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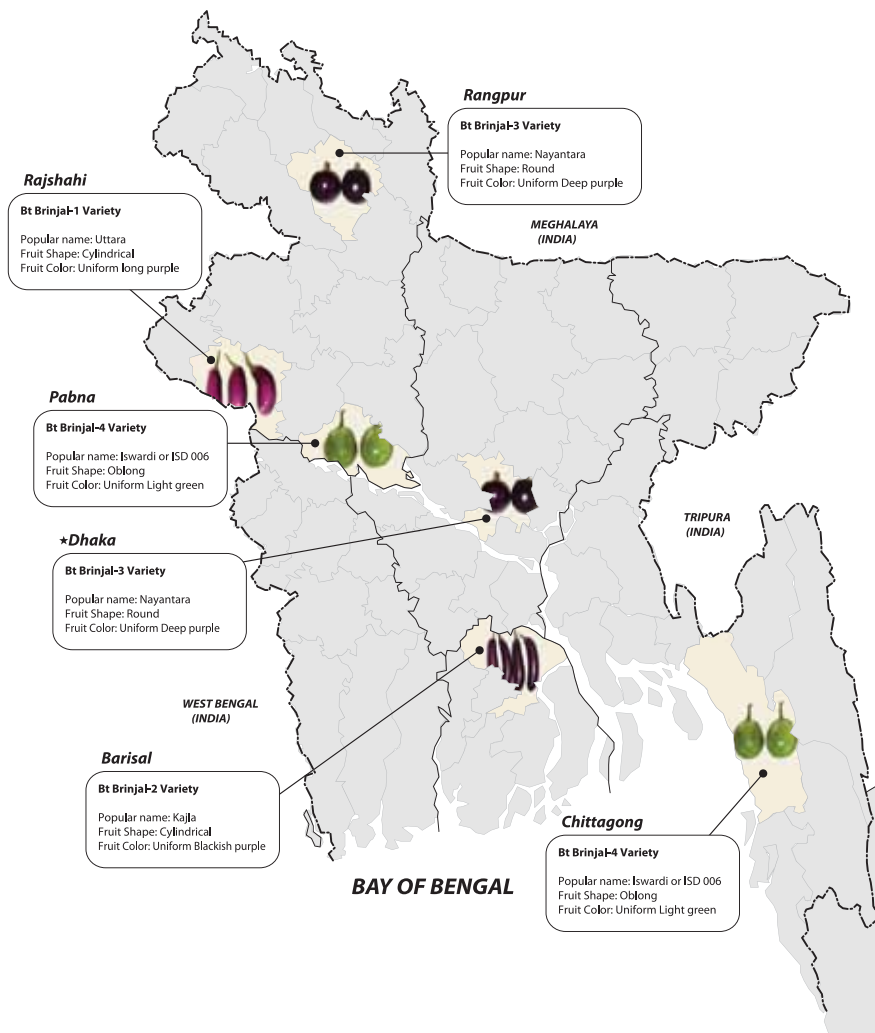
## ISAAA Briefs

### BRIEF 47

# The Status of Commercialized Bt Brinjal in Bangladesh

by

*Bhagirath Choudhary*  
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**Cover Picture:**

Map of Bangladesh illustrating the insect resistant Bt brinjal varieties approved for planting in six brinjal growing regions (map not to scale).

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## MESSAGE

The majority of people in Bangladesh depend heavily on agriculture sector for their sustenance and livelihood. With the limited arable land of 9 million hectares, the country produces 37 million metric tons of food grains annually. However, agriculture is becoming highly vulnerable to climate change with a large stretch of cultivated land facing unfavorable environment including tidal surge, floods and droughts. On the income side, half of the country's population lives on one fifth of the country's US\$115 billion GDP with agriculture contributing less than 20%. In an attempt to bridge income disparity, the Government of Bangladesh has made concentrated efforts to create enabling policy, increase investment and enhance R&D capacity to address challenges associated with agriculture and climate change. In 2013, the National Agriculture Policy 2013 was introduced to embrace a new value chain focusing on agricultural productivity, production and poverty alleviation by generating jobs and ensuring food security.

Bangladesh Agricultural Research Institute (BARI) has collaborated with many international institutions to deliver the benefits of biotechnology to farmers and consumers in Bangladesh. Insect resistant Bt brinjal, late blight resistant potato and nutritionally enriched golden rice have demonstrated the usefulness of biotechnology during the field trials conducted by BARI/BIRRI in different parts of Bangladesh.

