REPORTS

Prospects of Transgenic Food Crops in India

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***Bt* (*Bacillus thuringiensis*) eggplant may become the first transgenic vegetable crop to be commercialized in the Indian subcontinent. This exploratory study conducted in Maharashtra, India suggests that vegetable farmers are generally receptive to the technology - primarily for its pest resistance and cost saving attributes. While economic issues dominate the farmers' perception of *Bt* eggplant, ethical concerns were conspicuous for their absence. Nonetheless, the risks of the technology and risk management issues need to be better communicated through more effective channels such as the dealer network.**

Commonly referred to as the 'poor man's vegetable', eggplant is one of the most widely consumed vegetables in India. It is cultivated on 0.47 million hectares, mostly in the states of Orissa, Bihar, Karnataka, West Bengal, Andhra Pradesh, Maharashtra, and Uttar Pradesh (1). But each year, Indian eggplant farmers lose a significant portion of their crop – up to 100% - to a number of pests and diseases, including the highly destructive fruit and shoot borer.

Currently, chemical pesticides are the most common form of pest control used by Indian eggplant farmers. However, excessive pesticide use poses a risk to the health of farmers and

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consumers. Indeed, repeated pesticide application during the planting season has resulted in high levels of pesticide residues in the food chain. Persistent pesticide use also increases the resistance of pests to the chemicals, making the pesticides increasingly ineffective in long-term pest control (1).

Three groups in India – two from the public sector and one from the private sector - are developing transgenic *Bt (Bacillus thurigiensis)* varieties of eggplant that provide resistance to the fruit and shoot borer. The Indian Agricultural Research Institute (IARI) and Tamil Nadu Agricultural University (TNAU) are testing a variety that has the Cry1Ab gene while the Maharashtra Hybrid Seeds Company (Mahyco) is developing another that has the Cry1Ac gene (1). Given the widespread consumption and cultivation of eggplant in India, the development and commercialization of *Bt* eggplant has potentially significant economic and social implications for farmers in the country.

This exploratory study aims to assess Indian farmers' perception of the risks and benefits of transgenic *Bt* eggplant (The study is by necessity exploratory as the product is not yet available in farmers' fields and no farmer has any prior knowledge of the product). While there have been a number of reports on public attitudes toward agricultural biotechnology in developing countries such as Mexico, Philippines and South Africa (2, 3), almost all have focused on elite stakeholders such as policy makers, scientists and non-governmental organizations. To date, very little social science research has focused on the perception of marginal end-users such as farmers in developing countries.

As Indian farmers' understanding of agricultural biotechnology is likely to be minimal or nonexistent - survey findings show that most people even in the United States and Europe are not

able to give correct answers to basic questions about gene technology (4) - and as they are generally unfamiliar with survey research protocols, a narrative approach was used to elicit perceptions and concerns regarding the technology. As stories are the natural mode for humans to process information, narratives allow researchers to gain access to and express a network of beliefs (5). For example, it has been found that people use analogies to think about technology and frequently relate technical information to personal stories (6). Moreover, narratives can allow stakeholders to express their experience of stigma in ways that are not easily captured by the declarative statements of survey instruments (7). The narrative approach hence seems ideally suited to uncovering individual beliefs about a little known topic such as transgenic food crops. Significantly, narrative techniques have been found to be better predictors of public concern for environmental issues than more traditional methods (8). For this study, a prepared script describing the benefits and risks of *Bt* eggplant in a narrative format was read to the farmer, who was subsequently asked an open-ended question (i.e. "Please share with me any thoughts and feelings you have about this new eggplant seed") which was followed by a number of probes (9).

