Adoption and uptake pathways of biotech crops for small-scale farmers in China, India and the Philippines

Mariechel J. Navarro and Randy A. Hautea

Farmers coax seeds to grow and thrive in order to feed, clothe and provide fuel for themselves, their families and the rest of humankind. For a profession that builds on hope, the responsibility is great. Each day farmers tend their farms with an optimism that the investment they make on their land will eventually pay off in terms of higher yield, better productivity and enhanced quality of life for their families and communities.

Biotech, or genetically modified (GM), crops have been offered as a modern option for crop development to address the onslaught of pests and diseases, the vagaries of weather and other challenges to growing crops. Contrary to the notion that only farmers from developed countries are reaping the gains of modern biotechnology, about 85 per cent of farmers are small landholders in the developing countries of China, India and the Philippines.[1]

Small-scale farming in developing countries has been stereotyped as backbreaking, unprofitable and unappealing to the young

The project on the Adoption and Uptake Pathways of Biotech Crops by Small-Scale, Resource-Poor Asian Farmers: Comparative

Bt cotton production is still a male-dominated activity, but there is growing involvement of women in GM crop commercialisation in China

Studies in China, India and the Philippines was spearheaded by the International Service for the Acquisition of Agri-biotech Applications (ISAAA) to give a human dimension to the statistics on farmer adoption and uptake pathways of biotech crops and the changes these have brought about in the lives of resource-poor farmers. "Adoption" refers to how farmers acquire and eventually apply the knowledge and practices pertaining to the planting of a biotech crop, and "uptake pathway" involves the process of capturing how a biotech crop is introduced, adopted, spread and shared by farmers with others.[2]

Collaborators from the Center for Chinese Agricultural Policy, Chinese Academy of Sciences; the Indian Society of Cotton Improvement; and the College of Development Communication at the University of the Philippines Los Baños conducted three-country research in 2013 to gather insights on the following four questions:

1. Who are the biotech farmers?
2. What are the factors that farmers consider in adopting biotech crops?
3. How have they benefitted from adopting the technology?
4. Who influenced them in adopting biotech crops?

The research looked at Hebei, Shandong, Anhui and Henan provinces in the Huang-Huai-Hai cotton production zone in China, the cotton-growing states of Andhra Pradesh, Maharashtra and Punjab in India, and the maize-growing provinces of Pampanga, Iloilo and South Cotabato in the Philippines. These regions were surveyed to obtain farmer-related information. In addition,

discussion groups took place in different communities of about 10-20 farmer respondents. A participatory rural appraisal method called Innovation Tree Analysis was used for the qualitative part of the study. The method enables researchers to determine how the adoption of a biotech crop has started and spread in specific communities. It distinguishes various types of adopters and identifies social, economic, political and cultural factors that influence adoption, contextualisation and spread of an innovation. Several of these exercises were undertaken in the different study areas to identify the patterns or uniqueness of adoption and uptake pathways in particular communities.

Who are the farmers using GM crops?

Traditionally, small-scale farming in developing countries has been stereotyped as backbreaking, not commensurate with the efforts exerted, unprofitable, and particularly unappealing to the young. But farmers planting biotech crops paint a different picture. While *Bt* (insect-resistant) cotton production is still a male-dominated activity, there is growing involvement of women in GM crop commercialisation in China. Based on focus group discussions, indications are that more and more women are attracted to the benefits of growing *Bt* cotton as there is less labour involved than would otherwise be needed for pesticide applications. The three country surveys showed the dominance of male farmers, but the increasing role of women in production was revealed in the focus group discussions.

In China, the latest study suggests feminisation in Chinese agricultural production. Field work in cotton production was mainly conducted by women because the men engaged in more of the off-farm

Limited access to information about the new technology and inadequate government support contribute to delayed adoption

It is not the government agricultural extension services that are crucial in farmer adoption of new technology ...

jobs. Evidence from the focus group discussions indicates that the reduction in pesticide use and the labour saved due to the adoption of *Bt* cotton benefited women.[3]

In India, women were particularly observed to take an active role in farm operations such as weeding, picking and crop cleaning.[4]

In the Philippines, 75.1 per cent of farmer respondents were male. Land preparation and marketing were their major responsibilities. Although the women's role was mostly in food preparation and budgeting, they were seen to be increasingly involved in managerial tasks such as funding farm activities, deciding on inputs and hiring labourers to work on the farm.[5]

Filipino men dominate the planting process but wives control the input costs and spending, and thus are major decision makers in the choice of crop to plant and the farming methods to adopt. In Indian households the planting of *Bt* cotton has become a family affair, with the household head taking on the more strenuous activities and the mothers and children helping to pick and clean the cotton bolls.

