Science & Society

India joins the GM club

Nandula Raghuram

On 26 March 2002, after four years of speculation and controversy, the Indian government opened the doors to genetically modified (GM) crops. It has granted approval for the commercial release of transgenic cotton containing the *Bacillus thuringiensis* (*Bt*) gene, which renders the plant resistant to attacks by its main pest, the bollworm. The *Bt*-cotton varieties, the result of a joint venture between Monsanto (St Louis, MO, USA) and Mahyco (Mumbai, India), went through two rounds of field trials before the Genetic Engineering Approval Committee (GEAC) cleared them for commercial cultivation (Box 1).

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This decision is the first practical manifestation of the Indian government's stated commitment to biotechnology as an agricultural strategy. Currently, several transgenic crop varieties are at different stages of field trials, and the government has promised to allow 20 genetically manipulated crops to be planted commercially this year, ranging from transgenic cotton and mustard to protein-fortified potatoes and pest-resistant tomatoes. Although foreign companies have developed some of them, many others have been developed locally in government-funded laboratories. The range of Indian capabilities in modern plant biology and biotechnology has been reviewed recently [1].

Conditional approval

According to Mahyco, *Bt*-cotton would reduce pesticide costs and boost yields, fetching about Rupees 10 000 (about US$200) more per hectare than non-GM crops – a net gain of >70%. The GEAC did not give any official numbers, but its members informally agreed that up to 50% improvement is possible if all the other conditions in the field are favourable. The approval for three transgenic cultivars of *Bt*-cotton has been granted on certain conditions for a limited period from April 2002 until March 2005.

One of the conditions is that the seed company must ensure refugia around *Bt*-cotton fields as a barrier to pollen flow to non-transgenic crops, and to prevent build-up of resistance among insects. At least 20% of the farmer's field must be planted with non-*Bt*-cotton; five rows of non-*Bt*-cotton would have to be sown along the periphery of every field – a width of 2.5–3.5 m – irrespective of the size of the holding. This mandatory requirement implies that small land holdings would not be feasible for growing *Bt*-cotton. The majority of land holdings average less than a hectare, therefore a large proportion of Indian farmers will be excluded from the expected benefits of *Bt*-cotton. Many fear that this might further exacerbate the inequalities typical of Indian agriculture.

The onus of ensuring refugia around *Bt*-cotton fields, conducting studies on the *Bt*-susceptibility and emergence of *Bt*-resistant bollworms, and testing for genetic contamination of other plants by cross-pollination, has been left to the seed company. State governments bear the burden of monitoring and enforcing these regulations. There is a GM-labelling requirement for selling transgenic seeds, but not for selling other products derived from them for the domestic market, with the exception of oilcakes meant for export. The chairman of GEAC, A.M Gokhale, dismissed concerns about the safety of cattle feed or cotton seed oil used domestically as an edible product.

Use of pesticides

Cotton is a major cash crop in India. It occupies 9 million ha – the world's largest area under cotton cultivation. However, severe losses because of pests reduce yields to ~300 kg per ha, or half the world average, relegating India to third position among the world's cotton producers. Cotton accounts for 54% of the total pesticide consumption in India, ~100 000 tonnes per annum, even though the area under cotton cultivation is only ~6% of the total land area under agriculture.

This has exacted a deadly toll, both on farming and on farmers. According to Devinder Sharma of the New Delhi-based Forum for Biotechnology and Food Security, >10 000 cotton farmers have killed themselves using the fourth-generation pesticides (synthetic pyrethroids) introduced <20 years ago.

Farmers are caught in vicious cycles of debt to meet the high costs of cotton farming, debts they incur to purchase pesticides, fertilizers, water pump sets and hybrid seeds. For many, the only way out of the debt trap is to swallow the pesticides they purchase with their loans. The cycle of suicides has continued this year as large-scale crop failures defeated the already debt-ridden cotton farmers from the Northern state of Punjab to Karnataka in the South.

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Environmentalists quote cotton as a classic example of the failures of the 'green revolution', whereas the Indian government views biotechnology as a solution for this reason. However, Devinder Sharma warns that this 'gene revolution' faces impending failure; reduced dependence on pesticides in *Bt*-cotton is short-lived, he maintains, quoting examples of the emergence of *Bt*-resistant pests in other countries such as China and Australia. Members of GEAC agree that stray incidents of resistance to *Bt* have also been reported from the USA and Indonesia, but point to the lack of systematic scientific data showing significance. They believe that *Bt*-cotton is the best solution available at present, and hope that continuous improvements will lead to better alternatives to tackle future challenges. One strategy being pursued already in India and elsewhere involves introducing two different *Bt* genes to delay or diminish the emergence of resistance.

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Box 1. History

In April 1998, the Indian Dept of Biotechnology's Review Committee on Genetic Manipulation (RCGM) permitted the first field trials of *Bt*-cotton. According to critics, this was a procedural irregularity. The Review Committee, which had authorized the import of *Bt* seeds in 1995, was empowered only to grant clearances for contained genetic experiments in laboratories or greenhouses. Only Genetic Engineering Approval Committee (GEAC), an enlarged inter-ministerial body, could give permissions for field trials.