The eggplant farmers were selected using a quota sampling procedure. Given the incomplete records on eggplant farmers, true random sampling (and its variants) was not a feasible option. Maharashtra consists of four geopolitical regions – Marathwada, Kandesh, Western Maharashtra, and Vidharba. 90 farmers - 30 in Marathwada, 30 in Kandesh, and 30 in Western Maharastra,- were interviewed (10). In each region, the major eggplant growing districts were identified – Aurangabad and Jalna (in Marathwada), Dhule and Jalgaon (Kandesh), and Ahmednagar (in Western Maharashtra). Within each district, a convenience sample of eggplant farmers was interviewed. 30 was chosen as the "magic number" as very few new concepts emerge after 20-30

interviews, such that the interviewer hears mostly familiar beliefs beyond that number (11). For purposes of triangulation, 10 additional eggplant farmers from Pune district (Western Maharashtra region) were interviewed at a subsequent focus group session. Al interviews were conducted in the local Marati language with the assistance of a qualified translator who has a postgraduate degree and field experience in agricultural extension.

89 (out of 90) farmers identified the fruit and shoot borer as one of the main problems they face in eggplant cultivation - 78 of the farmers (86.7%) consider it to be the number one problem they encounter (12). 62 of the farmers (68.9%) have some basic knowledge of *Bt* cotton while 15 (16.7%) have grown the crop and thus have first-hand experience with transgenic *Bt* technology. 81 farmers (90%) cited improved yield or productivity as a key factor to consider when deciding whether or not to adopt a new variety, with 75 (83.3%) listing it as the number one or only adoption factor. Ethical or environmental considerations are conspicuously missing from the adoption criteria.

The strong focus on yield/productivity is not surprising. A number of earlier studies (e.g. 13, 14, 15) have indicated that the adoption of new crop varieties by farmers in developing Asian countries is driven by the economic ramifications associated with the new varieties. Thus, Indian farmers defied laws to obtain illegal *Bt* cotton seed on the black market because of its superior yield and the significant profits to be derived from the new transgenic variety (16). Indeed, a study on farmers' reactions to *Bt* cotton in Andhra Pradesh showed that yield improvement was the primary consideration in adopting the crop (13).

Besides yield, reduced pesticide application and expenditure (19 mentions) and better product quality (17 mentions) were considered to be the next most important adoption factors

(17). The farmers' emphasis on reduced pesticide application needs to be understood in context: to combat pests and diseases, many Indian farmers have been using farm chemicals such as pesticides and herbicides. However, farm chemical use comes with a high price tag: cotton farmers alone spend Rs 16 billion each year on pesticides while vegetable growers shell out US$100-200 per hectare despite the fact that insects inflict US$2.5 billion in annual losses on vegetable production (18). In the focus group discussion, the Pune district eggplant farmers revealed that on average, pesticides account for 20 to 25% of their total cost of production. This figure can increase to as high as 50-60% during the *Kharif* season. In addition to cost savings, several farmers pointed out that the use of *Bt* eggplant will enable them to reduce the considerable amount of time and physical labor entailed in manual pesticide application.

In response to the narrative script, farmers' perception of *Bt* eggplant focused on its economic benefits (56 of 90 farmers). A typical comment comes from a 28-year-old farmer in the Kandesh region:

> '"I have seen the good performance of *Bt* cotton with my own eyes this year. So, I believe that *Bt* eggplant - which uses the same technology - will provide better protection against the fruit and shoot borer and give me better yield."

In the Western Maharashtra region, a 40-year-old farmer said:

> "Presently, I'm cultivating 5 acres of eggplant and I'm spending 50,000 to 60,000 rupees on pesticides for these 5 acres. But I am getting just three to four lakhs' income from this acreage. If I can grow *Bt* eggplant and get two to three lakhs' income from just two to three acres, I will enjoy greater benefits. I can also reduce my pesticide costs from 50,000 rupees to probably 12,000 or 10,000 rupees…With *Bt* eggplant, I can reduce my eggplant acreage from 5 to 1.5 acres and devote the remaining land to planting other crops."

