
Editorial: The economics of agricultural biotechnology – an overview

**Richard Bennett,* Bhavani Shankar
and Chittur S. Srinivasan**

School of Agriculture, Policy and Development,
Department of Agricultural and Food Economics,
The University of Reading,
Reading RG6 6AR, UK
Fax: +44-118-9756467
E-mail: r.m.bennett@rdg.ac.uk
E-mail: b.shankar@rdg.ac.uk
E-mail: c.s.srinivasan@reading.ac.uk

*Corresponding author

Biographical notes: Richard Bennett is a Professor of Agricultural Economics in the Department of Agricultural and Food Economics, School of Agriculture, Policy and Development at the University of Reading, UK. His research interests include the economic impacts of genetic modification in agriculture.

Bhavani Shankar is an Applied Economist working on Agricultural Development Issues, particularly GM crops in developing countries. He is coordinator of the Collaborative Unit for Biotechnology Economics and Social Science (CUBES) at the University of Reading, UK. He has been at the University of Reading since 1998 and has also worked for the Food and Agriculture Organization of the United Nations.

Chittur S. Srinivasan is a Lecturer in the Department of Agricultural and Food Economics, University of Reading, UK. His main research interests centre on the impact of intellectual property rights in agriculture and the economics of biotechnology. His recent research has focused on the impact of plant variety protection and agricultural biotechnology in developing countries.

This Special Issue is a timely one given the growing evidence and the number of studies on the economic impacts of genetically modified crops both in developed and developing countries. The papers contained within this Special Issue include consideration of the economic impacts of GM crops at the farm level, possible effects on national economies, consumer considerations, the influence of institutions and policies and implications for biodiversity in developed and developing countries. The papers highlight the many dimensions of the economic impacts associated with GM technologies.

The first four papers in this Special Issue estimate the farm-level economic impacts of GM crops based on various performance dimensions. The first round of literature had claimed significant success for the first generation of GM crop technologies. However, with the passage of time, more empirical evidence has been collected, the technology has been followed over a longer period of time, and the data have been subjected to a larger

variety of analytical techniques. As a result, studies coming to more nuanced conclusions are beginning to emerge. The paper by Shenghui Wang, Per Pinstrip-Andersen and David Just is one such, providing evidence to show that the emergence of secondary pests has gradually chipped away at the benefits of Bt cotton technology in China. They analyse primary household data over the 1999–2001 and 2004 periods in China, and incorporate a production risk dimension into their analysis via the use of stochastic dominance methods. The findings suggest that Bt cotton may need to be complemented with other forms of biological pest control to scale back the erosion of economic and environmental benefits. Otherwise, China (possibly along with other countries) is likely to experience disadoption. This paper highlights that the benefits of GM technologies may change over time and may, by themselves, not be sustainable unless used appropriately, for example, in conjunction with other technologies.

The production risk dimension is also addressed by Benjamin Crost and Bhavani Shankar, who estimate the risk effect of Bt technology on small holder farmers in India and South Africa using panel data sets. Using panel data provides a chance to control for farmer and farm heterogeneities which may well have biased previous cross-sectional estimates. Their analysis finds a risk-reducing effect of Bt cotton compared to conventional cotton varieties in India but an inconclusive picture in South Africa. Farmers in less-developed countries are generally risk averse and so a technology that is, at worst, risk neutral or better still one that is risk reducing is highly desirable.

Deepthi Kolady and William Lesser consider whether GM (Bt) eggplant is a good alternative to pesticide use from analysis of farm survey data and trial plot data in Maharashtra, India. This paper first carries out damage control productivity modelling to establish chemical input overuse in eggplant production, using survey data. It then moves to an analysis of Bt eggplant field trial data to speculate on the potential role that Bt technology can play. This study finds an over-use of pesticides in eggplant cultivation compared to optimum levels, because of the difficulty of controlling the eggplant shoot and fruit borer. The authors conclude that the GM technology is a good alternative to pesticide use for farmers growing vegetable crops with multiple harvests and heavy pesticide application in developing countries such as India. A technology that improves efficiency and potentially provides health and environmental benefits should therefore be welcomed.

