complex and frightening: most of the biotechnological research is controlled by multinational corporations (MNCs). The World Trade Organization (WTO) has institutionalized MNC–IMF–WB monopoly on the world economy.

Transgenics is marketed as the technology for meeting the increased food production demand for the estimated large population in 2025. That this is a misleading argument becomes obvious if we take note of the present situation: though there is an excess of food grains in India, poor people do not have access to it, and on the world scale it is not the shortage of food, but the inequity which is responsible for food insecurity. A more basic argument against GM crops is that this technology did not originate with the aim to help poor countries produce more food[2]. MNCs are in the business of profit-making, and WTO regime facilitates their easy entry in the developing countries, as well as forces the developing world to make IPR (intellectual property rights) laws most suited to them. Realizing that more than 60% of people in India depend on agriculture in contrast to less than 6% in USA, and that India is a bio-diversity-rich country compared to USA, we should not accept the recommendations of science academies for GM crops without independent studies in Indian conditions. It is strange that Bhatia cites such reports[3] as final scientific verdicts. Much less is known of transgenics in the tropical environment and its impact on the natural bio-diversity over a period of time. Apprehensions and concerns expressed by Bharathan[4] taking *Bt*-cotton as an example, deserve serious consideration; should we be concerned to placate MNCs[3] or be responsible to the interests of the people? Even a single case of suicide would have jolted the policy makers in USA, but more that 50 suicides by farmers have not sensitized the science/political leadership in India. A view has been expressed by Juma, an adviser to WB that for poor countries, environmental safety or health are not key issues for transgenic crops[2]. The Vision 2001 statement released at the 88th Indian Science Congress bears the imprint of WTO guidelines; therefore it was nice to hear M. S. Swaminathan's demand for a white paper on GATT-94 and the Indian government's commitment on agriculture. Why has this not been pursued?

To conclude, lack of credibility, foresightedness and honest commitment to the welfare of the people characterize the science establishment in India; gene revolution administered by MNCs is a grave threat to the agriculture, biodiversity and poor of the country. It is likely that WTO may not survive by 2005 due to clash of interests between USA and the European Union, and assertive voices of some developing countries and NGOs, but drastic policy changes conforming to WTO in India may cause irreversible damage to the socio-economic fabric of the country.

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Bt-cotton in China

In the article 'Technological developments and cotton production in India and China' (*Curr. Sci.*, 2001, **80**, 925–932), Bhagirath Choudhary and Gaurav Laroia have overlooked several aspects of *Bt*-cotton in China. Although it is interesting, some statements are inexact and are not based on facts. It is the intention of this correspondence to provide a clarification on the research and commercialization of *Bt*-cotton in China, which are elaborated below:

Firstly, Chinese scientists, from the Chinese Academy of Agricultural Sciences (CAAS) and other institutes, began research on *Bt*-cotton in late 1980s[1,2] and not in 1991, but the first scientific paper about obtaining transgenic *Bt*-cotton by genetic engineering and its insect-resistant characteristics was published in 1991 (ref. 3). Bollworm outbreak and dramatically decreasing cotton yield because of bollworm infestation in China in the early 1990s made the Chinese government divert more attention and money on *Bt*-cotton research. But, it is not the main reason for initiating *Bt*-cotton project in the 863 High Technology R&D programme; this is because the *Bt*-cotton project was initiated before bollworm outbreak.

Secondly, by the end of 1996, although there were many *Bt*-cotton lines bred by Chinese scientists, including scientists in CAAS and other institutes, no *Bt*-cotton variety had been bred and developed in China[1]. The first *Bt*-cotton variety was licensed in China in 1997 to NewCot 33B, imported by Jidai Cotton Seed Company Ltd from Monsanto Company. In the following year (1998), eight *Bt*-cotton varieties were developed and licensed; of these four (CRI 29, 30, 31 and 32) were developed by the Cotton Research Institute of CAAS; the remaining Goukang 1, Jimian 26, Jiza 66 and JD-3, were developed by the Biotechnology Research Center of CAAS, the Shanxi Cotton Research Institute (in collaboration with Biotechnology Research Center of CAAS), the Hebei Cotton Research Institute and the Jidai Cotton Seed Company Ltd, respectively[1,4]. In 1999 and 2000, more and more *Bt*-cotton varieties were developed and licensed in China. At present, at least 15 *Bt*-cotton varieties are cultivated in China; four of them were developed by Monsanto Company or its joint enterprise, Jidai Cotton Seed Company Ltd[5]; the others were developed by Chinese scientists[1,4]. Besides these *Bt*-cotton varieties, at least 30 breed lines with *Bt*-cotton or *Bt* plus *CpTI* genes have been developed and are being considered for variety license[1,4].

