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Bt Brinjal: Introducing Genetically Modified Brinjal (Eggplant/Aubergine) in Bangladesh

Mst. Meherunnahar and D. N. R. Paul*

Abstract

Brinjal, also known as eggplant and aubergine, is Bangladesh's third most important vegetable in terms of both yield and area cultivated. It is only surpassed by potatoes and onions. However, the yield of brinjal could be much higher would it not be decimated by the brinjal shoot and fruit borer, which is the most destructive insect pest in South and South East Asia. Genetically modified brinjal (Bt brinjal) has the potential to bump up agricultural productivity in Bangladesh and other countries. This paper provides a brief overview of Bangladesh's vegetable sector and reviews the key issues of introducing Bt brinjal in Bangladesh. It summarizes the results of recent research undertaken in Bangladesh on the environmental safety of Bt brinjal and concludes that Bt brinjal could make a significant contribution to Bangladesh's agricultural sector and more broadly, Bangladesh's economy and living standards.

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I. Introduction

Brinjal (*Solanum melongena L.*, also known as aubergine or eggplant) is an admired vegetable crop, grown all over the world, though there is a heavy concentration in Asia. In 2007, China and India contributed respectively 56 percent and 26 percent of the world's production of brinjal. The crop is mainly cultivated on small family farms and is an important source of cash income for many resource-poor farmers. It is also an important source of nutrition. Yet, the growth and production of brinjal is – due to a dozen of insect pest species, among which the most serious and vicious one is the brinjal shoot and fruit borer – significantly diminished.

Bt brinjal is the genetically modified version of regular brinjal. "Bt" stands for "Bacillus thuringiensis", which is a gram positive soil bacterium that contains a protein that is toxic to a narrow range of insects, including the brinjal shoot and fruit borer, but otherwise considered to be harmless to the environment by the majority of scientists. Strains of Bt have been used safely as commercial microbial pesticides.

Based on progress in other countries, a number of Asian countries, including Bangladesh, have recently developed a set of research programs on genetically modified food crops with potentially beneficial agronomic traits. In the last few years, the global production of genetically modified (GM) crops (mostly cotton and corn) has not only increased dramatically in terms of volume but also spread across countries. As stated in Choudhary and Gaur (2009, p. i), "in 2007, the twelfth year of commercialization of biotech crops, of the 23 countries growing 114 million hectares of biotech crops (equivalent to more than two-thirds of the total arable land of India), 12 were developing countries; and the trend in favor of developing countries is expected to continue in the second decade, as more and more developing countries from all three continents in the South embrace biotech crops."

This paper reviews the key issues of introducing Bt brinjal in Bangladesh and summarizes the results of recent research undertaken in Bangladesh on the environmental safety of Bt brinjal. It builds on the more comprehensive research recently undertaken in India by Choudhary and Gaur (2009). Genetically modified food crops have the potential to bump up agricultural productivity in Bangladesh and other countries. However, the long-term environmental safety of genetically modified crops (also called biotech crops) remains highly controversial. Despite increasing evidence on the safety of biotech crops, their production outside a secured experimental area could come with the risk of losing market access to biotech sensitive importing countries (mostly Europe), not only for the exports of biotech crops but for all crops of a commercial biotech country. The paper is structured as follows. The next section (Section II) provides a brief overview of Bangladesh's vegetable sector, followed by an overview of brinjal in section III. The fourth and fifth sections focus then on Bt brinjal and its environmental safety, before the last section provides some conclusions.

II. Bangladesh’s Vegetable Sector

Bangladesh’s economy is extremely dependent on its agricultural sector which accounts for about 35 percent of the country’s gross domestic product (GDP) and employs about two thirds of the country’s labor force (Runge and Ryan, 2004). Sustained government investment in irrigation facilities, rural infrastructure, agricultural research, and extension services have helped Bangladeshi farmers to achieve dramatic increases in agricultural production (Key and Runsten, 1999), though agricultural productivity continues to lack far behind that of India. The process of agricultural production is underpinned by the increasing use of agrochemicals and multiple cropping. Significant production transformation has been achieved and food production has more than doubled since independence in 1971 (Ali and Hau, 2001). This has helped to feed the country’s growing population, though food security still remains a major development issue in Bangladesh (Hoque, 2000).

