems of labeling of genetically modified crops.

Perceived disadvantages of genetically modified crops may also include exchange of genetic material between the transgenic crop and related plant species and selection for resistance among populations of the target pests as well as other problems related to cultivation of genetically modified crops.
(I) Illegal Seed, Illiteracy and Lack of Awareness of the Biotechnology:

It is found that the high cost of official seed of Bt cotton, low price of Navbharat Bt seeds, illegal seeds and scarcity of the seeds as well as delay of release varieties among cotton growing farmers in different Indian states have led the farmers to increase supply of illegal seeds.

In many countries including India there are delay in releasing varieties, one of the major causes for illegal trade, where some transgenic cotton varieties were reported to be planted illegal before the official release of GM cotton. Jayaraman, K. S. (2004) cites ‘industry sources’ as estimating that more than half of the transgenic cotton in India comes from unapproved varieties. Data from Navbharat seeds indicate that on an all-India basis, about 34 per cent of the cotton seed packets sold are transgenic, of which 9 per cent are legal and 25 per cent stealth. Yet these estimates apply only to packaged and branded stealth seeds, not to loose seeds. The ratio is highest in the North Zone (Punjab, Haryana, and Rajasthan): 107,000 packets of legal transgenic seeds to 1,170,000 illegal packets, together accounting for about a third of cotton acreage. In Maharashtra, Madhya Pradesh and Punjab, in addition to Gujarat where the mixture of Bt varieties has been known to exist since at least two years. Farmers in Guntur (which planted the largest acreage) were willing (on condition of secrecy) to admit that they had procured seed of the Navbharat varieties from Gujarat. Other farmers were not willing to admit the real name and source of their seeds since they were aware that the Navbharat varieties are illegal and their purchase is punishable (S. Suman, and S. Rehman, 2004). Navbharat seeds were being sold at Rs. 100 per bag since they were illegal. A little like selling on the black market, at a lower cost. Cost of seed worked out to Rs. 200 per acre and there would be some savings on pesticide costs (Sahai, Suman 2002). Sonu Jain, relating the story in the Indian Express (Delhi) of 20th April 2002, quoted Patel(illegal Bt grower and dealer in Gujarat) as saying ‘If I live in Gujarat and go to Shimla, I will not die, so the same way these seeds developed in Gujarat will grow’. Patel’s Bt seeds sold at Rs 555 per packet of 500 grams, less than a third the officially approved Mahyco–Monsanto seeds’ price. By June of 2005, it was
found that the range of locally-hybridised transgenic cotton cultivars in Gujarat sold for Rs 250–700 per packet (roughly enough to plant one acre land (Scoones, I. 2003, & Gruere,G. P., Mehta –Bhatt, P. and Singupta, D. 2008)7&8.

In the second generation of illegal seed which is called as F2, because of given the high cost of official seeds and the scarcity of the very effective NB151 (illegal Bt cotton seeds), farmers themselves began breeding new transgenic hybrid varieties. They use Navbharat 151 seeds for the male contribution and a local variety especially well suited to their agronomic conditions as female. From this process, a new Gujarati word has been hybridized, ‘Navbharat variants’. There are uncounted branded and packaged Bt variants in circulation: Luxmi, Kavach, Viraat, Sarathi, Vaman, Agni, Rakshak, Maharakshak, Kranti, the generic Kurnool Bt and simply ‘151’ playing on the original Navbharat 151 variety, among many others. These locally back-crossed hybrids made by farmers were and are sold by local merchants, who sometimes guarantee the seeds, to distinguish them from the many spurious seeds claiming Bt status in the market. To indicate transgenic character semi-covertly, some variants have printed ‘Best Cotton Seed’ on the package. There has been a farmer to farmer transaction of modified and crossed transgenic seeds with no name. “The decision matrix of farmers facing this volatile seed market is complex, as there is great agronomic and cost variation, but farmers in Gujarat have largely naturalized stealth Bt as part of their time-tested decision matrix” (Roy et al., 2007, & Iyengar S. and Lalitha N. 2007)9&10.

Gujarat is not only the top cotton-producing state but also the largest manufacturer of illegal Bt cotton seeds in the country. The cotton bowl of India manufactured 5 million packets of spurious or illegal Bt seeds in 2007. Besides, Gujarat also stands numerousness in sowing spurious cotton seeds in the country. In 2007, total area under illegal Bt cotton seed production stood at 3 million acres of which Gujarat constituted 1.58 million acres, followed by Punjab, Maharashtra and Haryana with 0.42 million, 0.29 million and 0.24 million acres, respectively. Of the total 21.42 million acres under cotton crop cultivation in 2007, Bollgard Bt cotton seeds were grown on 14
million acres and 3.5 million acres witnessed sowing of conventional varieties of cotton (Reporter B. S, 2008, & Srinivas, R. K., 2002)\textsuperscript{11,12}. Another factor, which has helped the sale of spurious seeds, is the confusion related to the large release of approved Bt cotton varieties by the government of India in recent years. In the summer of 2007, there were 135 varieties of Bt cotton hybrids approved by the GEAC. This figure is up from 62 approved varieties in 2006 and 20 in 2005. The new varieties are available for sale in one or more of the six originally approved states of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, and Tamil Nadu, along with three new states of Haryana, Punjab, and Rajasthan (Gruere, G. P., Mehta –Bhatt, P. and Singupta, D. 2008)\textsuperscript{op.cit}.

“Illegal” Bt cotton is occupying almost as much area as occupied by “legal” Bt cotton varieties. With no quality assurance, no after-sale support and no answerability, this malady is bound to hurt all parties. Farmers must be educated of the consequences and must shun the temptation of quick profit and should buy only certified seeds. Clear guidelines for risk assessment and transparent and unbiased testing procedures and approval of GMOs are \textbf{sine qua non} for rational development and utilization of the technology. Unofficial release of transgenics must be prevented. Since GM seeds are costly and the risk taking capacity of the majority small farmers is low, further, in order to curb production and distribution of spurious seed, if the crop fails due to poor quality and genetic infidelity of the seed, the company must compensate the losses incurred by the farmer (National Commission on Farmers, 2005)\textsuperscript{13}. In most Asian countries, where 60-70 percent of the total population of farmers they simultaneously are also the major consumers or end users. A major thrust is needed to build awareness among farmers of this new technology, its safety precautions, and such consequences to build an informed society and to help growers to take informed decisions on GM crops and biotechnology. In largely populated countries, capacity building at the grass roots level is an important. In India, according to Dr. Suman Sahai, at the moment where more than three million hectare of land is used for genetically modified crops, there are no mechanisms in place to label GM food and food products, nor have any awareness programs been conducted to explain the nature of GM foods.
and the need for labelling them. For most consumers, especially rural consumers, GM foods are a black box and unless they are made aware of the nature of GM foods, labelling would be meaningless (Sahai Suman, 2006.)

Another study conducted by Dr. Tom Wahl, Director International Marketing Program for Agricultural Commodities and Trade (IMPACT), Centre Washington State University U.S.A. (with Dr. Jill Mccluskey) in June 2004 to assess the willingness to pay for and the acceptance of two types of GM wheat chapatti among Indian consumers. The two products were assumed to come from the first and second generations of GM crops—the first type provided nutritional private benefits to the consumers (heart healthy) while the second was promoted with regard to the public benefit to consumers (pesticide reduction). The study included in-person surveys of 600 consumers (400 in metro Delhi and 200 in Patna, in the rural state of Bihar) at four grocery stores in each city. Of the sample surveyed, 54 percent of consumers had no knowledge of biotechnology, 5 percent had good knowledge; and 41 percent had some knowledge. Sixty eight percent did not have any opinion on the risks of biotechnology. Eighty-seven percent of the respondents said that they would buy the product if it helped reduce pesticides. In conclusion, Dr. Wahl noted the importance of information on consumer attitudes toward GM food products. As a result, unless these consumers are convinced to the contrary, these crops are likely to be successful in a country like India.