The commercial approval of Bt brinjal is a step in right direction. First 20 farmers who received Bt brinjal seedlings from BARI have successfully raised the crop. They realized the significance of insect resistant Bt technology that helped them reduce chemical sprays and combat the infestation of a major insect pest of brinjal. Farmers successfully harvested fresh and blemish free brinjal. In the future, our institutes will produce enough quantity of Bt brinjal seeds and undertake large scale distribution to farmers across brinjal growing areas. The Government will also ensure that the experts regularly monitor Bt brinjal crop and report its performance. We accord the highest priority to the safety and benefits to the society but shun any activity that intends to spread misinformation and misguide the public about Bt brinjal or other products that are evaluated by public sector research institutions.

It is worth mentioning that Bt brinjal being open pollinated variety, farmers will be able to keep their seeds and will not be dependent on company at all. Bt brinjal is not a panacea to protect all biotic/abiotic stresses. Scientists should develop varieties to address other problems as well. Until then, the farmers need to take usual care to protect them.

ISAAA Brief 47 "The Status of Commercialized Bt Brinjal in Bangladesh" is a comprehensive report on development, regulation, approval, adoption and economics of Bt brinjal in Bangladesh. This document will help readers understand the rationale for commercial release of Bt brinjal in Bangladesh, where farmers often spray chemical pesticides every other day to save brinjal crop from damage. The document will also be useful to those who are directly and indirectly involved in sustainable agriculture and environment protection. I wish to congratulate the authors for bringing facts on Bt brinjal out to the people of Bangladesh and to the global society.

Joy Bangla, Joy Bangabandhu  
Long live Bangladesh.

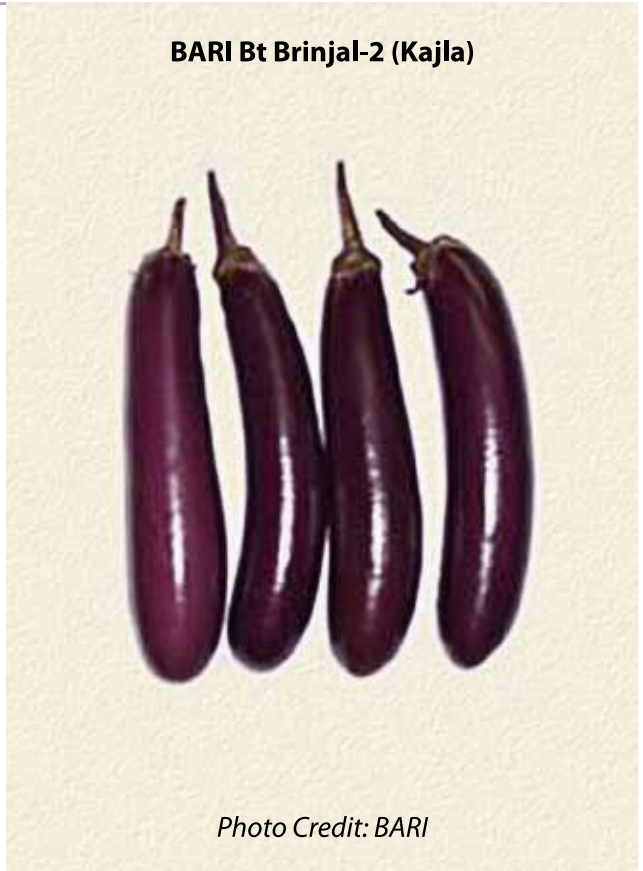
*Matia Chowdhury*  
(Matia Chowdhury)

**BARI Bt Brinjal-1 (Uttara)**



*Photo Credit: BARI*

**BARI Bt Brinjal-2 (Kajla)**



*Photo Credit: BARI*

**BARI Bt Brinjal-3 (Nayantara)**



*Photo Credit: BARI*

**BARI Bt Brinjal-4 (Iswardi/ISD006)**



*Photo Credit: BARI*

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## BANGLADESH: AGRICULTURE PROFILE



Population	: 154.7 million
GDP	: US \$ 115.6 billion
GDP per Capita	: US \$747
Agriculture as % GDP	: 19%
Agricultural GDP	: US \$22 billion
% employed in agriculture	: 47.5%
Arable Land (AL)	: 8.52 million ha
Ratio of AL/Population*	: 0.25
Major crops	: Rice, wheat, jute, pulses, potato, brinjal and other vegetables

Commercialized Biotech : Bt brinjal/eggplant (Begun)

Crop(s)

