BOOK REVIEW

The Development of Transgenic Crop Technologies in India: Past Experiences and Future Prospects

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Rao, N. Chandrasekhara, Pray, Carl E., and Herring, Ronald J. (eds.) (2018), *Biotechnology for a Second Green Revolution in India*, Academic Foundation, New Delhi, pp. 434, Rs 1,310.

The cultivation of transgenic crops has contributed significantly towards improving agricultural production across the world. In 2015, 180 million hectares of transgenic crops were planted globally, including crops such as soybean, cotton, maize, and canola (National Academies of Sciences, Engineering, and Medicine 2016). In India, Bt cotton occupied over 90 per cent of the total area under cotton cultivation in 2014 (Suresh *et al.* 2015). Most large-scale scientific studies of transgenic crops have arrived at the consensus that they are as safe to cultivate and consume as non-transgenic crops (Nicolia *et al.* 2014). However, despite their widespread adoption and the scientific consensus on their safety, the debate over transgenic crops continues. This debate, which concerns the real and perceived risks (and benefits) of transgenic crop use, is in part a political one (*ibid.* 2016; Herring 2015; Ronald 2013). We may speculate on a second reason: namely, wilful ignorance with respect to empirical data on the safety and socioeconomic performance of transgenic crops.

By the end of the present decade, transgenic crops would have been cultivated globally for well over 30 years. Thus, literature based on three decades of transgenic crop cultivation will soon be available, and will have to be taken into account. The book of essays under review should be seen as an important addition to this global literature. The editors of the book – N. Chandrasekhara Rao, Carl E. Pray, and Ronald J. Herring – have made contributions over an extended period to analysing the socioeconomic and political issues relating to the cultivation of transgenic crops. In the Indian context, this book is perhaps the first systematic review of the performance of transgenic crops in agriculture, and it offers also an assessment of their future potential.

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The book has fifteen chapters (including an overview chapter by the editors) that are divided into three broad sections: macro-issues related to transgenic crops in India, the potential of new transgenic crop technologies, and the performance of Bt cotton. The first chapter, by Ronald Herring, takes stock of the debate surrounding transgenic crops in India and sets up the argument of the rest of the book. Herring begins by pointing out that despite the fact that Bt brinjal and Bt cotton are products of the same technology and are subject to similar regulatory processes, the two crops have been subjected to different outcomes in terms of their deployment, with Bt brinjal continuing to face a moratorium on its use. The author attributes this to the differential perceptions of risks associated with a food crop and a non-food crop, a disregard of the empirical evidence of Bt cotton cultivation, and, more importantly, arbitrary decision-making by the Ministry of Environment and Forests (MoEF), Government of India. Herring also highlights the role of transnational NGOs and their disproportionately large influence on regulatory policies affecting transgenic crops.

Despite differing regulatory regimes, transgenic crops across the world seem to be at the centre of similar debates (referred to as "uniformity of framing"). This similarity pertains to questions of health and environmental safety, socioeconomic benefits, intellectual property rights (IPR), and the threat of private monopoly over transgenic technologies. These questions form the basis of the second chapter of the book. The authors of this chapter – G. D. Graff, G. Hochman, C. Suntharalingam, and D. Zilberman – describe how regulatory frameworks dealing with transgenic crops have become detrimental to the interests of developing countries. This is due to a combination of decision-making based on the precautionary principle and a unique regulatory framework governing transgenic crop technology. The unique framework refers to how transgenic crops, which primarily display traits of pesticide and herbicide resistance, were interpreted and regulated as pest-control products derived through genetic modification. These regulatory frameworks have unwittingly created several barriers to the adoption of transgenic crops by developing countries and for the public sector enterprises that produce them.

The third chapter, by Sangeeta Bansal and Guillaume Gruere, looks at the issue of labelling transgenic crops (a practice currently mandated by legislation in India) and its economic impact. The findings of the chapter show that the economic costs of labelling far outweigh the benefits for developing countries. Further, the authors point to how the implementation of labelling practices is difficult in unregulated and unorganised markets, and when most agricultural products are not even packaged. The chapter, or perhaps the first section of the book in general, could perhaps have looked at a more fundamental question with regard to labelling: if scientific studies of most agricultural products demonstrate that transgenic crops are as safe to consume and use as non-transgenic crops, what consumer interest is served by GM

labelling? A related question is: why label products at all, if there is no transgenic variety of the product/crop (for example, if there is no GM apple, why label apples)?