In India, it is a significant sign that *Bt* cotton is attracting the young, with more than 50 per cent in the 21–40 age bracket among those surveyed in the cotton-growing areas of Punjab, Andhra Pradesh and Maharasthra.[4]

Interestingly, in the Philippines even college graduates are venturing into GM maize production, thus finding it a viable income-generating option. For

farmers in China, on average, the net revenue for *Bt* cotton from a unit of land is US$ 667.30 per hectare. In Anhui province, farmers earned US$ 860.30 per hectare, followed by farmers in Henan at US$ 657.40. Hebei farmers earned US$ 634.00 per hectare while Shandong farmers earned US$ 474.80 (2004 data).[3] The Philippines reports two to three times higher income from planting GM crops, while Indian farmers obtain twice the income compared to traditional varieties.[6]

Farmer leaders or village cadres have become local champions of GM crops as they take frontline action in trying out the technology

Reasons for adopting GM crops

Higher economic and yield benefits, freedom from or reduced infestations of cotton bollworm or corn borer, and a dramatic reduction in pesticide use and frequency of spraying are the principal motivators for adopting GM cotton in the three countries. The presence of private traders who sell seeds and provide capital loans, as well as the trust and strong ties between the farmers that contributed to the information flow on biotech crops, also facilitated adoption.

Yet, as with any technology, there are certain factors that limit or delay the adoption and uptake of biotech crops (Table 1). These include lack of capital and the high cost of farm inputs, especially in India and the Philippines. The influence of elders and church groups skeptical of biotech crops in these two countries were also noted. In China, local seed companies could not meet the demand for biotech seeds in the initial years of commercialisation. Limited access to information about the new technology and inadequate government support also contributed to delayed adoption.

Table 1. Limiting factors in the adoption and uptake pathways of biotech crops

Category	Limiting factors
Economic	• Lack of capital (India, Philippines) • High cost of farm inputs (Philippines) • Inadequate supply of biotech seeds due to high demand in the initial release of the crop (China) • Poor availability of seeds (Philippines) • Low market price of harvests (Philippines
Political	• Indecisive local politicians (Philippines)
Cultural	• Influence of elders skeptical of biotech crops (India) • Influence of church groups who are against GM products (Philippines)
Agriculture-related	• Lack of land areas for biotech crop production (Philippines) • Unsuitability of farm area for biotech crops (Philippines) • Availability of alternative crops to plant (Philippines) • Unfavourable weather conditions (India and Philippines)
Communication-related	• Lack of knowledge of biotech crops (all countries) • Misinformation about biotech crops (all countries)

Interestingly, it is not the government agricultural extension services that are crucial in farmer adoption of new technology. Rather, farmer leaders or village cadres have become local champions of GM crops as they take frontline action in trying out the technology after seeing a demonstration field trial, sharing their knowledge and signalling commitment to spread the benefits to fellow farmers within and beyond their community.

Carlos Guevara, a Filipino early adopter of GM maize, was given the National Farmer of the Year Award and feted by the Department of Agriculture. A risk taker and innovator, Guevarra is an inspiration to farmers in his community

who have tried the technology and reaped the benefits, thereby changing lives and communities. Filipino farmers planting *Bt* maize have registered unit yield increases of as much as 37 per cent, with a reduction in expenditure on insecticides of 60 per cent.[7]

Li Wenjing, a Chinese farmer from Hebei Province, was persuaded by his village council to grow *Bt* cotton. He tried planting the crop and noticed a significant reduction in the cotton bollworm population and use of pesticides compared to the traditional variety. As a result, his higher income enabled him to renovate his house and buy a new tractor and television set. Seeing the benefits and potential of the technology, Wenjing did not hesitate to recommend it to relatives and farmer friends in other villages.

Similarly, Mohammad Habibbudin, an Indian farmer from Andhra Pradesh, changed to *Bt* cotton after suffering a huge loss in yield due to bollworm infestation. This decision proved correct, as his eventual yield increased from some 1,000–1,250 kilograms per hectare using traditional varieties to around 2,500–3,000 kilograms per hectare using *Bt* varieties, and this was as a result of the control of the bollworm infestation rather than a direct increase in yield. Quite significantly, farmers in his village reduced the number of times they applied pesticides from 10–12 occasions on non-*Bt* cotton to only 2–3 occasions on *Bt* cotton for the control of other pests.[8]

Early adopters are usually committed to sharing biotech crop know-how with their relatives and peers

Uptake pathways of GM crops

Field research indicates that early-adopting farmers in India and the Philippines take the risk of a new technology by trying out a

It is not scientists, institutional advocates, extension officers or other government agents that play key roles in making farmers adopt a new technology

biotech crop which they initially heard about from a demonstration field trial set up by seed companies or from progressive village leaders. Other farmers in the community have a more "wait-and-see"' attitude, taking time to observe how things progress but becoming motivated to try the new crop after seeing the early adopters' convincing results of higher yields and bountiful harvests.

Early adopters are usually committed to sharing biotech crop know-how with their relatives and peers. Among the farmers and other actors in the farming system, knowledge-sharing is highly interpersonal and face-to-face. This is due to the strong prevailing peer system among farmers and the belief that they owe it to themselves and their fellow farmers to share what would benefit everyone in the community (Table 2).

In China, the role of village cadres is quite important in that they coordinate with technicians to arrange training and convince farmers to participate in activities. Hence, the factors that facilitate early adoption are three-fold: (1) support given by trusted village leaders for GM crop production; (2) close ties between farmers; and (3) avoidance of the heavy losses incurred by farmers cultivating non-GM crops.

