The Cotton Controversy

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Abstract

Bt Cotton has been one of the widely adopted and effective transgenic crops grown worldwide. Bt cotton holds great potential for India, but so far extreme environmental groups and inefficient regulation have stopped the introduction of Bt cotton. The All India Biotechnology Association's Report on the Indian Biotechnology bravely sets forward the flaws of biotechnology regulation in India and is an essential read for anyone involved or interested in the Bt cotton debate. The environmental concerns regarding not only Bt cotton but also biotechnology do deserve consideration. Bt cotton has been shown to have some manageable affects on the environment. A risk / benefit approach to biotechnology is preferable. If the risks of Bt cotton can be managed and the benefits are significant, farmers should be able use to this crop. The economic benefits should be the sole concern of farmers, not the state. This paper is written with the viewpoint that Indian farmers are capable of learning to use new technologies and should be allowed to modernize and prosper. The approval process for Bt cotton has been shrouded by mystery and created great controversy. The recommendations by the AIBA in regards to biotechnology regulation are substantiated by what has happened with Bt cotton. If reforms are implemented, a greater emphasis can be placed on the liability of companies introducing biotechnology products.

The first annual meeting of the "Stop Mules" campaign will be held at 8:42 at the house of Dr. V Scammathon, a certified "natural animal" breeder. The program presented will be "How mules will destroy the genetic diversity of horses and donkeys." The forced breeding of horses and donkeys by evil corporations (E Cs) will certainly bring an end to rich variety of species of horses and donkeys. The evil corporations will gradually gain control over all horses and donkeys to breed mules, leaving poor farmers in a situation where they have no choice but to purchase mules from the E C. All benefits from the mules will go to the E C, and poor farmers will be more destitute than ever. This must be stopped! All those who believe in "natural animal" breeding are encouraged to come out and stand up for the rights of poor farmers everywhere.

Fortunately, the "Stop Mules" campaign failed after the first annual meeting. The staunchest supporters of this campaign seem to have moved on to campaign against Bt cotton in India. Bt stands for bacillus thuringiensis, a bacterium that occurs naturally in the soil and produces a protein toxic to Lepidoptern insect pests. Lepidoptern insect pests include some of the worst cotton pests. Through

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biotechnology, scientists have inserted a gene found in Bt into cotton genes. Bt cotton naturally produces a protein toxic to some cotton pests.[2] With much controversy, Bt cotton has been widely adopted in different countries worldwide. In 2000 Bt cotton was the seventh most widely grown transgenic crop in the world making up 3% of the total transgenic crops and was grown on 1.5 million hectares. Other crops, including corn and potato, have also been genetically engineered to produce Bt toxins. All crops producing Bt toxins make up 27% of the total transgenic crops grown by covering 11.5 million hectares.[3]

Logic has been defied as Bt cotton has moved through the complicated machinery of approval of transgenic crops in India. Bureaucrats, environmentalists, and industrialists have debated the dangers of Bt cotton while those most affected have been left to battle the elements. The Indian Bt cotton story tells of the irrationality of unfree environmental organizations and of the complicated committee / permit / license maze of approval for transgenic crops in India. The appropriate role of government in biotechnology regulation is highly contested. The experience of India with Bt cotton sheds light on this controversial issue and can give direction for future policy.

Technology rarely doesn't have some kind of adverse impact, yet people continue innovating and accepting the new challenges that come with new freedoms. The environmental groups fighting BT cotton most likely sit in an office in Delhi cooled by an air conditioner that spews some kind of harmful matter into the atmosphere. If society abandoned all technologies that involved some kind of risk, everyone would have to move to the forest and survive off the nuts and berries. Nevertheless, society must be responsible for the technologies that it develops.