Rice, wheat, jute, sugarcane, tobacco, oilseeds, pulses and potatoes are Bangladesh’s principal crops. In the past, before the onset of Bangladesh’s garment sector, jute was Bangladesh’s main export. The government is attempting to diversify the economy to avoid heavy reliance on a sector that is highly vulnerable to natural disasters, such as cyclones, droughts and floods. Producing enough food to sustain Bangladesh’s growing population is a major goal of the agriculture sector. However, Bangladesh still relies on imports to meet domestic demands especially during years when yields are inadequate. Bangladesh is a major importer of wheat as it is part of their staple diet, and imports about 3.3 million tons annually. Over the last few years, Bangladesh also imported approximately US$70 million of fresh and dry fruits per year as they are popular items amongst Bangladeshi consumers (James, 2006).

Table 1: Vegetable-Based Cropping Patterns in Bangladesh

<table>
<tr><th>Land Type</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Low land</td><td colspan="4">Rabi crops (cont.): maize, water melon, onion, chili, pulses, and oilseeds</td><td colspan="4">Rice, fish integration</td><td colspan="4">Rabi crops (beginning)</td></tr>
<tr><td rowspan="2">Medium land</td><td colspan="3">Rabi crops (cont.): maize, water melon, onion, chili, pulses, and oilseeds</td><td colspan="3">Summer vegetables</td><td colspan="3">HYV aman specially rice</td><td colspan="3">Rabi crops (beginning)</td></tr>
<tr><td colspan="4">Rabi crops (cont.): maize, water melon, winter vegetables, onion, chili, and pulses</td><td colspan="4">HYV aman specially rice</td><td colspan="4">Rabi crops (beginning)</td></tr>
<tr><td rowspan="2">High lands</td><td colspan="4">Cotton (cont.)</td><td colspan="4">Summer vegetables, jute</td><td colspan="4">Cotton (beginning)</td></tr>
<tr><td colspan="12">Perennials (banana, papaya, sugarcane) intercropped in the first Rabi season with pulses, oilseeds or vegetables</td></tr>
</table>

Source: Faruqee (1998).

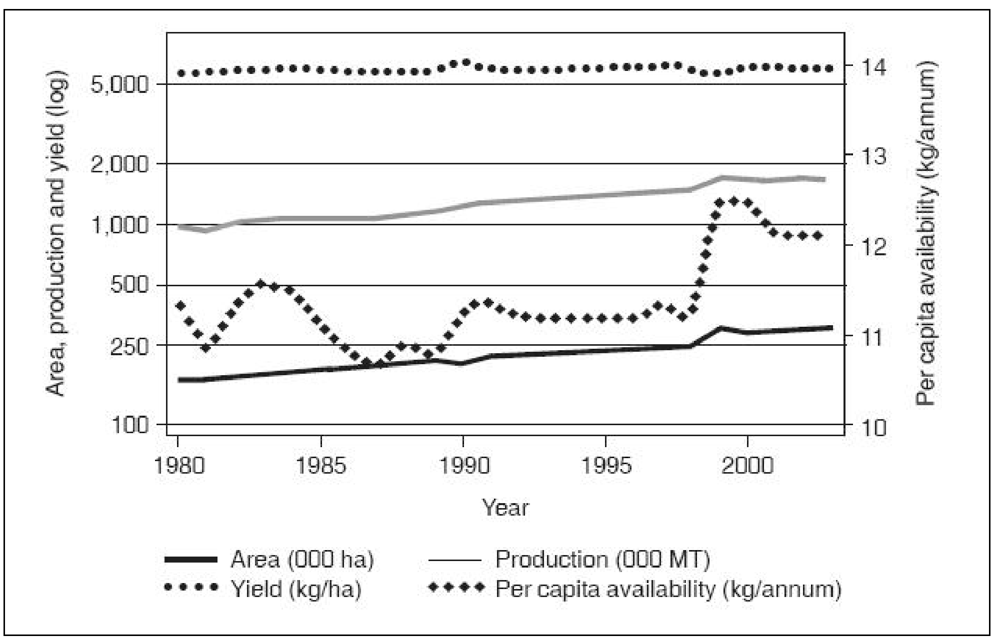
II.1. Vegetable Growing Patterns in Bangladesh