The first section of the book continues with Deepak Shah's comprehensive review of the institutions that encouraged the adoption of Bt cotton in India (chapter 4). These include seed price regulations adopted by States in India, and investment in research and development by public and private sector enterprises. All of these led to a clear growth of yield, productivity, income, and profitability in Bt cotton cultivation.

Present and Future Potential of Transgenic Crops

An interesting deviation from existing methods of analysis of transgenic crops presented in the book is the use of economic surplus models. Economic surplus models measure changes in producer and consumer surpluses resulting from the adoption of transgenic crop technology in a given year in monetary terms. This forms the tool of analysis in the next two chapters of the book. In chapter 5, P. Ramasundaram, A. Suresh, J. Samuel, and S. Wankhade carry out an ex-post analysis of the gains from application of Bt cotton. They establish that improvements in yield, area cultivated, and productivity in cotton cultivation in India have resulted in a total gain of Rs 220 billion, of which Rs 188 billion have accrued to producers and Rs 32 billion to private sector enterprises. This chapter complements earlier work by the same authors on cotton cultivation in India (Suresh *et al.* 2015). In chapter 6, S. Kumar, P. A. Lakshmi Prasanna, and S. Wankhade conduct an ex-ante analysis to determine the potential gains of adoption of Bt brinjal. In monetary terms, this gain could vary from Rs 62 billion to Rs 142 billion. This also includes savings on health expenditure that accrue to farmers on account of the non-use of insecticides. While these evaluations are useful methodological tools for analysing the socioeconomic benefits of transgenic crops in developing countries, an analysis of the distribution of producers' surplus and economic benefits by size-class of producers would have been even more useful.

Assessment of the future potential of new transgenic crop technologies as presented in the book includes a chapter on herbicide-tolerant (HT) maize in Kenya by Nicholas Kalaitzandonakes, John Kruse, and Marnus Gouse. The chapter is an ex-ante assessment of the adoption of HT maize in Kenya. The authors' analysis is based on the premise that poor weed management is a source of high cost and high yield loss in maize production. Second-generation transgenic crops show a clear advantage over first-generation transgenic crops (such as Bt maize), and also offer the potential to deploy both pesticide- and herbicide-resistant traits in the same crop. This section of the book ends with a chapter by Niti Mehta (chapter 8) on labour absorption and weeding operations in the cultivation of Bt cotton. Their study is based on a survey of cotton-cultivating farmers in Gujarat. Mehta makes the argument that since weeding constitutes a major operation in terms of labour cost and labour time on farms, the use of herbicide-tolerant cotton that eliminates weeding operations would

save expenses on such farm operations (especially on resource-poor farms). This is complemented by perceptions of the farmers themselves, who identify weeding as drudgery. The author's analysis, however, does not discuss the number of labour days and costs of production incurred across different processes of cotton cultivation. Not only would this have better supported the author's argument, but would also have indicated the potential cost reduction that can be achieved by eliminating weeding operations.

The Story of Bt Cotton in India

Having examined the macro-issues and the future potential of new technologies, the book examines the story of Bt cotton in India. This section contains six chapters, some of which might already be known to those familiar with the debate around Bt cotton in Indian agriculture. Each chapter in the section represents a cross-sectional analysis or a time-series analysis of the comparative performance of Bt cotton, across the major cotton-producing States of the country.

In the first chapter in this section (chapter 9), Latha Nagarajan, Carl Pray, and Anwar Naseem analyse the role of private-sector Bt cotton hybrids. Their analysis is based on data from a large-scale survey of nine major cotton-growing States, conducted by a private market research firm. It establishes the improved performance of private sector Bt cotton hybrids as compared to public sector hybrids, an outcome the authors attribute to the increased investment in research and development by private enterprises. Although they do not mention it, the results can also be interpreted as indicative of the lack of investment in research by the public sector and the failure to market the public sector Bt cotton variety developed by the Central Institute for Cotton Research (CICR). Prakash Sadashivappa, in chapter 10 of the book, provides an analysis of the impact of Bt cotton adoption using panel data. He uses data from a survey of over 300 farmers (including Bt cotton cultivators and non-Bt cotton cultivators), conducted across three different points in time (2002–03, 2004–05, and 2006–07). The panel data point to a consistent increase in yield and consistent decline in the use of insecticide in Bt cotton cultivation over time, in comparison with the cultivation of non-Bt cotton. The next chapter by K. R. Ashok, K. Uma, M. Prahadeeswaran, and H. Jeyanthi describes the favourable economic and environmental impacts of Bt cotton (over non-Bt cotton), visible in the States of Gujarat, Maharashtra, Andhra Pradesh, and Tamil Nadu. The chapter measures the comparative changes in yield and expenditure on pesticide between Bt and non-Bt cotton, and the surplus that accrues to producers and consumers, using the economic surplus model. An interesting contribution of this chapter is the development of a measure called the Environment Impact Quotient (EIQ), which measures the adverse impact of individual pesticides on farm workers, consumers, and the ecology of a place.