Total area under biotech : 2 ha

crops in 2014 (spring season)

*\*Ratio: % global arable land / % global population*

*Source: The Economist, supplemented with Data from the World Bank, FAO and UNCTAD when necessary.*

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## EXECUTIVE SUMMARY

**Brinjal (eggplant/aubergine) is a very important vegetable in Bangladesh where it is grown by about 150,000 very small resource poor farmers on about 50,000 hectares, in both the winter and summer seasons. Brinjal suffers regular and heavy losses from a very destructive insect-pest called the fruit and shoot borer (FSB) which conventional insecticides cannot control effectively. However, during heavy infestation, farmers have no option except to attempt controlling it by applying insecticides, sometimes every other day, up to a total of about 80 applications per season, resulting in serious implications for producers, consumers and environment. On 30 October 2013, in a historic decision, Bangladesh approved the official release of four biotech, genetically modified, varieties of insect resistant Bt brinjal for seed production and initial commercialization. Sowing of Bt brinjal began in early 2014 in the spring (basanta) season. The seedlings of four Bt brinjal varieties were distributed by Hon'ble Union Minister of Agriculture, Ms. Matia Chowdhury, to 20 small brinjal farmers on 22 January 2014, who became the first Bangladeshi farmers to plant Bt brinjal over 2 hectares in four representative regions of Gazipur, Jamalpur, Pabna and Rangpur where these varieties are well-adapted and carefully monitored. Bt Brinjal-1 variety, popularly known as Uttara, was planted in Rajshahi region; Bt Brinjal-2 (Kajla) in Barisal region; Bt Brinjal-3 (Nayantara) in Rangpur and Dhaka regions; and Bt Brinjal-4 variety, Iswardi/ISD006, was planted in Pabna and Chittagong regions of the country. The Bangladesh Agricultural Development Corporation (BADC) in collaboration with BARI has undertaken seed multiplication of four Bt brinjal varieties to be distributed to farmers in the forthcoming Kharif season 2014. By the next year, Bt gene will be introduced in five other popular brinjal varieties including Dohazari, Shingnath, Chaga, Islampuri and Khatkatia to meet the growing requirement of Bt brinjal seeds which will be planted in different brinjal growing areas. Notably, in the next five years, the government of Bangladesh plans to bring 20,000 hectares or approx. 40% of total 50,000 hectares across 20 districts under nine Bt brinjal varieties.**

**It is evident from the field performance of Bt brinjal that Bt technology is set to benefit farmers by mitigating economic losses and substantially increasing marketable yield, thus ensuring a bountiful harvest. For the first time, Bangladeshi consumers would have access to blemish-free brinjal fruits. Previous experimental data indicate that Bt brinjal can improve yield by at least 30% and reduce the number of insecticide applications by a massive 70-90% resulting in a net economic benefit of US\$1,868 per hectare. This is a princely sum for some of the poorest farmers in the world, in a country where the annual per capita income is only US\$700. At the national level, Bt brinjal is estimated to have the capacity to generate a net additional economic benefit of US\$200 million per year for around 150,000 brinjal growers in Bangladesh. Consumers will benefit from a cleaner, improved and more affordable food product.**