Based on the growing season, vegetables are categorized as summer/rainy season vegetables, winter season vegetables, and all-season vegetables (see Table 1). Winter season vegetables include tomato, cabbage, Chinese cabbage, cauliflower, brinjal/eggplant, carrot, spinach, bottle gourd, bush bean and radish. Crops like okra, heat-tolerant tomato, eggplant, carrot, spinach, many leafy vegetables and small onion are grown all year round. Summer vegetables are cultivated during the monsoon season from May to October. On the other hand, winter vegetables are grown from November to April. The production of vegetables is higher during winter (60 to 70 percent) and most districts produce a marketable surplus during that season.

II.2. Trends of Vegetable Production

Vegetable production in Bangladesh has increased between 1980 and 2003, with an average annual growth rate of 2.8 percent. Studies conducted by Quayum and Mustafi (2001) indicated that most of this growth can be attributed to area expansion (2.6 percent) and only a small share to yield increases (0.2 percent). Current yields of vegetables are 5.8 tons/hectare (t/ha) in 2003, as compared to 5.7 t/ha in 1980 (Weinberger and Genova, 2004). Excluding brinjal and potatoes, total average annual production of vegetables during 2000-2003 was 1.8 million tons, compared to 2.6 million tons during 1998 and 1999. The share of area under vegetable cultivation in total arable land has nearly doubled from 1980 to 2002, from 1.9 percent up to 3.6 percent (Asian Development Bank, 2001). This increase has also translated into greater per capita availability of vegetables, which increased from approximately 11 kg to 12 kg (see Figure 1 below). Altogether domestic vegetable availability is still far from fulfilling domestic demand, which explains the large trade deficit for horticultural products.

Figure 1: Trends of Vegetable Production in Bangladesh



Source: Weinberger and Genova (2004), Figure 3 (p. 8), based on FAOSTAT data 2004.

II.3. Main Imports and Exports of Vegetables

Based on the database of the United Nations Food and Agricultural Organization FAOSTAT, which does however not contain any information specifically on brinjal, Bangladesh imported an average of US$98.5 million of vegetables per year during 2004-2006, while it exported an average of US$15.4 million during the same period. The main vegetable imports in terms of US dollar values were onion and garlic, counting respectively to 75 percent and 21 percent of total vegetable imports during 2004-2006.

The main vegetable exports in terms of US$ values were in the FAOSTAT category of "vegetable freshness"[1], which amounted to 88 percent of total vegetable exports during 2004-2006. The second largest exports were potatoes, amounting to 6 percent of total vegetable exports during 2004-2006, though Bangladesh's potato imports exceeded Bangladesh's potato exports three times during 2004-2006.[2] Although vegetable production has increased over the years, its contribution to Bangladesh's total export earnings continues to be marginal. The United Arab Emirates, the United States and the United Kingdom are Bangladesh's largest export market for agri-food products.

II.4. Current Distribution of Vegetable Production

As Figures 2 and 3 below show, brinjal is the third most important vegetable of Bangladesh, in terms of both, production area (hectares) as well as in terms of production weight (tons). The share of brinjal amounted to 7.8 percent in terms of Bangladesh's vegetable production areas and to 4.8 percent in terms of production weight.