Graham Brookes reviews the economic impacts of GM insect resistant (Bt) maize crops in the European Union over the 1998–2006 period. He finds yield and profitability benefits at the farm level and a reduction in insecticide spraying with associated environmental benefits. He also finds improvements in grain quality due to reductions in the levels of mycotoxins in the grain. Clearly, the former largely benefits the producer, but the latter is a clear benefit for consumers also. Demonstrating the potential benefits of GM for consumers is likely to be highly influential in the acceptance of GM food and feed products within the EU. This aspect is addressed by later papers in this Special Issue.

While impact assessment remains the theme in the next paper, the scale moves from the farm to the national level. Jeffrey Vitale, Harvey Glick, John Greenplate and Oula Traore analyse the case of Burkina Faso, which has shown more positive intent with regard to GM technology than much of the rest of West Africa. Their paper first reports on the first three years of Bt cotton field trials in that country. The trials found that Bt cotton increased yields by 20% and reduced pesticide applications by two-thirds.

Using an economic model of the cotton sector in Burkina Faso and extrapolating from the field trial data, they estimate that Bt cotton adoption would generate benefits of over \$100 million per year at the national level. This paper confirms that benefits of Bt cotton noted in other countries, such as South Africa, can also be realised by other African countries and potentially make a substantial contribution to the economies of these countries.

While much of the early literature on GM technologies in developing countries has been preoccupied with evaluating farm level benefits or surplus changes at the national level, fundamental development questions such as employment effects have been paid scant attention until recently. Jenifer Piesse and Colin Thirtle present some work in progress in their use of panel data for Africa, Asia and Latin America to investigate the effects of factor endowments and biased technological change (such as that associated with GM crops) on productivity growth, labour incomes and poverty reduction. They refer to different GM technologies in maize in South Africa. They show that, in terms of labour usage, Bt varieties are neutral, herbicide tolerant varieties are labour reducing and conventional high-yielding varieties associated with the Green Revolution are labour using. Their analyses suggest that it is labour productivity growth that reduces poverty and that because of this GM technologies, such as herbicide tolerant white maize combined with minimum tillage, can reduce or increase poverty depending on whether the technology is sufficiently output increasing for employment to be maintained when labour productivity is enhanced.

The political economy of regulatory decision making on GM technologies is an under-studied area with rich possibilities for future research, especially in developing countries. Seife Ayele studies such decision making in the contrasting cases of Ethiopia and South Africa, with special reference to biodiversity issues. Based on material drawn from policy documents and personal interviews, he concludes that scientific, technological and institutional capabilities are important determinants of which side of the adoption/rejection divide these countries fall on. He argues that inadequate scientific and technological capabilities can contribute to overly-protective policies in Africa, resulting in lost opportunities to add value to biodiversity-derived products. The potential benefits of GM for African countries, which currently are not being realised because of many countries' reluctance to adopt GM (which is linked to problems of GM acceptance in Europe and elsewhere) are hotly debated and this paper is a useful addition to that debate.

The issue of the impact of GM crop technology adoption on producer livelihoods is addressed in the paper by Stephen Morse and Richard Bennett. They present evidence from primary household data collection on the livelihood impacts of Bt cotton adoption by resource-poor farmers in Makhathini Flats in South Africa. They report that the vast majority of farmers experienced an increase in income from adopting Bt cotton and that this income was used to improve farm household livelihoods in a number of different ways. These include greater education for children, more investment in growing cotton, repaying debt, investment in other crops and an increase in asset base for most. This paper demonstrates that GM technology can result in real and tangible benefits to small, resource-poor producers in developing countries and can help to improve livelihoods.

The Special Issue concludes with two papers addressing acceptance of GM products by consumers, with particular emphasis on the role of trust. Wallace Yee and colleagues consider consumer attitudes to GM foods and their Willingness To Accept (WTA) them, using experimental auctions carried out in the USA, UK and France. Benefit perception

is found to be the key determinant of WTA, and this perception is found to be heavily influenced by trust in industry-provided information. Intriguingly, the final paper in the issue, by Andreas Boecker, comes to the conclusion that trust plays a relatively minor role in consumer product evaluation and risk perception in a sample drawn from Germany used in the research. Together, these two studies provide much food for thought about alternative ways to model the links between trust, benefit perception and GM product acceptance.

The papers presented in this Special Issue provide unbiased empirical analyses to help inform the ongoing debate concerning genetically modified crops and their associated merits and limitations from an economic perspective. There is a growing literature on the economic aspects of agricultural biotechnologies and we are sure that the papers presented here will be a welcome contribution to that literature.