Another study was conducted by Ms. Purvi Mehta-Bhatt, Coordinator, South Asia Biosafety Program, India, provided an overview of some of the challenges faced by the Indian extension system, and emphasized the fact that reaching farmers is an important but difficult task in view of the large and diverse farming population of India (234 million farmers in 638,365 villages) with less than 40 percent literacy rate and low connectivity. The existing extension system in the country is rather weak, with only one extension worker per 2,000 farmers. These factors contribute to a low level of information availability for Indian farmers with the result that the average Indian farmer is less capable of making informed decisions on technology, especially on new technologies like biotechnology. Less-informed farmers and end users, combined with the limitations of communication linkages between labs and land, give rise to the illegal seed trade. Another writer, Dr.
Pakki Reddy, Project Coordinator, Andhra Pradesh-Netherlands Biotechnology Programme (APNLBP), India, said information about Bt cotton is limited. Unfortunately the extension system is rather weak and non-existent. So farmers have to rely on the dealers to get any information. The group of farmers are faced with two issues: i) dependence on government subsidies, though the group is planning to get around that by encouraging contract farming; and ii) a rapidly expanding industry that increasingly appreciates education; for example, processing mill enterprises can benefit from educated farmers. From the farmers’ angle it is important to be competitive, and even if farmers appreciate many of the NGOs, they realize that none represent them well (International Food Policy Research Institute and Research and Information System for Developing Countries, 2007)\(^{1/6}\). A pilot study in the state of Gujarat involving 1000 farmers covered a cross section of farmers across the state representing different economic educational and agro-climate background, gender, age etc. The following observations were made from the study- a) Most respondent ,that is, 97.2 percent regardless of their economic and educational background were interested in knowing about biotechnology but cautious and needed to be personally convinced that use of the technology will be economically beneficial to them. b) 83.6 per cent farmers in the study did not find the present extension system, adequate and capable of handling new technologies. A need to strengthen extension machineries at the grass root level were exhibited (Mehta-Bhatt P., Ebora R. P., Cohen J. I, Zepeda J. F and Zambrano P. 2005)\(^{15}\). Another study on the economics of Bt cotton in the state of Karnataka was conducted during the first year of commercial introduction of Bt cotton in India. It is based on a survey of 100 farmers in the 2002/2003 cropping season that included farmers that had purchased Bt cotton and others who planted conventional, non-transgenic varieties. The survey was carried out in three talukas of Dharwad district (Hubli, Dharwad, Kalghatagi) and one taluka of Belgaum district (Bailhongal) in Karnataka. These areas were chosen to ensure comparability of data, as they are all located in the same agro-ecological zone. Forty-eight per cent of the interviewed farmers received information about Bt cotton from their seed dealers. Company promotion (Mahyco) reached another 18 per cent. Informal
interviews revealed that extension staff often had no knowledge about the new technology (Orphal J., 2005)\textsuperscript{16}.

In Gujarat in collaboration with the Gujarat Institute of Development Research, Ahmedabad undertook a study of selected farmers in Gujarat who had grown Bt during 2002-03 agricultural season. In ten districts of Gujarat, 410 farmers were surveyed for the study. The chosen districts were Kutchch, Sabarkanta, Gandhinagar, Bhavnagar, Rajkot, Bharuch, Vadodara, Surendranagar, Amreli and Narmada which are all traditionally cotton growing areas. The survey was carried out by Jatan volunteers. 39 per cent of the farmers have confirmed that they were informed about the requirement of cultivating non-Bt cotton variety in the Bt cotton field. Only 10 per cent of the farmers reported receiving information regarding the nature of the Bt cotton and its impact on pests. Most importantly, a negligible percentage of farmers have reported awareness regarding the fact that the approved variety has been given conditional approval for three years. The role of diffusion agencies like the approved seed sellers and the extension workers in the private and public sector become very essential. They will have to play an active role in educating the farmers about the salient features of the seed, the nature of planting, requirement of fertilizer, timing of pesticides, etc. Adoption of new technology will be easy only if the farmers have adequate information about the new technology. However, only 11 per cent of the farmers have received information about Bt cultivation practices from the company propaganda, while 54 per cent of the farmers have received information from friends and neighbours. The role of the government agriculture department or the media in providing information about this technology to the farmers has been nil. In spite of this, 81.3 per cent of the approved Bt cotton cultivators have stuck to the refuge schedule perhaps due to the information provided by the neighbour farmers. A negligible percentage of unapproved variety cultivators have also stuck to the refuge criteria. Frequent visits by approved agents or extension workers help the farmers in getting appropriate advise about the new technology and also in ascertaining the actual area under Bt cultivation, stages of pest attack, amount of pesticide used, impact of pollination, etc. out of the 155 responses for this question, 43 per cent have confirmed visits by
some supervisors. But 52 per cent have responded negatively (Iyengar S. and Lalitha N. 2007)\textsuperscript{op.cit.}

The higher price paid for Bt cottonseeds by the farmers is justified by the reduction in pesticide use since the plants themselves guard against bollworms. But this does not mean a total elimination of pesticide sprays. To have maximum yield results from Bt cotton, pesticide sprays should be optimized and targeted to the secondary pests that used to be covered by the wide-range pesticides used before Bt cotton. However, farmers lacking knowledge about the requirements for Bt cotton, followed their own spraying schedules. In a survey of farmers in Maharashtra and Gujarat, Shetty (a writer) in 2004 found that farmers in Guntur and Warrangal districts sprayed cotton 20 to 30 times, when the optimum required was only 15 times. This indiscriminate spraying led to development of resistance in the bollworm and hence pest infestation returned, lowering the yield from Bt cotton in these regions. The survey also revealed that farmers changed pesticide types and doses to combat the development of resistance among bollworms (Gruere,G. P., Mehta –Bhatt, P. and Singupta, D. 2008)\textsuperscript{op.cit.}

Whenever the cotton crop failed in certain areas, be it due to drought or other environmental stress, wilt or other diseases, sucking pests or any other reason, the farmers attribute it to failure of the Bt-technology and blamed the company as well as the government. They did no know the fact that Bt-cotton has been developed specifically to offer protection against bollworms, not against any other adverse factors. It is because of incorrect knowledge which is more dangerous than ignorance. It is the duty and role of DBT (Department of Biotechnology) which stood by this technology organizes several educational seminars on biotechnology in several states in this regard (Manjunath, T. M, 2004)\textsuperscript{17}. The performance of Bt cotton vis-à-vis non transgenic variety is being evaluated by MoEF (Ministry of Environment and Forest) in coordination with Ministry of Agriculture, Department of Biotechnology and state governments. Continuing with its efforts for sensitization and creating awareness about the transgenic crops among various stakeholders i.e. state government officials, research institutions, agricultural universities, seed companies and distributors and farmers, MoEF
organized a series of workshops on “Biosafety issues related transgenic crops”. Several intensive workshops are being organized in various cotton growing places (Verma, D.D, 2004)\textsuperscript{18}. Alarmed by the situation, Mahyco-Monsanto and the government have started taking steps to caution the farmers about the ill-effects of spurious Bt seeds. Mahyco-Monsanto Biotech, a 50:50 joint venture of Monsanto, USA, and Mahyco, have launched anti-illegal seeds awareness campaign to educate farmers. So far, the company has conducted 700 meetings for the purpose and 76,000 farmers in Gujarat have promised to purchase seeds only with pucca bills from the retailers. The government has also conducted raids and educational efforts to highlight the risk of illegal seeds. As a result, the cultivation of spurious seeds has begun to come down. In Gujarat, area under illegal seeds cultivation came down to 1.58 million acres in 2007 from 2.17 million acres in 2006. Nationally, it has declined from 4.33 million acres in 2006 to 3 million acres in 2007 (Reporter B. S, 2008)\textsuperscript{op.cit}.