A sad situation

Hardship and inefficiencies characterize cotton farming in India. India has the largest area of cotton grown in the world but is only the third largest producer in the world, after China and the United States of America. Cotton is grown largely throughout India, except in the eastern region. The yield of cotton in India is significantly less than the world average. Yields of 943 kg / ha in China, 769 kg / ha in the USA, and 552 kg / ha in Pakistan overshadow India's average yield of 321 kg / ha. Textiles are very important to India's economy and account for 30 percent of India's total export volume. 58% of the insecticides used in India are used for cotton. 60% of the insecticides used on cotton are to control the “bollworm complex,” which happens to be the major group of insects controlled by Bt.[4]

Cotton crop failures have added to the misery of farmers in India. Major insect pests have constantly developed resistance to pesticides due to indiscriminate use. Farmers have been known to use a mix of several pesticides, referred to as a

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[2] Ghosh P K "Genetically Modified Crops in India With Special Reference to Cotton," Silver Jubilee Lecture Series, Indian Society for Cotton Improvement, June 23 2000

[3] "Bio-Stats," *RIS Biotechnology and Development Review*, Vol. 3 No. 2, 2000 December

[4] Choudhary B and Laroia G, "Technological developments and cotton production in India and China," *Current Science*, Vol 80 No 9, pp. 925-927

"pesticide cocktail" and spray up to thirty times per season. Yearly it is estimated that 344 million dollars are spent on cotton pesticides. Bollworm (the target pest of Bt) control is estimated to cost farmers 235 million dollars yearly. In 1998, 500 cotton farmers were officially reported to have committed suicide due to crop failures and high debt.[5]

Cotton farmers in India do need more technology and innovative techniques to improve their situation, whether "modern" or "traditional." Bt cotton could improve cotton farming, but is not the only "answer." A recent "Cotton Technology Mission" has been launched by the Ministry of Textile to improve research and production of cotton (among other objectives) to the tune of Rs. 593 crore. Interestingly, 78% of the fund is earmarked for the spread of technology that has yet to be developed.[6] If cotton farmers are to prosper, they must be allowed to choose among new technologies and innovations. No matter how "ignorant" or "illiterate" a farmer may be, he still deserves the opportunity to improve his operations.

Bt cotton in India

The Maharastra Hybrid Seeds Company (Mahyco) imported Bt cottonseeds into India in 1996. The seeds were imported from Monsanto Enterprise, which own a 26% share in Mahyco. After being crossed with Indian cotton varieties, Mahyco conducted greenhouse and small-scale field trials on the newly developed varieties through 1999. In 2000, the first large-scale field trials were approved two months after planting time. In 2001, Mahyco was instructed to undertake one more year of large-scale field trials before commercialization of Bt cotton could be considered.[7]

The public sector has also been developing Bt cotton since as early as 1994. A project funded by the Department of Biotechnology (Ministry of Science and Technology), based in the National Botanical Research Institute ended in 1998 with no Bt cotton variety. Five crore are estimated to be spent on this project, in comparison to the two crore offered by Monsanto to Indian Council of Agricultural Research in the mid 1990's for this technology. Two Bt cotton varieties were developed at the Central Institute of Cotton Research at Nagpur, without the knowledge of the Department of Biotechnology, which is embodied with legal powers to cover such developments.[8] These varieties developed at the CICR were not developed further due to agronomic problems. Currently, the public sector has two projects to develop Bt cotton. One project is funded by the National Agriculture Technology Fund (World Bank) and the research is being conducted by the ICAR. Another project using "slightly different" Bt technology is being conducted at the University of Delhi, South Campus.[9]

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[5] Sharma D, "The Introduction of Transgenic Cotton in India," *Biotechnology and Development Monitor Journal*, March 31 2001
[6] See footnote 4
[7] See footnote 5
[8] See Footnote 4, page 928
[9] Kumar A As per communication. ICAR

The results of the Bt cotton field trials have not been fully made public, despite protest by environmental NGOs. Mahyco could make this data public, but has strangely remained removed from the debate. However, the results of the trials have been reported to be positive, both by agronomic and environmental measures. The field trials have shown that Bt cotton provides control for the main caterpillar pests: the American Bollworm, the Spiny Bollworm, the Spotted Bollworm, and the Pink Bollworm. Chemical sprays were less used, decreasing to 0-2 times from 9-12 times. Bt cotton was also shown to not be compatible to out-cross with any related plants in the Indian environment. Overall Bt cotton was reported to have no significantly different risks for the environment as compared to non-Bt cotton.[10]