Conclusion

The champions of GM crops are the farmers. It does not take much to realise that it is not scientists, institutional advocates, extension officers or other government agents that play key roles in making farmers adopt a new

Table 2. Facilitating factors in the adoption and uptake pathways of biotech crops

Category	Facilitating factors
Economic	• Financial benefits of cultivating biotech crops, e.g. good physiological and physical traits of crops, high quality and volume of harvests, lower expenses for labour and pesticides (all countries) • Proof of good yield and income provided by first and succeeding adopters (all countries) • Presence of private traders selling biotech crop seeds (all countries), providing capital loans for biotech crop production (India, Philippines), and buying harvests (all countries) • Availability of other financiers who provide the necessary capital for biotech crop production (Philippines) • Experience of financial losses from planting non-biotech crops in previous years (China, Philippines)
Political	• Village cadres help to coordinate *Bt* cotton training seminars and organise visits to *Bt* cotton demonstration fields (China) • Breeding contract between local seed companies and village chiefs for seed production (China) • Presence of farmer associations providing support, such as cooperatives (India, Philippines)
Cultural	• Trust and strong ties between farmers (all countries) • Rapid spread of information on biotech crops (all countries)
Agriculture-related	• Synchronised farming (Philippines) • Variety portfolio (China)

technology in the first place. At the end of the day, it is the individual farmer who makes the crucial decision of whether to plant a crop or not, decides on the variety to plant and adopts new techniques and cultural practices. He has tilled the land for so long, and has a wealth of experience informing what is best for him and his community.

Farmers are risk-averse and may need more progressive village leaders to outline the benefits of new technologies. Yet once they see the benefits there appears to be no turning back. Nevertheless problems still exist, requiring the participation and cooperation of both the public and private sectors.

The amazing fact is that farmer adoption of *Bt* cotton now accounts for more than 95 per cent of total cotton production in China and India, while 80 per cent of Filipino yellow corn farmers are planting biotech maize. Indeed, as an excerpt from the poem *The Farmer's Creed* articulates:

> *I believe that by my toil I am giving more to the world*
> *than I am taking from it, an honor that does not come to all men.*
> *I believe that my life will be measured ultimately by what I have*
> *done for my fellowman, and by this standard I fear no judgment.*[9]

References

1. **James C. (2013).** *Global Status of Commercialized Biotech/GM Crops: 2013*. ISAAA Brief No. 46. Ithaca, New York, NY, USA. Available at www.isaaa.org
2. **Navarro, M. and Hautea, R. (2014).** *Adoption and Uptake Pathways of GM/Biotech Crops by Small-Scale, Resource Poor Farmers in China, India, and the Philippines*. ISAAA Brief No. 48. Ithaca, New York, NY, USA. Available at www.isaaa.org
3. **Wang, X., Huang, J., Liu, H., Xiang, C. and Zhang, W. (2013).** *Adoption and Uptake Pathway of GM Technology by Chinese Smallholders: Evidence from* Bt *Cotton Production*. Center for Chinese Agricultural Policy, Chinese Academy of Sciences, Beijing, China. Available at www.isaaa.org
4. **Mayee, C.D. and Choudhary, B. (2013).** *Adoption and Uptake Pathways of* Bt *Cotton in India.* Indian Society for Cotton Improvement, Mumbai, India. Available at www.isaaa.org

5. **Torres, C., Daya, R., Osalla, M.T. and Gopella, J. (2013).** *Adoption and Uptake Pathways of GM/Biotech Crops by Small-Scale, Resource-Poor Filipino Farmers.* College of Development Communication, International Service for the Acquisition of Agri-biotech Applications SEAsiaCenter, and SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture, Los Baños, Laguna, Philippines. Available at www.isaaa.org
6. **ISAAA (2013).** *Cadres of Change: Transforming Biotech Crops in China, India, and the Philippines.* International Service for the Acquisition of Agri-biotech Applications, Center for Chinese Agricultural Policy, Chinese Academy of Sciences; Indian Society for Cotton Improvement; and College of Development Communication, University of the Philippines Los Baños. Ithaca, New York, NY, USA. Available at www.isaaa.org
7. **Yorobe, J. (2006).** Economic impact of *Bt* corn in the Philippines. *The Philippine Agricultural Scientist* 89: 258–267.
8. **ISAAA (2013).** *Farmers First: Feedback from the Farm*. International Service for the Acquisition of Agri-biotech Applications SEAsiaCenter, Los Baños, Laguna, Philippines.
9. *The Farmer's Creed.* http:agriculturepreud.com/2013/02/25/the-farmers-creed-poem-characteristics-of-a-farmer/

Authors

***Dr Mariechel J. Navarro**, Director of the Global Knowledge Center on Crop Biotechnology, International Service for the Acquisition of Agri-biotech Applications (ISAAA), Metro Manila, Philippines*

***Dr Randy A. Hautea**, Global Coordinator, International Service for the Acquisition of Agri-biotech Applications (ISAAA), Metro Manila, Philippines*