Benefits (or the absence of risk) to human and animal health are the next most important group of responses to the narrative (see table 1). For instance, a 44-year-old farmer in the Kandesh region said:

> "There is this problem of insecticide residues on vegetables. Over time, we have been spraying more and more insectide to control the fruit and shoot borer problem, but the residues remain on the vegetables – that's harmful to people. The *Bt* gene does away with the need for chemical sprays so there will be no residue on vegetables. Thus, *Bt* eggplant is 'pure'."

A 22-year-old farmer in the Marathwada region made this analogy:

> "Animals and human beings have been eating by-products of *Bt* cotton and there have been no reports of health problems. So, there is no question about any health risk in relation to *Bt* eggplant."

The need for official assurances of *Bt* eggplant's safety to human or animal health formed the third most important category of perceptions and concerns. According to a Jalna farmer:

> It is the company's duty to test whether *Bt* eggplant is safe for consumption. I want to get the assurance from company representatives and experienced farmers that it's safe before I will adopt it.

In short, economic (followed by health) issues dominate farmers' perception of *Bt* eggplant. Ethical concerns are conspicuous for their absence (19). The findings of the focus group discussion lend support to these observations. This appears to be in line with earlier claims that non-expert decision-making on risky technologies is often determined by economic and safety concerns (20, 21). Nonetheless, seven farmers withheld judgment and indicated a preference for a wait-and-see approach: they wished to see the trial results of *Bt* eggplant before forming any opinion on the technology. Indeed, the role of experience in farmers' decision-making is well documented (22).

Despite the absence of solicitations from the interviewer, 68 farmers expressed a clear interest in adopting *Bt* eggplant while 14 gave a qualified endorsement. The remaining 8 farmers did not express a judgment, were uncertain, or expressed no interest in adopting the transgenic vegetable.

While none of the 90 farmers (and the 10 in the focus group) expressed any concern with the need for a refuge area, the poor compliance with technical specifications for *Bt* cotton in India has caused concerns in the scientific community (23, 24). This state of affairs has been attributed to the Indian government's failure to educate farmers about the risks of transgenic crops as well as the serious difficulties faced by farmers (given their very small land holdings) in setting aside land to meet refuge criteria (24). A study found that while in general *Bt* cotton farmers in Maharashtra have adopted the recommended five-row refuge around the *Bt* plots, only two rows or three rows were seen at some places (25). Regular monitoring of Bt cotton by the Department of Agriculture to ensure compliance to Genetic Engineering Approval Committee (GEAC) guidelines appears to be nonexistent: a 2002 report by David and Sai (13) showed that farmers in their study had not been visited at all by any governmental functionary. As the Department of Agriculture continues to face several constraints in providing adequate extension support to farmers, little attention has been given to diagnostic field visits, capacity building, and advice on technological options (26).

Communicating to eggplant farmers about the risks of transgenic crops will be a tall order. Only 12 of the 90 farmers (13.3%) interviewed consider the mass media as a key source of information on agricultural innovations and products. Further, only 6 farmers (6.7%) mentioned state agricultural or university extension agents as a key source of agricultural information. This

study indicates that the most effective channel of communicating technical information to vegetable farmers in Maharashtra is the dealer network: 72 of the 90 farmers (80%) cited dealers as a key source of agriculture-related information while 65 farmers (72.2%) listed dealers as their top or only information source. The dealer plays several roles simultaneously: intermediary between seed companies and the farmers; credit facility, one-stop information resource, and social contact. Moreover, the local dealer shop is often a rendezvous for the farmers in a particular village.

Poverty persists for about 230 million Indians who remain food insecure because of the low productivity of their agricultural resources and lack of access to food (18). As part of a comprehensive package of solutions, *Bt* eggplant may reduce input costs, increase productivity, and boost incomes to help lighten the burden of poverty afflicting economically disadvantaged farmers in the country. Preliminary responses to the technology appear to be positive, but as this is an exploratory study, the results are not conclusive and further research is warranted.

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