(II) Lack of Regulatory System in India:

One of the other reasons for spread of illegal seed in India and other countries is lack of regulatory system. Here it is indicated that how the government of India was unaware when Bt cotton produced by Navbharat was being purchased and planted before the seed approved by GEAC (Genetically Engineering Approval Committee). This should be fully endorsed to the lack of monitoring and regulation, which has resulted in farmers indiscriminately crossing of any variety of cottonseed. The impact of such crossing is likely to create disasters in the future (Iyengar S. and Lalitha N. 2007)\textsuperscript{op.cit}.

It was only in 2000 that the RCGM (Review Committee on Genetic Manipulation) recommended to the Genetic Engineering Approval Committee of the Ministry of Environment of India large-scale contained field trials, which entailed seed production for testing. At this point Navbharat transgenic seeds had been in fields for at least one year and were spreading to new acreage, but no regulatory authorities knew it. More field trials under support of the Indian Council for Agricultural Research were planted. In 2001, a second year of field trials was ordered by the GEAC under the supervision of the ICAR.
Before these results could be scrutinized, the Robin Hood seeds appeared in Gujarat, noticeable only because a bollworm rampage had wiped out other varieties. In 2002, field-trial results were submitted to the GEAC, which subsequently, in March 2002, approved three Bt hybrids for commercialization (R. J. Herring, 2007). Illegal seed were being sown in India. In India, the Government could not know that the cotton plants that survived the bollworm infestation of 2001 were transgenic and illegal prior to genetic testing. After knowing, it was declared that Navbharat Company had violated the act of biosafety of India. The exposure of this put the central regulatory authorities in a difficult position. The Ministry ordered the destruction of the illegal crop, but the farmers and the state government argued for compensation. No action regarding this approach was taken by the central government while some inspectors from Delhi visited the place where the illegal seeds were growing and some burning of cotton was done in view of the press. At last, the arrest of Patel the Managing Director of Navbharat Seeds and other issue were pushed aside. After one year by any reason the seed was approved by GEAC (Scoones, I. 2003). It shows lack of regulatory system in India. India faces a huge risk and problems because safety norms on genetically modified crops are not being enforced, says a UN study, adding that it also makes the country vulnerable to bioterrorism attacks. The study’s Melbourne-based lead author Sam Johnston told IANS (Indo-Asian News Service) from Bonn(Germany): “India still has a huge problem of biosafety enforcement. Many farmers are using genetically modified crops without government approval. For example, it was recently reported in The Hindu Business Line that 28 percent of area in Gujarat was planted with illegal GM crops (Bhandari Neena, 2008).” Critics of the Indian Government’s handling of the Bt Cotton evaluations say that the Government has supported serious irregularities and safety violations by Monsanto-Mahyco. They complain that the process lacks transparency and public debate and that the Government has neither the political will nor the technical and infrastructural ability to monitor or regulate this controversial technology (Scoones, I. 2003 and Gruere,G. P., Mehta–Bhatt, P. and Singupta, D. 2008,).
In many countries, such as India, delay in releasing varieties are also one of major causes for illegal trade, where some transgenic cotton varieties were reported to be planted illegally before the official release of GM cotton. This type of illegal trade causes serious regulatory, policy, and trade implications (Jayaraman K.S., 2005)\(^{21}\). And low regulatory capacity is a major factor slowing approval even of products that have already undergone extensive testing, such as Bt-rice in China and transgenic mustard and eggplant in India (Pingali, Prabhu. 2007)\(^{22}\).

But as knowledge, experiences, and exchange of information continue to grow, increased familiarity with GM technologies will enable regulatory agencies to have confidence to reduce requirements, thereby decreasing the approval costs per event. The significant increase in the rate of adoption of the technology by farmers, endorsing farmer’s acceptance of the technology will also play a very important role in facilitating regulatory and political will for future crops (Mehta-Bhatt P., Ebora R. P., Cohen J. I, Zepeda J. F and Zambrano P. 2005)\(^{23}\).

For this, Committee on Agricultural Biotechnology, an authority, steered by an Advisory Committee comprising scientists, representatives of public and private sectors, industry, NGOs and farmers, should combine both advisory and regulatory responsibilities and coordinate and harmonize the various development aspects, including IPR and bioethical and biosafety norms. Farmers in industrialized countries are supported by capital, technology and subsidy. In contrast, Indian farmers, a majority of whom cultivate 1 or 2 hectares or less are handicapped by a very unfavourable cost-risk-return structure in farming. Interest rates are high, drought is frequent and markets are not pro-small farmers. Hence, farmers can take to new technologies like biotechnology only if they are supported by appropriate packages of services and public policies. In a globalised world, we have to enhance our agricultural competitiveness through productivity and quality revolutions. Biotechnology can help, but only if it is pro-poor, pro-women and pro-environment (National Commission on Farmers, 2005)\(^{\text{op.cit}}\).
(III) Terminator Seed:

A farmers’ organization in Karnataka, namely Karnataka Rajya Raitha Sangha (KRRS), uprooted and burnt a few approved experimental crops in 1998 and also in 1999, wrongly accusing that Bt-cotton contained the so-called ‘Terminator Technology’ and the gene would escape and cause ‘Gene pollution’ and sterility in other plants. They also alleged that Bt protein is harmful to humans, farm animals, other beneficial organisms and soil. Obviously they were unaware of the real technology and the highly selective action of the concerned Bt-protein. They threatened the farmers with serious consequences if they planted Bt-cotton. They also held repeated public demonstrations against this technology (Manjunath, T. M., 2004) op.cit. A farmer, Shri Shankarikoppa Mahalingappa, a member of the Karnataka Rajya Raitha Sangha (KRRS) organized the burning of Bt cotton crops on two test plots in Raichur and Bellary districts of Karnataka state, but was unconvinced by its leadership. Shri Mahalingappa had taken away 100 seeds from biosafety trials on his land, that was, he planted them and found germination by 95 of the 100 ‘suicide seeds’. The terminator construction dissolved before the organic empiricism of a farmer concerned about pesticide costs and farm income. Shankarikoppa Mahalingappa concluded that ‘terminator’ talk was ‘just propaganda’. It was against the notion that farmers were duped by corporate propaganda, he said: ‘no one’s word can be taken; you have to see for yourself . . . farmers must be convinced personally that a crop is beneficial; only the farmers can decide’. His perspective is simply practical farm management. Mahalingappa now buys Bollgard MECH-162 and finds it profitable despite high seed cost; he spends less on chemicals and gets higher yields because of reduced bollworm damage. He said ‘Why does he not use the cheaper stealth seeds so popular in Gujarat?’ and a farmer could perceive no threat from the new seeds (Herring R. J., 2007) op.cit.