Regulatory confusion

Any organization / company that wishes to develop a transgenic crop must first form an Institutional Biosafety Committee. The IBSC has a Department of Biotechnology Representative and can approve low risk contained research and must report to the Review Committee on Genetic Manipulation. The RCGM approves all small-scale trials of transgenic crops and power to monitor the trials. Recently, a Monitoring-cum-Evaluation Committee has been appointed by the RCGM to visit and evaluate standards at trial sites. The State Biotechnology Coordination Committee and the District Level Committee also have roles in monitoring transgenic crops at the corresponding levels. The Genetic Engineering Approval Committee is the ultimate authority that decides whether or not a transgenic crop can be commercialized or if large scale field trials can be conducted (over 20 acres).[11]

The GOI is often criticized for the arbitrary and confusing process of GMO approval, which shouldn't be a surprise as the inefficiency of bureaucracy is no great secret. The All India Biotechnology Association (AIBA) released a damning report in November of 2000 blaming the complicated bureaucratic process for the failure of India to adopt GMOs. Their report bravely covered all the inadequacies of GMO regulation. Six reasons were listed for this failure:

1. Testing and Approval Has A Poor Track Record
2. Private And Public Sectors Conflicts Blocks The Former At The Entry Point
3. Mission Overlap: Regulators Are Competitors
4. Large public sector funding disfavors private investment
5. Prioritization by R&D in public sector is unresponsive to Market needs
6. Sub-critical resource allocation from Lack of focus.[12]

The AIBA report critically clarified the problems of biotechnology regulation. The progress or lack of progress for BT cotton substantiates some of these claims. Two committees have made the majority of the decisions regarding BT cotton approval,

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[10] See footnote 2

[11] Ghosh, P K "Evaluation of the Transgenic Organisms: An Overview of Rules and Procedures in India," *RIS Biotechnology and Development Review*, Vol. 3 No. 2, December 2000

[12] All India Biotechnology Association, "Report on the Indian Biotechnology Industry," 2000 Available online: www.aibaonline.com

the *Review Committee on Genetic Manipulation* and the *Genetic Engineering Approval Committee.*

The RCGM approved all import, research, and field trials for Bt cotton up to the year 2000. The GEAC came into the picture in 2000, when it finally approved Bt cotton for large-scale field trails two months after regular planting time. The GEAC decided this year that Bt cotton would not be commercialized and that one more year of trials was necessary. Although the RCGM gave the go-ahead for Bt cotton for four years, the final decision is now in the hands of the GEAC. The waste in public resources is apparent, as the committee members of the GEAC would have to acquaint themselves with trial results and related information already well reviewed by the RCGM.

The makeup of both committees is similar in some respects. The RCGM has a DBT representative, the GEAC is co-chaired by a DBT representative. The RCGM has an Indian Council of Agricultural Research (ICAR) Representative, while the one of the expert members of the GEAC is the Director General of the ICAR. A similar make-up exists in regards to the Indian Council of Medical Research and the Council of Scientific Research.[13] The ICAR therefore is partially regulating its own development of Bt cotton along with the Bt cotton variety of Mahyco.

The Research Foundation for Science, Technology, and Ecology has a pending court case against the Department of Biotechnology (Ministry of Science and Technology), the Ministry of Environment and Forests, the Ministry of Agriculture, Monsanto-Mahyco Biotech (India) Private Limited, and M/s. Maharashtra Hybrid Seeds Company Limited (Mahyco).[14] The court case is mainly based upon technicalities in the laws governing biotechnology regulation and is not being taken seriously by government or industry. Interestingly, the RFSTE has documented instances where trial fields were planted before official approval was given. Could Mahyco have known that approval would be given? The significance of the court case so far has been that it has slowed the approval process and shed light upon the technical problems in the laws related to biotechnology.

Interestingly, both sides on the biotechnology debate have criticized the regulation of GMOs on a few counts. Lack of transparency and no means to appeal decisions of the RCGM and GEAC are common complaints. The distinction between small-scale and large-scale trials has drawn criticism. The RFSTE court case was partially based upon an unclear distinction between small and large-scale trials. The AIBA Report on the Indian Biotechnology Industry also called for end to the distinction between small and large-scale trials.[15] Such a vague difference in the regulatory process could hardly be anything but arbitrary and creates overlaps in regulation.