Vandana Shiva, an environmentalist and critic of globalization, took the matter to the Indian Supreme Court, challenging the field trials. In July 2000, before the case was decided, the GEAC granted permission for large-scale field trials, apparently after reviewing the data from the small-scale field trials. It did not make data generated in these field trials public. However, the GEAC organized an open dialogue on 18 June 2001, which was attended by Greenpeace, scientists, officials and farmers.

Greenpeace raised questions about the scientific and environmental aspects of *Bt*-cotton. Agricultural scientists later objected to the trials on the ground that because of the late planting, the pest load was low and the yield data and the net agronomic advantage derived from the study could not reflect true values. The GEAC ordered a one-year extension for field trials of *Bt*-cotton before taking a decision. On this occasion, the trials were held on 100 ha under the direct supervision of the Indian Council of Agricultural Research (ICAR).

In January 2001, shortly after environmentalists challenged the field trials of *Bt*-cotton in the Supreme Court, a ten-member US delegation of judges and scientists met Supreme Court Chief Justice A.S. Anand in New Delhi. The delegation, organized by the US-based non-profit Einstein Institute for Science, Health and the Courts, offered to hold workshops for the judges of the Indian Supreme and High courts to educate them about transgenics and safety protocols in biotech research.

In June 2001, a Greenpeace expose pointed to contamination of popular food products such as Pringles potato chips and Isomil baby food with Monsanto's genetically engineered crops. Members of the GEAC agree that neither Monsanto nor the manufacturers of Pringles and Isomil, Proctor & Gamble (Cincinnati, OH, USA) and Abbott Laboratories (Casa Grande, AZ, USA), respectively, had sought or obtained approval from the GEAC for those products. But neither were they aware of the sale of such GM-contaminated products in India, nor have they received a formal complaint in this regard.

Illegal use of GM crops

Other pressures operate on the government as well. Monsanto and Mahyco have complained about delays in clearance of their *Bt*-cotton varieties, even though they adhered to all the standards required and repeated field trials. Meanwhile, the illegal sale of *Bt*-cotton last year by another Indian company, Navbharat Seeds (Ahmedabad), without any clearance went unnoticed. Subsequent official estimates revealed that illegal *Bt*-cotton was planted on >4000 ha in the Indian state of Gujarat alone, and that huge quantities of seeds might have been sold to several other states. The government ordered the company to stop further sales and farmers to burn the GM illegal crops, but farmers refused to oblige.

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Gene Campaign, a New Delhi based non-governmental organization (NGO), has filed a petition in the Delhi High Court charging the government with negligence for allowing large-scale planting of *Bt*-cotton. The petition, which was admitted by the court, demands that GMOs be released only after a rigorous regulatory procedure and an evaluation by an independent regulatory agency (not the government-controlled GEAC). The court is yet to give its verdict on this petition.

Although the illegal sale and cultivation of *Bt*-cotton has highlighted the difficulties in enforcing regulations on the ground, and gave a strong weapo to the anti-GM critics, its instant popularity among the farmers (who were unaware of its GM origin) also emboldened the pro-GM lobbies. They feel that regulatory delays not only deny the farmers' right to access better technologies, but also lead to uncontrolled spread of illegal, unapproved GM varieties. On the day before the 26 March 2002 GEAC meeting, wealthy farmers' leaders such as Sharad Joshi of the Shetkari Sanghatana, publicly warned the government that if GEAC denied Mahyco permission to commercialize its *Bt*-cotton, farmers would disobey GEAC and grow *Bt*-cotton across the country as an organized show of protest. But members of the GEAC feel that farmers are unaware of the consequences of allowing GM crops without any trials or regulations.

Critics of the Indian government's handling of the *Bt*-cotton evaluations 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. Suman Sahai of Gene Campaign finds it 'truly alarming that Mahyco–Monsanto, the company that will sell the transgenic *Bt*-cotton seeds, has been appointed its own monitor'.

P.M. Bhargava of the Society for Scientific Values feels that permitting the sale of transgenic seeds for a limited period of three years does not make any scientific sense because a living organism once released on a large scale cannot be recalled. He argued that if the GEAC felt that there was *prima facie* evidence for permitting the release of *Bt*-cotton, it should have first made public the entire trial data and allowed concerned scientists and citizens to assess it. He also questioned the wisdom of importing the *Bt* technology from Monsanto when institutions exist in India with the necessary expertise to produce *Bt*-cotton.

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Some members of the GEAC agree that data from field trials should be available for public scrutiny. However, there has not been any official decision to this effect to date. In the meantime, in anticipation of the GEAC clearance, Mahyco has already created a seed bank of *Bt*-cotton to cover 150 000 ha of the cotton area. It is not clear how the regulations will be enforced at the farm level. The success of this technology in Indian agriculture will depend crucially on preventing gene pollution, combating resistance and most importantly, avoiding any social fallout such as further marginalization of small farmers.

Reference

1 Raghuram, N. (2002) Indian plant biology enters the biotechnology era. *Trends Plant Sci.* 7, 92–94

Nandula Raghuram
Dept of Life Sciences, University of Mumbai, Vidyanagari, Mumbai – 400098, India.
e-mail: raghuram@umail.mu.ac.in

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