The Chairman of Mahyco, Monsanto’s Indian business partner, BR Barwale emphasized that the seeds being tested had been approved by the Department of Biotechnology for trials and have ‘nothing to do with the so-called terminator genes’. Monsanto’s marketing director for India argued that the farmers’ suicides had nothing at all to do with Monsanto’s Bt seeds (which
were not even on the market), but ironically might have been prevented by its
technology (Mistry, 1998). With transgenic cotton, he said, farmers would
have had less debt from pesticide purchase and less crop loss to bollworms –
less poverty, fewer suicides. More obviously, since the hybrid transgenics
under testing had been back-crossed into local cultivars, there were at least
six generations of Bt cottons in India at time of the field tests: a clear
indication that no terminator genes were in the cotton (Ghosh, P. K., 2001).
If anti-Bt, pro-farmer organizers were interested, a countervailing discourse
was readily available, and in high profile.

It is clear that the Bt cotton technology are spreading, not terminating in
India, since farmers are finding different ways to obtain illegal and illegal
seeds and to breed transgenic hybrids themselves.

(IV) Refuge Problems in India:

GM seeds entail a specific kind of cropping pattern that is entirely new
to Indian farmers. For example, in the case of Bt cotton, farmers are
supposed to follow resistance management plans, which include a “refuge
strategy,” i.e., planting non-Bt cotton in at least five rows surrounding Bt
cotton, or in 20 percent of the total sown area, whichever is more. To help
farmers implement the refuge strategy, Mahyco-Monsanto sold seed
packages with two packets: a 450-gram packet of Bt cotton and a 120-gram
packet of non-Bt cotton for the refuge. The logic behind this is that when non-
Bt cotton is planted within or around a Bt cotton field, the non-Bt cotton acts
as a “refuge” for Bt-sensitive insects that will breed with Bt-resistant insects,
thereby minimizing or delaying the development of Bt-resistant insects. The
refuge of non-Bt cotton is also supposed to act as a “pollen-sink,” or border,
to prevent out crossing of transgenic Bt cotton pollen. Furthermore, the refuge
strategy is alien to farmers’ age-old agricultural practices. The National Seed
Policy of 2002 in India suggests that packets of transgenic seeds or planting
material be labeled to indicate their transgenic nature and their agronomic
benefits (Kumbamu A., 2006). But with an average literacy rate of 59 percent
in rural areas (as per the 2001 Census), there are real questions as to how
many farmers in India can read the instructions provided on the seed packet.
Because of the inadequacy of public sector agricultural extension services,
the high rates of illiteracy, absence of community awareness programs and campaigns, and insufficient monitoring mechanisms, farmers often depend on middlemen or retail dealers to advise them on what seed variety will give them the greatest financial margin and agronomic benefits.

When asked about the purpose and management of the refuge strategy, farmers in Warangal district expressed widely ranging views. Some farmers thought that the company provided them both Bt and non-Bt cotton seeds just to compare the yields of these two varieties. Many farmers believed that it served as a “wall” to incoming moths and caterpillars. Some rejected the refuge strategy outright, because they believed that mixing Bt cotton with non-Bt cotton would totally damage the crop. Even the agricultural extension service workers those who are supposedly knowledgeable about the new technology and able to demonstrate the farming methods were not clear about the purpose of the refuge strategy. This lack of understanding is particularly important in countries like India where there are no effective crop insurance or compensation policies to protect farmers financially in case of crop failure (Thies, Janice E. and Devare, Medha H., 2007). It can be observed from the table that only 63 per cent of the BT cotton farmers have grown refuge crops. Though good percent of BT farmers have grown refuge in Warangal (84%) and Nalgonda (78%), the farmers in Guntur (27%) and Kurnool (2%) have not cared to grow it. This practice is almost non-existent in Kurnool. The farmers revealed that they have now stopped growing refuge, though they cultivated it in some rows in the first year. They feared losing some portion of their land and further they observed that the bollworm attack is very heavy for the refuge rows, which in turn makes it necessary to spray some chemicals (Dev, S.M. and N.C. Rao, 2007). Lack of awareness about biotechnology and Bt cotton is also one main reason not growing the crops. So far as awareness about biotechnology is concerned, especially transgenics/GMOs, varied from as low as 2 percent to as high as 80 percent in different cotton growing areas. However, the genetic literacy was generally low as most of the Bt cotton farmers grew no refugia (area of refuge) and did not provide recommended isolation distances needed for preventing cross-pollination between Bt and non-Bt strains so as to reduce the chances for the
breakdown of resistance to bollworm in Bt cotton varieties (Tabshnik B., 2005 and National Commission on Farmers, 2005)\textsuperscript{29}. A general misgiving prevails, maybe partly due to aggressive advertisement by seed companies, that the Bt cottons need no pesticide application, forgetting that the Bt provides protection (often not 100 percent) only against bollworms. For controlling other pests, which at times assume serious proportions, such as aphids and white fly, pesticides will need to be applied as per recommendations. The reason for ignoring refuge is that this non-Bt attracts a lot of bollworm and the farmers do not want to risk their Bt crop by exposing them to these bollworms. This only explains that the farmers have not been adequately informed either by the company or by the government officials about the role of the refuge in the cultivation of Bt cotton. Critics such as Suman Sahai have argued that in a country like India where the holdings are small and hardly enough to feed the family on the land that is operated, farmers will have hardly any incentive to provide 20 per cent of the acreage for non-Bt cotton (Iyengar S. and Lalitha N. 2007)\textsuperscript{op.cit}. Implementing such laws require great awareness at the grass roots level, a strong extension network which can carry forward the message, and special attention for monitoring implementation (WHO/EURO, 2000 and FAO, 2005)\textsuperscript{30}.

(V) Lack of Infrastructure:

Scientists, politicians, and the public have also expressed concern about aspects of cloning, genetic testing, and gene prospecting, etc. The sustainable development of biotechnology will require a renewed focus on stakeholders and their needs. This, in turn, demands a clearer understanding of public concerns as well as attention to issues of institutional structure and representation in decision-making processes.

However, the emerging scenario of transgenic crops and GM foods calls for further up-gradation of infrastructure of the institutions, training of manpower in advanced techniques, including analytical detection methods, and strengthening of institutions for addressing issues of environmental risk and food safety. For environmental risk assessment and evaluation of food safety, a series of protocols are to be developed to address specific safety
issues and effect on non-target species including on soil micro-organisms (Verma, D.D., 2004)\textsuperscript{op.cit.}

(VI) Difference in Expenditure of Private and Public Sector:

Investments in transgenics are concentrated largely in the private sector, driven by commercial interests and not necessarily focused on pro-poor traits and crops. Almost all promising technologies for food crops have been developed by the public sector, which has underinvested in R&D generally and in biotechnology specifically. The CGIAR (Consultative Group on International Agricultural Research), arguably the global leader in agricultural research targeting the needs of the poor, spends about 8 percent of its budget, or about $25 million, on biotechnology. Brazil, China, and India have large public biotechnology programs, which together may spend 10 times this amount. But these numbers are still small in comparison to the $1.5 billion spent annually by the four largest private companies (Pehu and Ragasa 2007)\textsuperscript{31}. Any costly revolutionary crop requires more time. The approval process of any genetically modified and other crops takes minimum of 25 years. Therefore, every country does not effort for such work such as, unfortunately GM research in India is not being made to evaluate potential harm to human health and environment. This is because the GEAC (Genetic Engineering Approval Committee) does not want the companies to spend more on research (Bhandari Neena, 2008)\textsuperscript{op.cit.}. Maximum countries face this type of problems. For avoiding the problems, GEAC should emphasize biological risk assessment. GEAC should regulate genetic technology like the US Recombinant Advisory Committee (RCA) does for genetically engineered drugs. RCA makes it mandatory for companies to provide a list of negative and harmful impacts and minimizes that impact before approving for commercial sale. And so long as, private sector is leading in expenditure in any type of development research, the price of that commodity and IPR will be much high. Therefore, the government must think about it.