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[13] "Rules for the Manufacture, Use, Import, Export, and Storage of Hazardous Micro Organisms Genetically Engineered Organisms or Cells," Ministry of Environment and Forests Notification, New Delhi, 5 Dec. 1989

[14] Research Foundation for Science, Technology, and Ecology, "Monsanto Quit-India Campaign Update: Cover-up of Monsanto's Illegal Trials in India," July 21, 2000

[15] See footnote 12

The common consensus on certain aspects of regulation by opposing sides of the biotechnology debate indicates the drastic need for changes.

A recent study indicates that India has been promotional of GM crops through investment in public research, while being precautionary on biosafety aspects. In trade and intellectual property rights India has had a record of a preventive approach. Public research can play an important role in developing crops targeted towards poorer farmers that have so far been left out of the "market" for GM crops[16]. However, the history of spending on research and the experience of regulation has been quite contradictory. India is shooting itself in one leg while strengthening the other.

Biotechnology in most countries where it is allowed is regulated by a number of agencies and committees at a very high cost. In the United States GMOs are regulated by three agencies and the cost going through the approval process is estimated to be as high as two million dollars.[17] Despite the high cost, several GMOs have been commercialized and more are in the pipeline. One cannot say that the approval process in India is necessarily more complicated or expensive than that of other countries, but going by the current situation the approval process has definitely been ineffective. The All India Biotechnology Association and the Confederation of Indian Industry have called for a single-window clearance for transgenic crops. Simplified regulation would be an improvement and speed the implementation of biotechnology in India. The regulation could be simplified without changing existing laws.[18]

An alternative to the regulatory approach to transgenic crops is a liability-based approach.[19] When a company has to prove to a committee or agency that a product is safe, the approving body isresponsibile for its decisions. Under a liability-based approach without government approval or regulation, anything that would go wrong with the GMO would essentially be the full responsibility of the company that introduced the product. Under the current system, a company produces a GMO and creates data so the regulatory body can determine whether or not the product is safe. Start-up costs for biotechnology development would be lower, increasing the possibility for more competition. India may not have the institutions to handle this kind of approach to biotechnology, but it also has not proven that the regulatory system can keep pace with the rapidly growing biotechnology industry.

Environmental concerns

The environmental impact of Bt cotton or other Bt crops is not yet fully known but has been predicted by scientists as both sustainable and highly detrimental. Strong objections to Bt cotton have been based on projected negative impacts on the

[16] Paarlberg, Robert. "Governing the GM Crop Revolution: Policy Choices for Developing Countries," International Food Policy Research Institute, Washington, D C December 2000.
[17] Shantharam, Shanthu. "Costing Biotechnology Regulations; Imperatives for Scientifically Rationale Regulatory Oversight. *Background Paper*, Biotechnology on the Fast Track: Releasing Regulatory Reform Conference, 2001.
[18] Prakash C as per communication. AIBA
[19] Morris J as per communication via e-mail, Institute for Economic Affairs, London.

environment. Generally, those opposed to Bt cotton tend to be opposed to biotechnology. The environmental concerns raised do deserve serious consideration and ACTION.

Development of resistance by insects to Bt is of great concern to farmers, environmentalists, industry, and policy-makers. It is a well-established fact that insects can and will (under certain circumstances) develop resistance to Bt. In the United States, the Environmental Protection Agency has mandated that all farmers use "refugia" to prevent / delay the development of resistance. Several options are available and proven to prevent and / or delay resistance.

The refugia option mandated by the EPA in the USA involves planting non-Bt cotton as a certain percentage of Bt-cotton. Insects without resistance are supposed to be allowed to survive in the non-Bt cotton and breed with insects that may have developed resistance. The strategy of using refugia to delay resistance has been considered highly successful in parts of the USA, but still resistance in some cases has been considered to have slightly increased. Non-compliance with refugia requirements of farmers in the USA is reported to be from six to nine percent.[20]

Another option for resistance management is the inclusion of more than one kind of Bt toxin or a different toxin (non-Bt). Developing Bt cotton to have more than one active Bt toxin is referred to as 'gene pyramiding.' There are over fifty known strains of the Bt toxin and each attaches to different receptors in the stomach of the targeted insects. The ICAR is utilizing this method of gene pyramiding by incorporating two strains of BT into the variety being developing through the NATP. Mahyco's Bt cotton variety does not use this method.