II.5. Relationship between Vegetables Consumption and Income

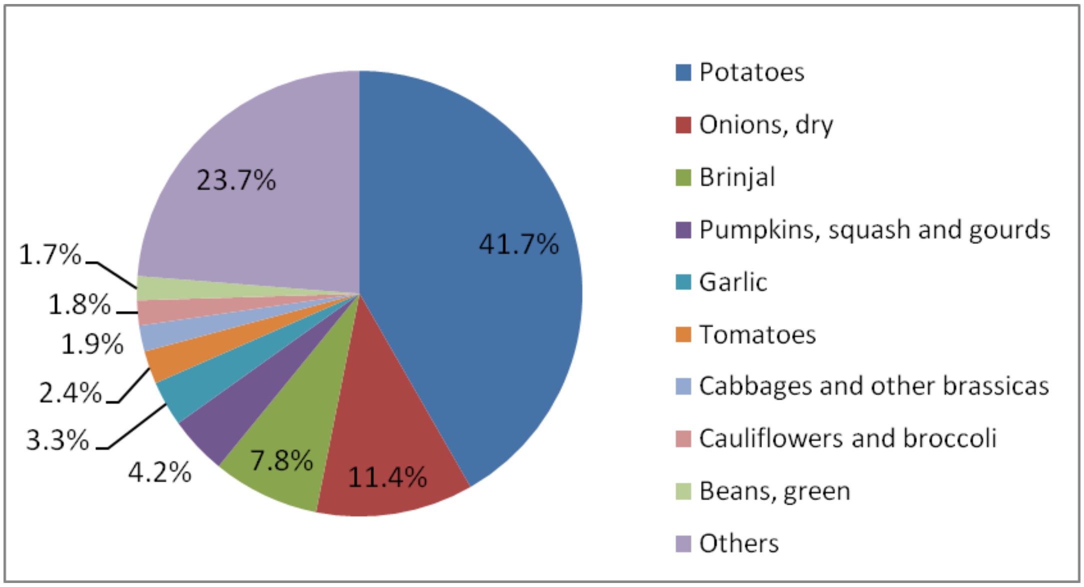
Studies from different time periods have shown that consumption of vegetables among women is more common in higher socioeconomic groups. Crawford et al. (2003) revealed that the daily consumption of fresh vegetables was more common among those with higher education and higher income, though the consumption of green leafy vegetables declines marginally with high income. In contrast, animal and fish consumption roughly doubles between low- and high-income families. Non-staple plant food consumption also rises with income. There are almost 50 percent increases in intake of non-staple plant foods between low- and high income families. In general the lack of income on vegetable consumption is a typical for non-staple foods. Although animal and fish consumption accounts on average for only 3 percent of total dietary energy intake, it

[1] The category of "vegetable fresh nes" includes bamboo shoots (Bambusa spp.), beets, chards (Beta vulgaris), capers (Capparis spinosa), cardoons (Cynara cardunculus), celery (Apium graveolens), chervil (Anthriscus cerefolium), cress (Lepidium sativum), fennel (Foeniculum vulgare), horseradish (Cochlearia armoracia), marjoram, sweet (Majorana hortensis), oyster plant (Tragopogon porrifolius), parsley (Petroselinum crispum), parsnips (Pastinaca sativa), radish (Raphanus sativus), rhubarb (Rheum spp.), rutabagas, swedes (Brassica napus), savory (Satureja hortensis), scorzonera (Scorzonera hispanica), sorrel (Rumex acetosa), soybean sprouts tarragon (Artemisia dracunculus), and watercress (Nasturtium officinale).

[2] The production, import and export of potatoes are highly volatile. While the import of potatoes has grown sharply from 1,400 tons in 2000, to 4,002 tons in 2005 and even 9,836 tons in 2006, Bangladesh imported 2,352 tons of potatoes already in 1980 but only 17 tons in 1985.

