as the transformation of the transgenic cells of cotton into fully grown plants has not yet been possible.

- The field trials conducted during kharif 1998 at forty locations by MAHYCO on its *Bt*-cotton hybrids were in a total area of about 5.164 acres only. No plantation was carried out by MAHYCO prior to its obtaining an approval for the conduct of the trials. All trials were conducted in accordance with an approved site plan, plantation plan and plan for collecting relevant information on parameters that are required to be measured to assess the safety as well as utility of the transgenic cultivars. All information on plantation and on data collection is documented.
- The information furnished in table 2 of the paper is not only misleading but is also biased, without any scientific basis. The author claims that implications of use of the gene are prone to the evaluation of resistance. The author has not given either the LD_{95} values of any pest of *H. armigera* nor has she mentioned about the levels of expressions of Cry1Ac proteins in different plant parts. Without such information, how can one make assessment about emergence of resistance? The issue of development of resistance is a complex phenomenon and the minimum that is required to be known are the above. There is also a need to evolve a suitable IPM in order to enable the most effective use of transgenic *Bt* cultivars in the field and to evolve an agronomic practice suitable to a region in the context of target transgenic cultivars tested. This is a part of the evaluation strategies of the Government while conducting the biosafety evaluation. This part has not been appreciated by the author. Further, the extent of cross-pollination has also been a part of the evaluation process under practical conditions in the field. It is true that there will be seed setting by cross-pollination between the non-transgenic tetraploid compatible cultivars from the transgenic pollens of cotton in the adjacent cotton field. However, the implication of such cross-pollination needs to be understood. By providing a separation between the border rows of transgenic cultivars and the non-transgenic ones it will be possible to substantially trap the escape of transgenic pollens to an extent that may not be significant on any count. Such data are being generated through Indian trials.
- The statement of the author made in table 2 (p. 1071) that 'Regulatory process non-transparent' is not clear. She further states that there is 'Need for public information and vigilance'. The regulatory process is as transparent as it should be. All the contained open field experiments are documented with the map of a site plan, the planting pattern and the isolation distances. The protocols for conducting the experiments are approved by the Review Committee on Genetic Manipulation (RCGM). The applicant watches the experimental site. There is a full record of persons conducting the experiments. Any outsider willing to visit the experimental site is escorted to the site by the applicant or his nominee provided the person discloses his identity and the purpose of visit. Records are maintained about the persons visiting the experimental sites. Copies of the authorization letter embodying all these aspects are available with the District Collector of the State where the experiments are conducted. The State Government is fully kept informed about the experiments. In what way therefore, is the regulatory process non-transparent? In addition to the regulatory authorization for the conduct of such experiments, DBT has convened several public meetings and has given statements to the press about these experiments.
- The toxicity and allergenicity information on *Bt*-cotton was generated by MAHYCO on the basis of the directives of the RCGM as such information on ruminants (goat model) was not yet available anywhere in the world. Similarly, allergenicity information was also not available, but was generated in Brown Norway (BN) rats. The information so generated did not show any additional risks from the use of *Bt*-cotton compared to its non-*Bt* counterpart.
- The author has stated (p. 1074) that 'Recapitulating points made earlier in the paper: the protein coded by this gene' (*Cry1Ac*) 'is known to be most toxic to the tobacco budworm, which is not a major pest of cotton in India. In laboratory studies *H. armigera*, a major Indian pest, is known to be variably susceptible to Cry1Ac protein, and can very quickly evolve resistance under selection'. This point is admittedly a relevant one and therefore, Indian experiments include the elaboration of the LD_{95} values for different Indian *H. armigera* along with the levels of expression of Cry1Ac proteins at different cotton plant parts at different ages. Unless the target *Bt*-cotton plants consistently express Cry1Ac proteins well above the LD_{95} values, it would not be useful to introduce such cultivars in commercial agriculture. In addition, as stated earlier, sound IPM strategies would also be built in to delay the emergence of resistance in *H. armigera.* It is pointed out in this context that management of the menace of *H. armigera* costs the country close to Rs 1100 crores annually. Strategies to cut such costs can in no way be belittled and ridiculed.

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Response:

I thank Ghosh for clarifying aspects of the regulation of the *Bt*-cotton project. It was precisely because accurate information is not readily available to the public that I presented my own understanding as gleaned from 'mere' newspaper reports of regulatory issues, and it is good to have at least a partial straightening of the public record. However, I am disappointed in the lack of answers to many technical questions raised in the paper.

- *MAHYCO vs Monsanto*: Ghosh has clarified that the major reason for non-approval of the Monsanto project was due to financial aspects. According to him, approval of the Monsanto project would have enabled India to be 'ahead of many countries in transgenic plant research as contemporary knowledge and training in transgenic research could be fast forthcoming'. He points to the absence of transgenic cotton in India as indication of a deficiency in indigenous expertise to do this. Perhaps others could comment on this statement?
- *Information in table 2*: Ghosh states that the 'information' in table 2 is misleading 'without scientific basis'. The only 'information' there is under column I (features of the *Bt*-cotton project), the other two columns containing questions

raised on the basis of other studies (referred to in the text) regarding relative susceptibility of pests in the laboratory, field, etc. Since he questions just one of these features (regarding transparency of the regulatory process), it seems that his statement is biased.