Integrated Pest Management can be used to delay the resistance of insects to Bt cotton indefinitely. IPM is already used in parts of India and involves careful use of a package of different practices. Designed to minimize chemical use, IPM involves the use of a variety of pest prevention techniques. These techniques include fungal viruses, botanical pesticides, and natural predators. Bt cotton can be an integral part of IPM, as it attacks the major cotton pests.[21]

Many aspects of IPM would work well with use of Bt cotton that were not possible with conventional pesticide practices. A strong possibility exists for Bt cotton and other insect-resistant cotton varieties to be the "foundation" for more sustainable and environmentally friendly IPM. If built in resistance can control the major pest, less significant pests can be controlled through IPM techniques that did not work with conventional pesticide use.[22] This IPM approach towards Bt cotton originates from Australia and differs significantly from the implementation of Bt cotton in North America. India farmers have the liberty of evaluating different approaches to using Bt cotton that already have been implemented in other countries.

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[20] "Changes In Bt Cotton Refuges?" *Progressive Farmer*, July 12, 2000

[21] See footnote 9

[22] "An Australian Approach to IPM in Cotton: Integrating New Technologies to Minimise Pesticide Use"

Resistance management is the most serious and pressing environmental issue for Bt cotton, but other less likely possibilities for environmental problems do exist. Bt supposedly can be harmful to beneficial insects, but has proved to be much better than conventional pesticide in this respect. Mahyco's Bt cotton does have an antibiotic resistant marker gene but the chance of this gene being passed on is almost nil. Bt cotton genes could also be passed on to weedy relatives, but this phenomenon is a part of the testing for approval and considered not to be a threat. In countries where it has been approved, Bt cotton has gone through rigorous testing.

Experiences of other countries

Opponents of biotechnology say that India cannot pursue biotechnology simply because it has worked for another country. However, India has the advantage of being able to analyze the failures and triumphs of other countries in biotechnology and apply this knowledge to the unique challenges it faces.

China's experience with Bt cotton is particularly insightful for India. Bt cotton was first commercially grown in China in 1998, although research began in 1991. This time span is comparable with the US, as Bt cotton had its first field trials in 1989 and was first commercially used in 1995. China is similar to India in the respect that it has many small farmers and scattered land holdings.

Bt cotton performed well on the environmental scorecard. Pesticide use was substantially reduced by around 15,000 tons. The reduction in pesticides did not only have positive ecological effects; it also improved farmers' health. In 1997 Bt cotton was found to improve the biodiversity of insects. 31 insect species (23 beneficial) were found in Bt cotton, while only 14 insect species (5 being beneficial) were found on non-Bt cotton treated with conventional pesticides. Little insect resistance developed due to the scattered plots, small farmers and available alternative hosts. Resistance could also have been delayed due to an extra insecticidal gene being present in the Chinese Bt cotton variety.

Bt cotton was found to be higher yielding on an overall basis than non-Bt varieties, with significantly lower costs. Bt cotton was also found to be clearly more profitable for farmers, especially smaller farmers. The study found that farmers with smaller farms and smaller incomes had constantly been enjoying larger increases in net income than the larger farmers.[23]

Farmers in South Africa have also had considerable success with Bt cotton. Large-scale farmers received benefits of $112 per acre, while small-scale farmers received benefits of $165 per acre. The small-scale farmers reduced insecticide sprays by 6 and increased yield by 26%, compared to large-scale farmers who reduced insecticide sprays by 4 and increased yield by 23%.[24]

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[23] Pray C, Ma D Huang J, Fangbin Q, "Impact of Bt Cotton in China," *World Development*, May 2001, Vol. 29, No. 5

[24] "Impact of Bt Cotton in South Africa. Available online: www.isaaa.org/kc/issues/benefits/benefits_safrica.html

In the United States, Bt cotton use increased from 12% of total acres in 1996 to 39% of total acres in 2000. Bt cotton has caused yield increased, insecticide reduction, and cost savings. In 1999 it is estimated that 260 million pounds of extra cotton was produced and revenues increased by 99 million dollars due to Bt cotton use. Average insecticide applications went from ten to two to zero due to Bt cotton use, with total reduction estimated to 2.7 million pounds in 1999.[25] Farmers hold ultimate power over whether Bt cotton is used or not. The increasing use of Bt cotton in the USA indicates that farmers have seen enough benefits from Bt cotton to increase adoption.