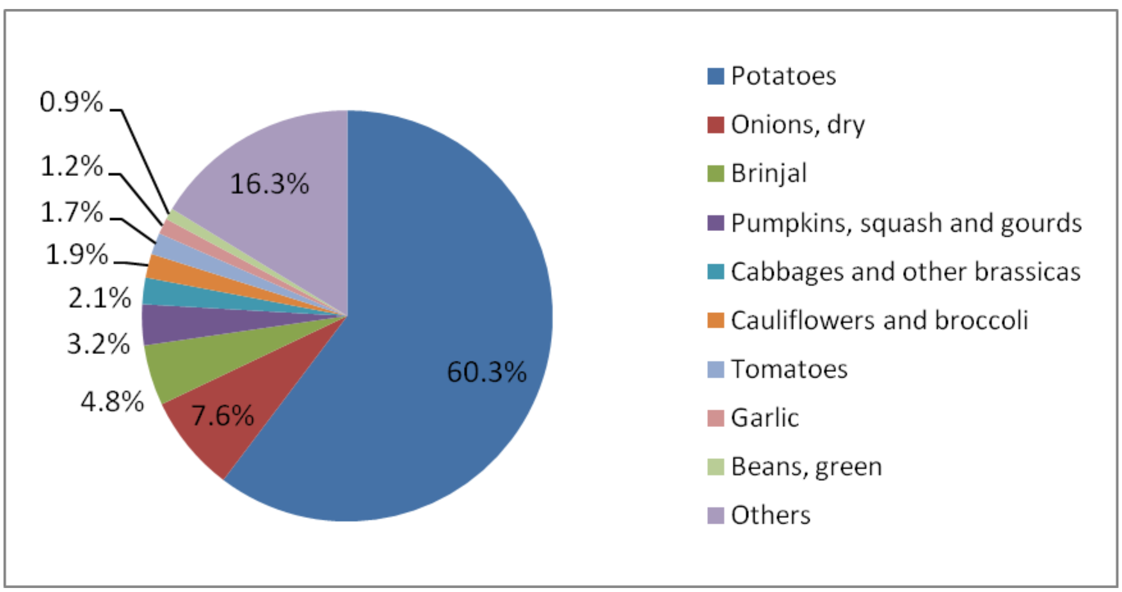
is striking that animal and fish consumption accounts for 20-25 percent of food budgets on average.

Figure 2: Distribution of Vegetables Production in Terms of Production Area (hectare)



Source: Compiled by authors based on data provided by FAOSTAT (FAO Statistics Division) as downloaded on February 27, 2009 and brinjal data provided by Choudary and Gaur (2009).

Figure 3: Distribution of Vegetables Production in Terms of Production Weight (tons)



Source: Compiled by authors based on data provided by FAOSTAT (FAO Statistics Division) as downloaded on February 27, 2009 and brinjal data provided by Choudary and Gaur (2009).

III. Characteristics of Brinjal

Though Bangladesh produced with 340,000 tons of brinjal only about 1.1 percent of the world's production in 2007, brinjal is like in other South Asian countries one of the most important vegetables. As Figures 2 and 3 showed, brinjal is third most important vegetable in Bangladesh, only surpassed by potatoes and onions. In Bangladesh, over 64,208 hectare of total cultivable land is devoted to brinjal cultivation.

Brinjal consists of almost 95 percent of water and is superior in terms of fiber, folic acid, manganese, thiamin, Vitamin B6, magnesium and potassium contents to that of most other vegetables. It has no fat and supplies 25 calories per serving. Please see Table 2 for further details.

Table 2: Nutritional Composition of Brinjal
(All values are per 100 gm of edible portion)

Nutrients	Value		Nutrients	Value
Moisture	92.70%		Calcium	18.0 mg
Energy	24 Kcal		Magnesium	16.0 mg
Fibre	1.3 gm		Phosphorus	47.0 mg
Fat	0.3 gm		Iron	0.9 mg
Protein	1.4 gm		Sodium	3.0 mg
Carbohydrates	4.00%		Copper	0.17 mg
Vitamin A	6.4 mg (124 I.U.)		Potassium	2.0 mg
Vitamin B	0.15 mg		Sulphur	44.0 mg
Vitamin C	12.0 mg		Chlorine	52.0 mg
Oxalic acid	18.0 mg		ß-carotene	0.74 µg

Source: As provided in Table 4 of Choudary & Gaur (2009), based on Chadha & Kalloo (1993)

The main problem with growing brinjal is that the yield of brinjal is decimated by a dozen of insect pest species, among which the most serious and vicious one is the brinjal shoot and fruit borer (FSB) (see Nair, 1986 and for further details). FSB is a small larva that bores inside shoots and bores into petioles and midribs of large leaves and tender shoots, causing shoot tips to wilt. Later on, they also bore into flower buds and fruits (see Figures 4 and 5 below). Attributable to its infestation, it affects the quality and quantity of fruits (Mall *et. al.,* 1992). Affected fruits are difficult to sell on the market (unless the price is discounted heavily) and contain significantly less vitamin C; see Abrol and Singh (2003) and Ghosh, Laskar and Senapati (2003).