(VII) Food and Human Safety Problems:

One of the fears about the introduction of GM crops is that they will become invasive, or that GM elements will transfer into wild plants, which will then become an invasive irritant. Some plants do “escape” but they do not
create invasive sub-populations. Most populations of escapees are short lived, although seed may persist for longer in the environment. Some people fear that GM plants might behave as alien invaders, in much the same way as some of the ornamental plants that have escaped from gardens into the wild (Fontes E, M.G, Pires C. S.S., Suji1 E. R. and Panizzi A. R. 2002 and Report of a Royal Society Discussion Meeting, 2003)\textsuperscript{32,33}. The Soil Association, an organization, also believes that GM crops are unsafe and should not be used for food (Azeez G. and Nunan. C., 2008)\textsuperscript{34}. All these concerns are taken into consideration before transgenic crops are commercialized.

There is one question related to livestock. When foods such as maize, soybean etc are genetically modified and the livestock such as cows feed them, they upset them. Research in this regard has only been done on mice and rats. The response is that a research has been carried out at Reading University on ruminants fed GM foodstuffs and there is no trace of transgenic DNA in the meat or the excrement of those animals (Report of a Royal Society Discussion Meeting, 2003)\textsuperscript{op.cit}. However, long-term risks for most conventional foods have never been analyzed. According to the judgment of the Nuffield Council of Bioethics, there is no empirical or theoretical evidence that GM crops pose greater hazards to health than plants resulting from conventional plant breeding (Nuffield Council on Bioethics, 2004)\textsuperscript{35}. Foodstuffs made of genetically modified crops that are currently available (mainly maize, soybean, and oilseed rape) have been judged safe to eat, and the methods used to test them have been deemed appropriate. These conclusions represent the consensus of the scientific evidence surveyed by the International Council for Science (ICSU) and are consistent with the views of the World Health Organization (WHO). However, the lack of evidence of negative effects does not mean that new genetically modified foods are without risk. The possibility of long-term effects from genetically modified plants cannot be excluded and must be examined on a case-by-case basis. New techniques are being developed to address concerns, such as the possibility of the unintended transfer of antibiotic-resistance genes (Hug Kristina, 2008 and Chassy B. M., 2008)\textsuperscript{36,37}. 
Thus, most of scientific experts agree that foods produced through biotechnology are as safe as, or safer than, any other food in the supermarket. Genetically modified crops aren’t new. For thousands of years plant breeders have worked to create genetically modified crop varieties. None of the crops that we eat today resembles its wild ancestor. Most ancestors were poisonous and low-yielding wild plants before early humans domesticated them. Today we can choose among hundreds of varieties of some crops, all so genetically different that they differ in size, shape, and even color. It has been argued that from the available experimental data, currently utilized GM plants appear safe and show no effects on animals or animal products. It has also been stated that risks caused by the use of GM plants appear to be so low that they should be negligible in comparison with their potential benefits (Schwember A. R., 2008). In India, only Bt cotton has been approved by rigorous testing in different government institutes of India. They are considered safe for both human and animals.

**(VIII) Problems of Safe Genetically Modified Food and Animal:**

The safety assessment of GM foods generally includes:

a) Direct health effects (toxicity);

b) Tendencies to provoke allergic reaction (allergenicity);

c) Specific components thought to have nutritional or toxic properties;

d) The stability of the inserted gene;

e) Nutritional effects associated with genetic modification; and

f) Unintended effects which could result from the gene insertion.

A laboratory study shows that pollen from Bt corn caused high mortality rates in monarch butterfly and caterpillars. Monarch caterpillars consume milkweed plants, not corn, but the fear is that if pollen from Bt corn is blown by the wind on milkweed plants in neighboring fields, the caterpillars could eat the pollen and perish. Although, the study was not conducted under natural field conditions. Gene transfer to non-target species, another concern, is that crop plants engineered for herbicide tolerance and weeds will cross-breed, resulting in the transfer of the herbicide resistance genes from the crops into the weeds. These "superweeds" would then be herbicide tolerant as well. Other introduced genes may cross over into non-modified crops planted next
to GM crops (Whitman, D. B., 2000)\(^{39}\). Scientists at the Central Institute of Cotton Research in India, in a study of Bt cotton, found that the amount of cry1Ac protein in Bt cotton varies across different varieties and, in some plants, decreases 110 days after sowing to levels that are inadequate to protect the plants from bollworm attacks. In a separate study, also by scientists at the Central Institute for Cotton Research, it was found that increasing reliance on a single gene in growing a variety of crops to make them resistant to bollworms could be dangerous and could lead to greater resistance among the pest population (Kranthi K. R., Naidu S., Dhawad C. S., Tatwawadi A., Mate K., Patil E., Bharose A. A., Behere G. T., Wadaskar R. M. & Kranthi S., 2005 and Iyengar S. and Lalitha N. 2007)\(^{40}\). An unprecedented number of hybrids of Bt-resistant cotton has been planted in India since 2002. Such simulating the development of insect resistance to Bt cotton predicts that such monoculture could lead to resistance within a few years. The risk of resistance as a consequence of gene monoculture is higher in India where Bt crops are planted illegally than in other countries producing transgenic crops (Jayaraman K.S. 2005)\(^{\text{op.cit.}}\). However, Bt cotton protects the crop only against one pest, cotton is attacked by no less than 165 pests. This raises the chances of a resurgence of secondary pests and farmers end up spraying the same quantity of pesticide (if not more) on their crop as they did earlier. In Andhra Pradesh, the number of attacks by aphids, thrips, jassids, etc, has risen since the introduction of Bt cotton in 2002. Tobacco leaf streak virus, tobacco caterpillars, etc, have emerged as new diseases and pests of Bt cotton in the state. The reports of fungal root rot in Bt cotton are beginning to pour in from Warangal district in Andhra Pradesh. The emergence of the mealy bug as a Bt cotton pest in Punjab also appears to be a case of secondary pest resurgence, and no amount or type of pesticide has been able to control it. Hundreds of farmers in this belt of Punjab and even in neighbouring Pakistan could have never imagined that Bt cotton could be hit by a virus. The white-colour bug, considered deadlier than the American bollworm, is now threatening the cotton crop in Punjab and elsewhere. At least 25 per cent of the crop is already destroyed (Goswami B., 2007)\(^{41}\).
Many children in the US and Europe have developed life-threatening allergies to peanuts and other foods. There is a possibility that introducing a gene into a plant may create a new allergen or cause an allergic reaction in susceptible individuals. A proposal to incorporate a gene from Brazil nuts into soybeans was abandoned because of the fear of causing unexpected allergic reactions (Whitman, D. B. 2000). The main source of worry is the potential for allergic reactions. One example of allergenic concerns arose in the summer of 2000, when traces of StarLink™ corn, a genetically modified crop, were detected in some food products, such as taco shells. StarLink™ was approved for use in animal feed, but not for human consumption. Approval for human consumption was suspended because the Bt Cry9c protein in corn did not disappear as quickly as other Bt proteins in test assays. The unintentional commingling (a mix part) of StarLink™ with corn in the food chain led to concerns about food safety (J. I. Cohen, et. al., 2003). Allergic reactions occur when the immune system interprets something as foreign, different and offensive, and reacts accordingly. All GM foods, by definition, have something foreign and different. And several studies show that they provoke reactions. Rats fed Monsanto’s GM corn, for example, had a significant increase in blood cells related to the immune system. GM potatoes caused the immune system of rats to respond more slowly. And a harmless protein was transformed into a potentially deadly allergen, when produced within GM peas. Although the potatoes and peas were not commercialized, they had passed the superficial tests normally used to approve most GM crops (Genetically Modified Foods, Wan-Ho, 1999 & Sharma D. and Kapoor A., 2004). A controversy has arisen about whether certain genetically modified plants (which are insect resistant because they carry the Bt gene) could harm not only insect pests but also other species such as the monarch butterfly (Greenpeace, 2008). Environmentalists and food security activists in India have renewed calls for a moratorium on genetically modified (GM) foods and crops after rats reportedly secretly tested with GM corn diets by the U.S. agribusiness and biotech giant Monsanto developed blood and organ abnormalities. In the United States itself, the Center for Food Safety has alerted the Environmental Protection Agency on the Monsanto trials and said that the rat study showed "unreasonable adverse effects," and these should
have been drawn to the attention of regulators, because failure to do so was a potentially criminal offence (Devraj R., 2005). Another study published in Bangalore, by the Austrian government identified serious health threats of genetically engineered (GE) crops. In one of the very few long-term feeding studies ever conducted with GE crops, the fertility of mice fed with GE maize was found to be severely impaired, with fewer offspring being produced than by mice fed on natural crops. Considering the severity of the potential threat to human health and reproduction, Greenpeace is demanding a recall of all GE food and crops from the market, worldwide (Ramadoss, 2008).