Thirdly, the environmental release and commercialization of genetically modified (GM) organisms (including plants, animals and microbes) are regu-

lated by the Office of Agricultural Biological Genetic Engineering Safety Administration (OABGESA) of the Ministry of Agriculture in China. Although China began to grow transgenic plants for commercial use in 1992, the first license for commercialization of GM crops was authorized by the OABGESA in 1997, and not in 1994, after assessing their biosafety[6]. *Bt*-cotton was first commercialized in 1994 by the Cotton Research Institute of CAAS, but it obtained license for commercialization in 1997 (ref. 6). Up to now, more than 8 *Bt*-cotton varieties have obtained licenses for commercialization from the Chinese government[7].

Fourthly, in China, like in USA and Australia, *Bt*-cotton needs insect resistance management schemes, but the authors mention in their paper that China does not need insect resistance management schemes, which is not true. Many field experiments have indicated the developing resistance of bollworm to *Bt*-cotton. Scientists in the Cotton Research Institute of CAAS have observed that resistance of bollworm to Bt toxin increased 6.6–9.8-folds in 1999 (ref. 4). The results have made Chinese scientists pay more attention to insect resistance to *Bt*-cotton.

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G. N. Ramachandran and applied research

G. N. Ramachandran is distinguished for his basic research in physics. His concern for the welfare of the people of this country and his interest in applied research, which could be of benefit to them, are not widely known. The following is a brief account of an applied project initiated by him, with which I was associated.

I met Ramachandran in 1942, when we were both students at the Indian Institute of Science (IISc), Bangalore. Our association continued after I joined the National Chemical Laboratory (NCL), Pune. He wrote to me in 1970, when he was still at Madras University, that he would like to discuss whether we could collaborate on an applied project of national importance. After considering several areas, we decided that utilization of the vast and renewable cellulosic resources of the country to meet our increasing needs for fuel and protein, would be of great potential value. Hydrolysis of cellulose to glucose by concentrated hydrochloric acid was carried out on an industrial scale in Germany, but it was feasible only during wartime, because of high cost and formidable corrosion problems. A biochemical process appeared to be more attractive. We had discussions with senior members of the Planning Commission and the CSIR. Atma Ram, then Director General, CSIR agreed to support the programme and a Silver Jubilee Grant of the CSIR was awarded to Ramachandran, T. N. Ramachandra Rao, CFTRI, Mysore and myself at NCL, for basic and applied research on the utilization of cellulosic materials by enyzmic hydrolysis to glucose or by microbial conversion to single-cell protein for animal feeds. This grant was for three years, the allocation of funds for equipment, chemicals, travel and staff was at the discretion of the project leaders and funds could be carried over from one year to another (features which seem to be worth copying in other grants!).

The beta-glucosidase linkages in cellulose make it difficult to hydrolyse compared to starch, with its alpha-glucosidase links. Basic studies on the structure of different celluloses were planned, but could not be undertaken. Ramachandran left Madras and joined IISc, when the project was begun. He was occupied with setting up a new department and was also away in Chicago for a year and was unable to undertake experimental work. However, his contributions in the form of discussions and advice on different aspects of the project and his continued interest in it, in spite of ill health, were invaluable.

The project on cellulosic materials has been in progress as a long-term programme at NCL, from the mid-1970s till today. After the Silver Jubilee Grant, two UNDP grants were obtained (the second one shortly before my retirement in 1981). Several exo- and endo-cellulases and beta-glucosidases were obtained in pure form and their properties studied. Two high cellulase-producing fungi were obtained and a large number of isoenzymes were also isolated, which acted synergistically in cellulose hydrolysis. This work has been presented in several publications and patents. Research in this area is in progress in several countries and the conversion of cellulose to glucose and ethanol is of potential importance as an alternate energy source.

This project was made possible by the initiative of Ramachandran and reflects his abiding concern for national development.

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