Chapter 12 is a reprint of one of the first analyses of Bt cotton cultivation, written by A. Narayanamoorthy and S. S. Kalamkar. The results of this study, published in

2006, show the impact of Bt cotton use in Maharashtra in the initial years after its adoption. The study highlighted the significantly higher costs of cultivation of Bt cotton over non-Bt cotton, and showed how pesticide consumption in the cultivation of Bt cotton was not significantly lower than in non-Bt cotton. It concludes, however, that Bt cotton cultivation implies higher productivity and cost efficiency of cultivation, as well as better profits per hectare. This caveat regarding pesticide consumption has been corroborated by another study in Maharashtra (Swaminathan and Rawal 2011).

The penultimate chapter in the book, by N. Lalitha and P. K. Vishwanathan, traces the adoption of Bt cotton seeds and pesticide technology in Gujarat. It provides a much-needed analysis of the role of private input dealers and the absence of extension services for Bt cotton. The authors also sound the note of caution struck in the previous chapter regarding claims of reduced pesticide use, and argue for better pest management strategies along with the adoption of Bt cotton.

The last chapter is an important study (originally published in 2012) by Ronald Herring and Chandrasekhara Rao, which examines the claim of the failure of Bt cotton – a claim that holds sway in civil society despite empirical evidence to the contrary. It includes the oft-quoted (though empirically unfounded) claim that farmer suicides in India are driven by Bt cotton cultivation. The broad objective of the paper is to highlight the wilful disregard for empirical evidence, along with a dismissal of the agency, experience, and skills of farmers who cultivate Bt cotton.

The Need for Transgenic Crop Deployment in India

The book, taken in its entirety, is a summary of the transgenic crop debate in the context of Indian agriculture. At the same time, based on empirical evidence, it argues for the greater advance of biotechnology in Indian agriculture. This, as the editors write, is important because of the fact that

> . . . the country's agriculture – in exactly the same acreage (140 million hectares of net cropped area or even less) – has to produce for a 50 per cent increase in population by 2050 . . . [and must include new technologies] that produce more for the same unit of water, withstand climate change, overcome degraded lands . . . [and] cater to the fast-rising consumer concerns of food safety, apart from just increasing production. (p. 49)

Transgenic technology can improve agricultural production and raise farm-level incomes. Biotechnology policy should be based on scientific decision-making, constant monitoring of issues of environment and health, and increasing public-sector expenditure on transgenic research. Over-precaution and arbitrary decision-making in the past have not only stifled the deployment of first-generation transgenic technologies (herbicide and pesticide resistance), but have also delayed the development of second-generation transgenic crops. The latter includes transgenic crops that can address concerns of drought, floods, and salinity, and enhance nutritional content.

Beyond these arguments, there is another reason why we must have an organised approach towards transgenic crops. In the early 2000s, Bt cotton was grown illegally and on a wide scale by farmers who planted the crop to avoid losses arising from bollworm attack. It was only later that agriculture in India was forced to develop regulatory mechanisms. There are reports of Bt brinjal grown in Bangladesh being adopted by farmers in India in districts bordering Bangladesh (Herring 2015). Herbicide-resistant cotton has reportedly been used in the major cotton-growing States of Maharashtra (Beraand 2018) and Andhra Pradesh (Arya 2018). The eighth chapter of the book under review refers to farmers in Gujarat who use herbicide-tolerant cotton (referred to as triple Bt cotton) even though it has not yet been approved for commercial use. There is a possibility that the development and adoption of new technologies will overtake the perceptions of "civil society" organisations. In the meanwhile, an approach that favours a blanket ban on transgenic technology instead of formulating safeguards for its development and use is problematic for the primary users of transgenic crops – millions of small farmers. Farmers and agriculture in India will stand to lose if we miss this opportunity.

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