In the field, no significant adverse effects on non-target species have so far been observed. Nonetheless, continued monitoring for such effects is needed and food security is an enduring issue. Without an effective biosafety regime and with increasing use of genetically-modified crops in many developing countries, future trade bans and disruptions are inevitable (Bhandari Neena, 2008). Therefore, test of genetically modified crops should be rigorous and large.

The UNFAO evaluated a large body of scientific literature on transgenic crops and found no evidence of any danger to human health from food plants currently being grown. However, they note that multiple-gene events under development warrant further study. The Nuffield Council Report (2004) concludes from a survey of existing literature “there is no empirical or theoretical evidence that GM crops pose greater hazards to health than plants resulting from conventional plant breeding.” Perceptions of food safety and environmental risks have slowed release, even though the scientific community widely agrees that the transgenics currently available are as safe as conventional varieties. And scientific evidence to date does not support environmental harm, such as gene flow to weed species, from commercial cultivation of transgenic crops. Despite a good track record, environmental risks and benefits need to be evaluated case-by-case, comparing the potential risks with currently used technologies and taking into account the specific trait, crop, and agro-ecological context (Food & Agriculture Organization 2004, WHO and Pingali, Prabhu. 2007). A study of two years of farm-level trials in China by Jikun Huang and colleagues in April 2005 in the journal...
Science taking 69 randomly chosen farm-holders and 397 rice production plots, and included farmers who chose to adopt new insect resistant GM varieties and farmers from the same villages who chose not to adopt GM rice. Farmers were allowed to use pesticide as they saw fit after making their own periodic observations on the severity of pest-infestation, and were not directly supervised by technical specialists. About 5 percent of farmers reported pesticide related illness after pesticide spraying on non-GM plots. No farmers in the study reported experiencing illness after spraying of a GM-rice crop. These results clearly show GM rice does substantially improve both environmental stewardship and farmers’ health in China. Thus, animal feeds frequently contain genetically modified crops and enzymes derived from genetically modified micro-organisms. The European Commission’s Scientific Advisory Board, the Joint Research Centre, was commissioned by MEPs in November 2006 to scrutinize the controversial topic. It conducted an extensive review of the existing evidence on the short and long-term effects of GM food, which included meeting 22 experts involved in its assessment and evaluation. The study has now concluded that “no demonstration of any health effects of GM food products submitted to the regulatory process has been reported so far” (CheckBiotech.com, 2008)\textsuperscript{51}. It was also observed that 27 and 18 per cent of the approved and unapproved cultivators have been using the residual of cotton as cattle feed and thus the Bt cotton has entered the human chain. Farmers have not observed any adverse impact on health (Iyengar S. and Lalitha N. 2007)\textsuperscript{op.cit}. There is general agreement that both modified DNA and proteins are rapidly broken down in the digestive system. To date no negative effects on animals have been reported. It is extremely unlikely that genes may transfer from plants to disease-causing bacteria through the food chain. Nevertheless, scientists advise that genes which determine resistance to antibiotics that are critical for treating humans should not be used in genetically modified plants.

A concern is that genes in transgenic crops may accidentally escape to other organisms, and for example, move from plants back to bacteria and thus cause harm. This is inconsistent with one another, if movement of genes from a plant to a bacterium does in fact occur in nature, as the people who worry
about adverse consequences of gene escape suppose, then some gene flow must occur naturally between species. It, thus, logically follows that inserting a gene in a new species is a process that occurred repeatedly in nature prior to the time when biologists started of deliberate genetic engineering in the laboratory. Gene movement occurs in nature between many different organisms, by many different mechanisms, and at very different frequencies. The gene exchange process, most humans are familiar with, that is conventional sexual procreation and not the only way genes move in nature. A conventional mating process is found with mammals and cross-pollinating plants, of course, generally occur in every generation, while less well known mating processes, between bacteria, or between bacteria and plants, may occur less often than one in ten-thousand generations, and other classes of genes movement between, from plants to bacteria, or humans to bacteria, or movement carried out by viruses, for instance can be much less frequent and are still be theoretically possible (Tribe, D)\textsuperscript{52}.

(IX) Religious Factor in GM Food:

Human emotions, moral judgments of value, and dietary laws handed down by religious tradition, rest on a different set of assumptions and rules to scientific assessment of nutrition and ecological impact, and it is quite likely that humans have innate psychological and emotional drives that make them very suspicious of any unusual features of a food. Such customs and convictions are obviously very important influences affecting opinions about foods.

But objections for genetically modified crops may not be new. At the turn of the 19th century, people objected to the creation by plant breeders of new fruits such as nectarines and boysenberries on the grounds that the creation of new species was God's work, not Man's. For about two hundred years or so the tomato did not gain acceptance as a food in Europe when it was first introduced because of suspicions about its red colour (Tribe, D)\textsuperscript{op.cit.} Religious dietary rules and other deeply held human instincts. Consider the question 'If I introduce a pig gene into chickens, and eat the meat of the modified chickens, am I eating pork which represents a common concern of this type. Genetic knowledge can help refine the question by telling us that it
is not the mere fact that the gene comes from a pig that makes it necessarily distinctive, because when one focuses on individual genes, a substantial part of the DNA from a pig is essentially the same as that of the chicken.

Religious groups, such as Jewish, Seventh-Day Adventists, and Buddhists want the labels to identify any product with remote traces of products that violates their religious beliefs. For example, religious vegetarians such as the Seventh-Day Adventists and Buddhists want to "avoid fruits and vegetables with insect, animal or humans genes in them" (Epstein, 1996). The Buddhists and Adventists doctrinal beliefs oppose genetic alterations on the grounds they are unholy and unhealthy, are founded in the writings of Ellen G. White, the Holy Bible, Sutras, Dhama pada, and Tao. Similarly, Jewish groups want labels on any food with non-kosher ingredients.