The brinjal fruit and shoot borer (FSB) is the most destructive insect pest in South and South East Asia. To control this insect pest, farmers all over the world use large quantities of chemical insecticides singly or in combination to get blemish free fruits. In the district of Jessore, farmers spray pesticides 140 times during a cropping season of 180-200 days. As a result farmers suffer numerous health problems (including skin and eye irritation, nausea, and faintness), resulting from direct exposure to pesticide during handling and spraying (Rahman, 2000; and Wilson, 2001). In Bangladesh, almost all farmers experienced sickness related to pesticide application (e.g. physical weakness or eye infection or dizziness) and 3 percent were hospitalized due to complications related to pesticide use (see Alam et al., 2003, p. 38). In India, 43 percent of brinjal farmers suffered from health hazards due to various complexities related to pesticide application (Kolady and Lesser, 2005).

Figure 4: Plant Death Caused by FSB Larva

Source: Agricultural Biotechnology Support Project II (ABSPII) (2005)

Figure 5: Nonmarketable Brinjal Caused by FSB Larva

Source: Agricultural Biotechnology Support Project II (ABSPII) (2005)

IV. The Emergence of Bt Brinjal

Partly related to climatic conditions and the sensitivity of brinjal to diseases, the productivity of Bangladeshi brinjal is with 5.8 tons per hectare among the lowest in the world.[3] India produces with 16.5 tons per hectare nearly three times as many brinjal per hectare. Despite some progress in improving the productivity of brinjal in Bangladesh through new vegetable techniques, recent experiments have shown that the productivity

[3] See Table 5 of Choudhary and Gaur (2009), which provides detailed information on the worldwide area, production and productivity of brinjal in 2007.

of brinjal could be more than tripled in both Bangladesh and India by growing genetically modified brinjal (Bt brinjal).

Detailed socioeconomic studies were conducted along with large scale trials of Bt brinjal. Crawford et al. (2003) and Quasem (2003) indicated the potential of Bt brinjal to increase farmers' welfare through insecticide reductions and an increase in marketable yields of brinjal fruits. Different studies were conducted separately by different universities (like the University of Hohenheim by Stuttgart, Germany and the Singapore Management University) to demonstrate the socioeconomic impact of Bt brinjal. They found that Bt technology has a significant potential to increase farmers' welfare through insecticide reductions and sizeable increases in marketable yield.

Box 1: Bt brinjal: How is it developed?

Bt brinjal is a genetically modified brinjal, carrying an additional gene that provides an in-built insect protection against fruit and shoot borer (FSB). The development of Bt brinjal involves the introduction of the so-called cry1Ac gene, expressing insecticidal protein to confer resistance against FSB. The cry1Ac gene is sourced from environment friendly and ubiquitous soil bacterium called Bacillus thuringiensis (Bt), which has been frequently used as a biological control measure in granular or powder form to control FSB and other insect-pests for many years. The Maharashtra Hybrid Seeds Company (Mahyco), a leading Indian seed company, has developed a new DNA construct, which contains a gene sequence encoding insecticidal protein in all parts of brinjal plant throughout its life. The cry1Ac gene along with two other supporting genes namely nptII and aad genes are put together in such a way that they work in tandem to produce insecticidal protein that is toxic to the targeted insect, in this case the FSB. The cry1Ac gene is under the transcriptional control of the enhanced CaMV35S promoter (P-E35S), which works as an on/off switch and regulates when and where cry1Ac gene should express. This new strand of DNA is called the 'gene construct'.

Source: Adapted and summarized based on Choudhary and Gaur (2009), Section 7.3.