Environmentalists and anti-globalization proponents may be able to dismiss the success of BT cotton worldwide as not applicable to India, but the millions of small and marginal farmers in India do not have this liberty. They are at the mercy of a committee to decide whether or not they can at least try out a crop that may (or may not) make a huge difference for their farming operations. Pharmaceutical companies often test a drug that is successful in one country in another country before they introduce the drug in the other country. They know that because the drug has been successful in one country, it also has the potential to be successful in other countries. The impact of Bt cotton in India would obviously not be the same as that of other countries but studies from other countries do give are an important indication of projected benefits.

Bt maize

Bt maize has been adopted and has been shown to be beneficial. Bt maize was grown on 7.3 million hectares in 2000. Bt maize made up 20% of the total transgenic crops grown in the world and 19% of the total corn acres grown in the United States in 2000. From 1997 to 1999 the net gain over the three years in revenues was 20 million dollars. Bt maize targets the European Corn Borer, which is documented to have different infestation levels yearly. In the long run Bt corn is projected to be beneficial to producers, despite varying levels of infestation. Environmentally, Bt corn has been determined to be relatively benign and the risks are quite manageable. The FDA has approved most Bt Field corn varieties for human and animal consumption after extensive testing. The EPA has granted temporary approval and studies are still being done on Bt corn.[26]

From committee to farmer

The plight of Indian cotton farmers is well documented. Several suicides have occurred due to the crop failures and mounting debts of cotton farmers. BT cotton may be able to improve the livelihood of Indian farmers. However, 70% of small and marginal farmers do have access to credit and extension facility.[27] BT cotton is

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[25]Carpenter and Gianessi "Agricultural Biotechnology: Updated Benefit Estimates" January 2000. National Center for Food and Agricultural Policy, Washington, D.C. pp 15, 16

[26] Carpenter J "Case Studies in Risks and Benefits of Agricultural Biotechnology: Roundup Ready Soybeans and Bt Field Corn," National Center for Food and Agricultural Biotechnology, Washington D C January 2001.

[27]Reddy P C and Murthy J R, "Betrayal of Indian Farmers," received via e-mail as per communication July 24 2000

believed to be most effective and environmentally friendly when used as a part of Integrated Pest Management. IPM is more complicated than a "recipe" for applying pesticides and farmers would have to be educated. Taxpayer's money would be better spent financing farmers' education than financing committees to deliberate the value of Bt.

A recent study on IPM in a village in Maharashtra indicates that IPM could be an economic and effective alternative to conventional pesticide use. However, difficulties are projected in the areas of farmer's education and production of bio-pesticides. Removing subsidies on chemical pesticides is one of the suggestions to increase implementation of IPM, along with adequate education / publicity.[28]

BT is here to stay

Bt cotton and other Bt crops are increasingly becoming a large part of modern agriculture. Challenges may arise and will have to be addressed. Bt cotton is one transgenic crop that holds great promise for India but has yet to be commercially used. A committee in Delhi has made a decision to delay the introduction of something that could be very beneficial to farmers. Members of the GEAC would receive a guaranteed paycheck but Indian farmers do not have this privilege. Indian farmers should have the chance to try Bt cotton and see if it works for them. Bt cotton and other transgenic crops have great potential in India. Farmers are best left to decide if the crop is economical, as they should be under no pressure to continue producing a crop that does not work for them. For environmental concerns, the AIBA and CII recommends that in the proposed single-window clearance systems, the leading committee should be able to put a moratorium on use of a potentially dangerous GMO. Otherwise companies introducing transgenic crops, such as Bt cotton, should have to go through the minimum level of bureaucracy and accept the maximum level of liability. Until the complexities of biotechnology regulation are addressed in India, farmers will go on facing the same hardships as before and continue waiting for committee approval.

[28]Birthal P, Sharma O P, & Kumar Sant"Economics of Integrated Pest Management: Evidence and Issues," *Indian Journal of Agricultural Economics.* Vol. 55, No 4, Oct-Dec. 2000, pp. 644-659