(X) Problems of Labeling of Genetically Modified Crops:

Two broad regulatory approaches for labelling of GM food exist: a) Voluntary labeling — which is driven largely by market forces, with no legislative requirements to declare the use of GMOs in food production; and b) Mandatory labeling — which requires declaration of characteristics imparted to a food by the use of gene technology (be they health-and-safety and/or process-related), or use of gene technology itself in food production. But there is no any labeling approach applied as standard in international level. In 1999, a molecular biologist and cancer researcher, Dr John Fagan advocated for labels on all GM foods and said "without labeling it will be very difficult for scientists to trace the source of new illness caused by genetically engineered food". In October 1999, a Philippine consumer group requested the government impose a label on GM products. Francis de la Cruz, of the Citizens Alliance for Consumer Protection Group claimed "if we cannot prevent the entry of GMOs...let us be given information to exercise our choice" (World Health Organization ,2005). Even United States do not have GM food labeling. Although labels can be useful, they rarely provide sufficient information to be truly informative. Additionally, there are no international labeling standards for GM foods despite efforts through the UN’s Food Standard Codex Alimentarius. This reflects a division over the need for
labeling in the first place. The risks associated from eating approved GM foods appears to be low, especially compared with other food safety issues such as food poisoning, but so far no worldwide consensus has emerged regarding the health and safety of all GM crops. It is claimed that Americans have eaten GM foods for years with no ill effects. But these foods are unlabeled in the US and no one has monitored the consequences. With other novel foods like trans fats, it has taken decades to realize that they have caused millions of premature deaths (Addison K., 2008). Therefore, labeling process of genetically modified crops should be adopted.

Social factors may appear to play a role in the rejection of GM food. One such factor is the issue of control over this technology. This lack of control is largely expressed as fears over consumption of GM crops without permission. For example, one might fear non-GM food contamination by GM foods, or fear food contamination by non-food GM crops or unapproved GM food. At the heart of this fear is the frustration of being unable to independently verify the source of the food, in other words losing control over knowing what one eats. This fear may be addressed through labeling if it is available and as long as post-market testing occurs. When scientists are asked to consider the longer term environmental and health consequences of this technology fewer answers exist because our experience is limited (Morin X. K. 2008). Therefore, all biotech products, especially those derived from GMOs, should be labelled. The precautionary principle should guide our policy. Village Knowledge Centres, along with other information and communication channels, can play an important role in this regard. As long as the individual autonomy of consumers and farmers is protected through adequate labeling and different strategies, and a real choice provided for all parties, the potential benefits of GM crop technology can be made accessible to those who wish to avail them (Elizabeth D. K. and Lesser W., 2006 & Hug Kristina, 2008).
7.2 Role of Public and Private Sectors in Green and Gene Revolutions:

During the Green Revolution of the 1960s and 1970s, governments in the developing world did not feel compelled to provide private companies or private plant breeders with exclusive intellectual property rights to the sale or use of new crop technologies. The new high yielding crop varieties then being offered to developing-country farmers had been developed by breeders working for philanthropic or public research institutions. The new seeds were not developed and sold by private companies, instead they were given away through international assistance programs, distributed by non-profit NGOs, or sold at subsidized prices by government corporations. So far as the GM crop revolution is concerned, it is private companies that have taken the lead. When public funding for international agricultural research faltered in the 1980s, the initiative in developing most new GM crops fell to private seed and bio-technology companies (Paarlberg, R. L., 2000). These companies do not normally behave like public sector extension services. To recover their expensive private investments in the development of GM seeds, they seek exclusive rights to sell or to license the sale of those seeds to farmers.

During the Green Revolution, the new HYV seeds and accompanying chemicals were more expensive than the landrace seeds that developing world farmers typically had used. Therefore, loan systems and cost reduction programs were established regionally in which farmers’ eventual profits from increased production could be used to reimburse lenders. In many settings, these programs proved to be no longer necessary several years after their successful adoption. Current R&D costs for genetically modified seeds are even higher than the R&D costs for the Green Revolution’s HYV seeds. At the price that U.S. farmers currently pay, GM seeds would be unaffordable to most developing world farmers. Cost reduction programs and loan systems similar to those that were established during the Green Revolution must also be established for the Gene Revolution, however, establishing such systems is more difficult now because of higher costs and because the seeds are produced by the biotech industry rather than by agricultural scientists in the public sector (Chopra, P and Kamma, A).
The permission of exchange of knowledge and regulation strategies of particular technology among different countries at free cost or bearable fee is crucial to the cooperation of the many stakeholders that are affected by GM crops and also for the sustainability of the GM crop movement in the foreseeable future. A generation ago, the regulatory environment surrounding the Green Revolution was extremely permissive. Scientists could move freely among nations to help breed and plant HYV crops, and there was no stigma attached to eating foods developed from these crops. Today, however, the regulatory world is divided between those nations that permit GM crops to move freely through their food system (e.g., the United States, Canada, China, and Argentina) and those (primarily the EU) that have strict regulations regarding GM crops in their food systems (Chopra, P and Kamma, A)\textsuperscript{op.cit}. There are many possible reasons for the disparity in regulations—differing consumer attitudes, trade issues, and differences in regulatory philosophy among them. Dr. Visvananthan (International Food Policy Research Institute and Research and Information System for Developing Countries, 2007) talked about how biotechnology helps reinvent democracy in India. He said that the Green Revolution was based on ideological beliefs and was expert driven; nobody asked the experts about the specific issues. In contrast, the arrival of agricultural biotechnology created a new democracy in India. Moreover, he noted that there is no centralized power in India, but rather fragmented power distribution. The state has reinvented itself, to use things like control-testing protocol.

In addition, other problem, now, is financial and ideological support taken from other countries. Policy makers in certain African nations have decided that they can not afford to permit GM crop planting, even if it is beneficial to their growers and consumers because they are suspicious of losing financial aid from the EU if they are found as taking a pro-GM crop stance (Chopra, P and Kamma, A)\textsuperscript{op.cit} To avoid the problems, the policymakers worldwide must ensure that risk assessments of GM crops should be conducted to address the specific concerns of their (developing countries) regions. In assessing risks, policymakers in developing nations must also consider all factors including types of native and agricultural plants.
that may be affected by the presence of GM crops, traditional farming practices and the desired traits of GM crops that may be planted in their regions in the near term and long term to get maximum profit from new technology.

7.3 Prospects of GM Crops (Bt Cotton) in India:

The loss observed in cultivation of Bt cotton is largely due to the lack of adequate Bt varieties (particularly for rainfed conditions under drought), the lower quality of cotton with some of these varieties, the high price of seeds, and the improper use of the technology associated with the limited knowledge of the technology among cotton growers (for example, use of the wrong variety, improper pesticide use, and the perception of Bt as a “silver bullet”). In other words, the technology, represented by the Bt trait, should not be blamed, instead, the conditions in which it was introduced, sold, and used causes some of the observed losses in specific regions of India (Naik, G., Qaim M., and Zilberman D., 2005). Whenever the cotton crop failed in certain areas, be it due to drought or other environmental stress, wilt or other diseases, sucking pests or any other reason, the farmers mischievously attributed it to failure of the Bt-technology and blamed the company as well as the government. They ignore the fact that Bt-cotton has been developed specifically to offer protection against bollworms, not against any other adverse factors. Their action and statements receive prominent coverage in the print and electronic media and creates a lot of doubt and confusion in the minds of innocent farmers and public.