Diversification into vegetable crops and increasing commercialization can support the development of the agricultural sector in several ways. Using genetically modified crops has been characterized by households moving from subsistence systems into semi-commercialize and commercializes systems (Pingali and Rosegrant 1995). Similarly, increasing capital intensity in production and processing leads to growth in the agribusiness sector. As a result, the number of agro-processing, distribution and farm-input provision companies increases (Reardon and Barrett, 2000). Commercialization can take place on the output side—when the farmer sells his products on the market—or on the input side with increased use of purchased inputs (von Braun, 1995). If these changes take place, income and employment opportunities subsequently grow causing an increase in real wages, then increasing commercialization and the development of agribusiness contribute to overall growth and economic development in Bangladesh.

V. Impact and Safety of Bt Brinjal in Bangladesh?

Given the many advantages of Bt brinjal reported from studies outside Bangladesh, Bangladeshi scientists have started to analyze the safety of Bt brinjal. Seeds of Bt brinjal were imported (with the approval of the Bangladeshi government) from Mahyco Seed Research Centre, Maharastra Hybrid Seed Company Ltd, Jalna, India. The seed was sophisticated in an isolated contained field (i.e., greenhouses) at the headquarters of the Bangladesh Agricultural Research Institute (BARI) and seven regional agricultural research stations in Rangpur, Jessore, Mymensingh, Tangail, Bogra, Dinajpur, and Jamalpur districts. The plots were marked with wire mesh net which was alienated and no same species of crops were permitted to grow within the 200m isolation distance.

The following trials were ongoing studies taking place in Bangladesh. Further, there is much experience of non-chemical brinjal cultivation in farmers' fields by many farmers practicing organic and Integrated Pest Management (IPM) in the country. Trial results suggested a sizeable yield increase in Bt brinjal plots. On average the pest force of FSB was significantly reduced on Bt plots. The average shoot damage as well as the fruit infestation in Bt hybrids was far lower than that in non-Bt brinjal.

In addition to growth and pest studies, a variety of safety studies were conducted for Bt brinjal at BARI in order to comply with the Bangladeshi regulatory process. Data from such studies demonstrate that the protein which is inserted into genes causes no adverse effects on humans, wild and domesticated animals, birds, fishes and non-target insects, including beneficial insects. The safety of Bt proteins is attributed to the mode of action, specificity and digestibility. Scientists continued to conduct rigorous tests to ensure that Bt brinjal is safe for human consumptions or not. It was found that Bt brinjal is substantially equivalent to food and feed from non-Bt brinjals.

The safety of Bt brinjal was also tested in various feeding studies (including among others chicken, cow and fish, see Box 2 below) and no toxicity was detected and no new allergenic compounds were found due to feeding Bt brinjal. Finally, Bt brinjal fruits were used to determine whether the Bt protein was present in cooked fruits. The Bt protein was undetectable in cooked fruits. This study indicates that the Cry1Ac protein in Bt brinjal fruits is rapidly degraded upon cooking.

Based on these results, a series of consultations and focus group discussions with scientific, agricultural, and regulatory experts were conducted in Bangladesh in July 2007, focusing on the potential effects of biotechnology improvements to resist biotic and abiotic stresses. The status of research, agricultural constraints, the potential of biotechnology, and other issues related to regulatory approval and consumer acceptance of transgenic crops were discussed with relevant experts. Questionnaires were provided among the participants in order to elicit subjective estimates of potential yield and input effects of future new technologies. In parallel, existing national and international studies of GM technology, productivity constraints, and technology potential were obtained.

Box 2: Chicken, Cow, and Fish Feeding Studies

A chicken feeding study was conducted at Bangladesh Agricultural Research Institute (BARI), Gazipur. The study showed that body weight gain, feed intake and feed conversion ratio did not differ among Bt. and non-Bt. treatments. Several blood biochemical constituents did not differ statistically due to dietary treatments including Bt and non-Bt brinjal incorporated diets. This study found Bt brinjal to be as safe as non-transgenic brinjal.