- *Resistance management and other technical questions*: Ghosh responds to specific questions under columns II and III with general statements regarding the 'need to evolve a suitable IPM' (exactly, we would like to know details), 'implication of such cross-pollination needs to be understood', (exactly, what information do we have on this?) and so on. Other questions not answered: Are 1 acre tests too small? Are 1–2 seasons of testing too few? Are 2 years sufficient for backcrossing and testing?
- *Transparency of regulatory process*: Ghosh lists the procedural aspects that are open to the public. However, his statement that the process 'is as transparent as it should be', the lack of specific responses to specific questions, and his reading of my paper as belittling and ridiculing the *Bt*-cotton project, suggest that he has missed the spirit in which it was written. Much more discussion on the nature of transparency is required before the public can be confident of obtaining information that it is entitled to. Openness lies in the 'nitty-gritty'.

I hope that there will be more such discussion that would not only clarify misconceptions but also answer some of the questions raised here. Such a discussion would go a long way toward building the basis for a truly democratic process of decision making on this, and future, genetic engineering projects.

GEETA BHARATHAN

Bt-cotton: The view from MAHYCO

While Geeta Bharathan argues in her article that 'It is imperative that assessments of *Bt*-cotton project and future GE projects should be based on considerations in which the biological basis of the technology are clearly distinguished from societal issues', she herself has done precisely so in her article. Further, there are many factual errors in the article, which need to be pointed out. Also, the uncanny way in which issues like the terminator technology and farmer suicides have been mixed up with the technology and regulatory aspects of *Bt*-cotton obfuscates the truth that these are totally unrelated.

I would like to set the record straight on *Bt*-cotton so that readers, who have not had the opportunity to closely follow the developments of *Bt*-cotton in India, get the correct picture.

1. Transgenic cotton today is grown on over 5.3 million hectares (m ha), an increase of 43% over the 1999 area of 3.7 m ha in 6 countries around the world. These countries include USA, Australia, South Africa, Argentina, Mexico and China. China increased its genetically modified (GM) cotton area to more than 10% of its cotton area in 2000. The fact that millions of cotton farmers in both industrial and developing countries opted for *Bt*-cotton speaks volumes of the confidence and trust farmers have in its ability to help them tackle the bollworm problem[1,2]. In fact, the area planted with GM crops worldwide increased to 44.2 m ha; up from 39.9 m ha in 1999, an impressive increase by 11% (ref. 2).
2. India has the largest acreage of cotton in the world[3]. The major pests impacting cotton growers in the country are the bollworms, predominantly *Helicoverpa armigera*, for the control of which insecticides worth around Rs 1200 crores are used annually. In spite of this, farmers are suffering huge losses. Their yields have reduced, incomes have dropped and debts have increased[4].
3. MAHYCO began discussions with Monsanto for licensing *Bt* technology in 1993. An agreement was signed and MAHYCO then received from the Review Committee on Genetic Manipulation (RCGM) in Department of Biotechnology (DBT) permission to import the *Bt*-cottonseed in 1995. It imported 100 g of *Bt*-cotton seeds in 1996. These were used for backcrossing into elite Indian varieties by achieving 3 backcrosses in a calendar year in a glasshouse approved by DBT. Only such lines which were either commercially being used or are likely to be introduced in the near future were considered.

Between 1996 and 1998, according to the direction of RCGM, MAHYCO had carried out extensive tests in India, which included studies on outcrossing, germination, weediness, food/feed safety, allergenicity, toxicity, pollen escape, etc. These studies have established that *Bt*-cotton is safe.

In 1998, following permission by RCGM, the first multi-centric field trials were carried out on 40 locations in nine states in India. The data were submitted in February 1999 and reviewed and accepted by the RCGM.

The data from the 1999 trials were also submitted and reviewed by RCGM in April 2000. In May 2000, after reviewing the data on bio-safety and field trials, RCGM recommended that MAHYCO approach the Genetic Engineering Approval Committee (GEAC) for further action. In July 2000, GEAC permitted MAHYCO to conduct countrywide field trails on 85 ha and seed production on 150 ha. These are now in progress[5].

4. The Government of India has banned the entry of terminator technology (Office Memorandum No. 82-1/98 PQD, dated 25 May 1998 regarding strict watch on any likely import of seeds having terminator gene) and statements to this effect have been made in the Lok Sabha and Rajya Sabha. Monsanto was not involved with this technology. However, since they were unnecessarily implicated, they have made public commitments not to commercialize this technology, even if it becomes available. This was widely publicized and the author does not seem to be aware of it.
5. The choice of genes and resistance development: The author has made a point that *Cry1Ac* gene is not the most appropriate gene for controlling the target pest. We would like to state that the choice of *Cry1Ac* as the most appropriate gene, is based on extensive studies. We wish to inform the author that Australia also has *Cry1Ac* in their commercialized cotton and not *Cry1Ab* as mentioned by her. To date there has been no report of any scientific data to show that *Cry1Ab* is superior to *Cry1Ac* to control *H. armigera* as implied by the author.

Our own in-house studies conducted in India have clearly shown that *Bt*-cotton with *Cry1Ac* is quite effective against the major Indian bollworms, namely *H. armigera*, *Earis vittela* (*Earis insulana*) and *Pectinophora gossypiella*. These have been confirmed by other workers also[6]. The author herself has cited a pub-