The Bt controversy began with a nationalist (and Gandhian) theme of resisting foreign threats to India. Attacks on Monsanto continue, but Bt technology itself has been naturalized. Leader of the farmer organisation Khedut Samaj in Gujarat, Bipin Desai, charged that the ‘failing’ – and foreign – Bt technology has been approved by the government, but the successful home-grown Bt variety (Navbharat 151), has not. Vice President of the organisation, Labshankar Upadhyay, added, ‘The BJP talked about Swadeshi (self-reliance). But it promotes a foreign company at the cost of an Indian firm. And we (farmers) stand to lose’ (Herring, R. J., 2007).
Better performance of Bt cotton could be assessed by acts of farmers and political leaders. In 2001, GEAC has ordered to destroy Navbharat seeds planted by Gujarat farmers but later it was announced by the Union Minister for Texiles, Kashiram Rana immediately after meeting with the Chief Minister of Gujarat that Gujarat would do nothing with the ordered issued by GEAC. He reasoned that since the Bt seeds reduced pesticide use and were favoured by farmers, opposition must be coming from the pesticide lobby. Likewise, the government of the neighbouring state, Maharashtra, was actively pressing for immediate approval of transgenic cotton; Maharashtra is the geographic base of the Shetkari Sanghatana. The Maharashtra Minister of Agriculture Rohidas Patil announced on 11th December 2001 in the State Legislative Council that the state Stealth Seeds 133 would make Bt cotton seeds available to farmers from 1st January onwards – three months before the Genetic Engineering Approval Committee (GEAC) in Delhi approved the technology. On (Threat by not approval of Bt cotton ) 25th March 2002, farmer representatives led by Sharad Joshi – a member of the Kisan (agriculturalist) Coordination Committee (KCC) – threatened to launch a civil-disobedience movement if Bt cotton were not approved by Delhi(Herring, R. J. 2007)op.cit KCC representatives from cotton-growing states across India – Gujarat, Maharashtra, Punjab and Andhra Pradesh – rallied for immediate approval, and threatened to cultivate transgenic varieties whether or not the government approved. The following day, 26th March, the GEAC approved three varieties of the Mahyco–Monsanto Bt cotton, making India the 16th nation in the world to certify a genetically engineered plant for commercialization, albeit provisionally and in the face of fierce opposition.

Indian farmers are experimenting widely with Bt cottons, both official and unofficial, both categories are multiplying rapidly. Neither duped nor passive puppets of multinational monopolists, cotton farmers continue the endless struggle of agriculture against insects, with a new tool. Their techniques continue traditions of seed saving, seed exchange, and seed experimentation (Gupta and Chandak, 2005 and Roy et al., 2007)60

Thus, awareness on biotechnology and genetic literacy should be enhanced. While the private sector is active in popularising its products, the
public sector is not doing enough to disseminate integrated information on various aspects of biotechnology. This gap should be bridged and the public sector should give high priority to increase the awareness of all stakeholders - farmers, private sector, extension agents, consumers, civil society and NGOs so that only science-based true information reaches all concerned, confusions are avoided and most importantly, informed and well-considered decisions are taken at various levels.

All biotech products, especially those derived from GMOs, should be labeled. The precautionary principle should guide our policy. Village Knowledge Centres, along with other information and communication channels, can play an important role in this regard. “Illegal” Bt cotton is occupying almost as much area as occupied by “legal” Bt cotton varieties. With no quality assurance, no after-sale support and no answerability, this malady is bound to hurt all parties. Farmers must be educated of the consequences and must avoid the temptation of quick profit and should buy only certified seed. Clear guidelines for risk assessment and transparent and unbiased testing procedures and approval of GMOs are beneficial for rational development and utilization of the technology. Unofficial release of transgenics must be prevented.

Due to a sort of monopoly, the hybrid Bt cotton varieties seed are priced highly, and are generally out of reach of resource poor farmers. The public sector must come up with competitive Bt cotton hybrids so as to lower the seed cost and benefit resource poor farmers. Further, non-hybrid Bt cotton varieties should be developed not only to further reduce seed prices, but also to enable the farmer to retain his own seed and to share it with other farmers. The Farmers’ Rights Provisions of the Protection of Plant Varieties and Farmers’ Rights Act (2001) should be enforced without further delay.

The extension system and Central-State linkages have generally been indifferent to biotechnology-led agricultural development. Extension personnel, particularly in those areas where commercialization of biotech products, especially transgenics, is being promoted, should be adequately trained. In Krishi Vigyan Kendras, a section on training in biotechnology
should be introduced to ensure safe and effective transfer of the technologies products.

In congruence with CBD (Convention on Biological Diversity), Gene Treaty, National Plant Variety Act, Farmers’ Rights, the proposed Seed Bill and the Food Safely Bill, the Biotechnology Policy must seek harmonization of the concerned standards and guidelines and codex alimentarius provisions. Farmer friendly IPR provisions and trade and legal literacy should be promoted. Efforts to patent the rice genome and other such moves should be resisted.

Since GM seeds are costly and the risk taking capacity of the majority of small farmers is low, insurance should be introduced along with GM seed sale. Further, in order to curb production and distribution of spurious seed, if the crop fails due to poor quality and genetic infidelity of the seed, the company must compensate the losses incurred by the farmer.

Technology needs extra cares to understand the details of the developments vis-à-vis the public participation and awareness. The currently on-going pros and cons are fueled by large knowledge gap between the biotechnologist and ordinary people. The scientist should translate their knowledge into languages that ordinary people could grasp. The method of publicizing the information on GMO product in order to giving the public’s right to choose as well as to get their judgment on the consumption of GMO products is essential. Products arising from modern biotechnology provide new opportunities to achieve sustainable productivity gains in agriculture. Concerns over their possible environmental and health implications stimulated regulatory mechanisms for agricultural food safety and environmental risk assessment. Building a legal and public participatory system and making it operational is complicated by the fact that there is no single best approach or standard that reflects national environmental, cultural, political, financial, and scientific heterogeneity. Policymakers in the developing world must set regulatory standards that take into consideration the risks as well as the benefits of foods derived from GM crops.

There is a need for larger investments in research in the public sector. Numerous studies have shown the importance of public sector R&D to
agricultural advancements, including the advancements of the Green Revolution. During the Green Revolution, partly because the R&D and its products were almost entirely in the public domain, intellectual property (IP) issues were not a barrier to scientists, for example, taking seeds from one region of the world, hybridizing them with seeds from another region, and producing new seeds to benefit yet another region. Today, however, the production and distribution of GM crops are largely within the domain of the biotech industry, and IP issues are central to the development of GM seed. While IP laws protect the rights of GM seed creators in industry, those laws are currently an impediment to disseminating the necessary knowledge and technology to those parts of the world that need them. Therefore, public sector research is essential if the GM movement is to assume revolutionary proportions. Partnerships between the public and private sectors can result in the more efficient production of GM crops that are useful to the developing world and expand the accessibility of those crops and their associated technologies to developing world farmers.

Prof. Swaminathan (National Commission on Farmers, 2005) stressed that a balanced approach to harness the positive aspects of biotech and to minimize the negative effects should be adopted. He pointed out that the policy framework should adequately address the issues of priorities, biosafety and regulatory aspects and urged the farmers’ leaders and the farmer achievers to put forth their experiences and views towards finalization of the National Biotechnology Policy which may most effectively serve the farming community and the nation. Above all, our agricultural biotechnology policy and strategy should be pro-poor and pro-environment.

Since biotechnology can serve as an important tool for facilitating agriculture in a country like India, and because there is a need to prepare the system for the safe and sustainable uptake of future biotechnology crops, the following suggestions should be adopted:

I) strengthen investment in capacity building; including monitoring and having the scientific communities reach out to farmers;

II) Make technology development and spreading a parallel effort; and
III) Encourage public–private partnerships so as to extend the benefits of agricultural biotechnology to farmers. There is a need for better linkages between what is being developed in the laboratory and its applications to the farmers.

The advantages of biotechnology can be optimized only when the farmers, the end-users of agricultural biotechnology, are able to make informed decisions. ‘Illegal proliferation of GM varieties must cease otherwise bio-safety regulation will become meaningless’. Because illegal trade of the Bt cotton may cause serious regulatory, policy, and trade implications in India.
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