Various cow feeding studies were conducted to assess the nutritional value of transgenic Bt brinjal fruit in comparison to non-transgenic (non-Bt) brinjal fruit in lactating cows in terms of feed intake, milk production and milk composition and to determine if the Bt protein was detectable in milk and blood of lactating cows fed ration containing transgenic brinjal fruits. From the study, it was concluded that the nutritional value of both transgenic and non-transgenic brinjal fruits were similar in terms of feed intake, milk yield and milk constituents without any adverse affect on health of lactating cows.

A fish feeding study was conducted at Central Institute of Fisheries Education, Bangladesh Agricultural University (BAU) in Mymensingh. The objective of this study was to evaluate Bt brinjal as a feed ingredient for common carp and to study the comparative growth and survival of fish fed with Bt brinjal. The study found that fish fed with Bt brinjal showed similar growth patterns to those fed with non-transgenic brinjal. There were no significant differences in terms of food conversion ratio, feed efficiency ratio and protein efficiency ratio among Bt and non-Bt brinjal treatments. Bt brinjal and non-Bt brinjal were found to be statistically similar in terms of fish growth responses and histopathological alterations in common carp.

VI. Conclusion

Given Bangladesh's fragile food security, the introduction of Bt brinjal could make a significant contribution to Bangladesh's agricultural sector and more broadly, Bangladesh's economy and living standards. Based on the studies undertaken so far in India and Bangladesh, Bt brinjal can be considered to be safe to the environment. Available information of scientific research indicates that the commercial use of Bt brinjal will not result in any adverse effects on the environment. Bt brinjal controls target insect pests without adversely impact of beneficial insects and other non-target organisms. It provides an ideal fit with Integrated Pest Management (IPM) and sustainable agriculture development programs.

Bt brinjal has agronomic benefits over conventional brinjal plants that must be sprayed with chemical insecticides for control of Lepidopteron pests. These benefits can be described as follows.

- Bt brinjal provides an effective means of control of lepidopteron insect pests specifically brinjal fruit and shoot borer and provides economic benefits to farmers.

- Bt brinjal controls target insect pests without adversely impacting beneficial insects and other non-target organisms.
- Growers can significantly reduce the amount of chemical insecticides applied to the crop while maintaining enhanced yields. Chemical insecticides are expensive and sometimes ineffective due to environmental conditions.
- Reduced use of insecticides will reduce worker exposure to pesticides; reduce the costs associated with manufacturing, packaging and shipment of insecticides.
- Bt brinjal provides an ideal fit with Integrated Pest Management (IPM) and sustainable agriculture development programs.

It was reported that the average shoot damage in Bt brinjal hybrids ranged from 0.06 percent to 0.4 percent as compared to 0.18 percent to 1.7 percent in non-Bt brinjal hybrids. The percentage of damaged fruits reportedly ranged from 2.5 percent to 20 percent in Bt brinjal to 24 percent to 60 percent in non-Bt counterparts. Heavy use of pesticide sprays also adds to the cost of non-Bt brinjal production. On average, it costs Bangladeshi farmers US$300/ha to produce hybrid non-Bt brinjal. Of that, 60 percent is spent on crop protection (based on a field assessment and estimates prepared by BARI consultants). With growing Bt brinjal, it is possible to reduce the costs of small and marginal farmers by 25-80 percent, largely due to the reduction in pesticides spray.

Brinjal bio-safety studies have shown no significant differences between Bt and non-Bt brinjal. In the Bangladesh brinjal sector, it is expected to bring about significant increases in productivity. It is currently being tested in the field and will be commercialized by BARI and East West Seed Company in open field but in restricted area.

While scientists were successful in inserting the Bt gene into brinjal, the concern on potential risks of the GM brinjal has been raised by various environmental non-governmental organizations (NGOs). Environmentalists and some health experts have warned the government against introducing any GM crop and food in Bangladesh without proper testing due to fear of possible health problems. Bangladesh's Ministry of Agriculture intends to release a type of genetically modified crops to farmers if ongoing research turns out to be successful and the government does not have any objection to GM technology.

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