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## OVERVIEW OF BRINJAL CULTIVATION IN BANGLADESH

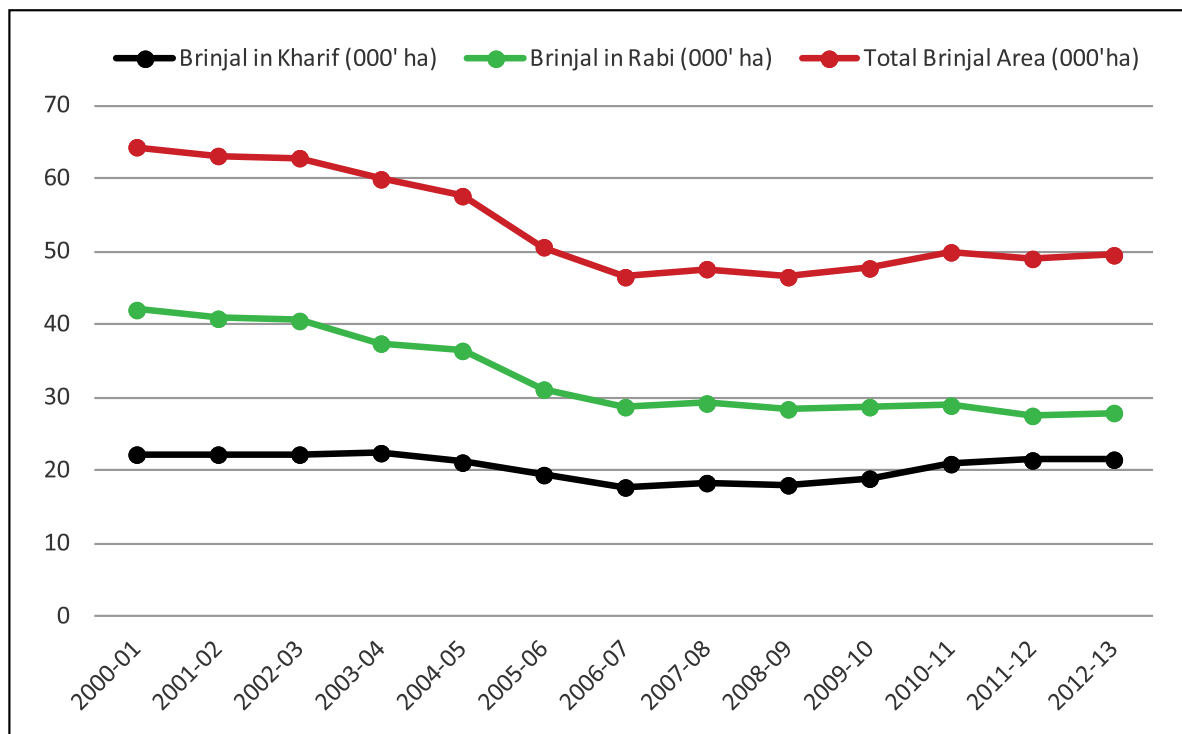
The People's Republic of Bangladesh is situated on the fertile Bengal delta in South Asia. It is bordered by India on three sides and by the Union of Myanmar on the South-East. Bangladesh with a population of around 150 million is one of the World's poorest and the most densely populated country. The World Bank categorizes Bangladesh as a low income country with 31.5% of the population living in extreme poverty and widespread hunger. The majority of Bangladeshi depend largely on agriculture, which contributes 20% of the gross domestic product (GDP) of US\$115 billion or equivalent of US\$700 per capita (FAO, 2013). Agriculture is characterized by small and fragmented land holdings and employs about two-thirds of the population. There are approximately 15 million farm households in Bangladesh, of which 85% are marginal and small farmers. Approximately 9 million hectares of arable land is cultivated with a per capita availability of less than 0.05 hectare, which is by far the smallest per capita land holding in the world. Notably, agriculture in Bangladesh is highly vulnerable to climate change. Large stretches of cultivated land face unfavorable environment with 2 million hectares being prone to tidal surge, 0.75 million hectares to floods and 1.3 million hectares to droughts (World Bank, 2011). Rice, potato, sugarcane, wheat, maize and vegetables, including onion and brinjal, are the principal crops in Bangladesh.

Brinjal (*Solanum melongena L.*) is one of the most important indigenous vegetables in Bangladesh (Saifullah *et al.*, 2012). In terms of consumption, brinjal ranks third after potato and onion. "*Begun bhaja*" is the most popular traditional dish in Bangladesh, which is eaten along with rice and fish curry. In particular, the dish "*Beguni*" is considered a must for an *Iftar* party in the holy festival of Ramadan in Bangladesh (Bdnews24, 2010; The Independent, 2013). Brinjal is grown on approximately 50,000 hectares by 150,000 farmers across the country. It is cultivated in two major cropping seasons - summer (*Kharif* season) and winter (*Rabi* season). However, farmers prefer to grow 60% of total brinjal under the favorable climatic conditions during the winter season. They plant different types of brinjal, varying in color, shape and size. The Bangladesh Agricultural Research Institute (BARI) has, under its conventional breeding program, released a dozen of brinjal varieties and hybrids, including 8 open pollinated varieties (OPVs) and 4 hybrids, in the last three decades for commercial cultivation in both seasons throughout the country (Chowdhury and Hassan, 2013). These brinjal varieties are very popular among farmers and widely planted in the intensive brinjal growing regions of Rajshahi, Gazipur, Jessore, Dhaka, Pabna, Chittagong, Ishurdi, Barisal, Rangpur, Jamalpur and Rangamati, among others.

Brinjal is transplanted from nurseries at different times of the year to produce two crops, each of 150 to 180 days' duration. Farmers start harvesting fruits after about 60 days of planting and continue to do so for 90 to 120 days, thereby, ensuring a steady supply of food for the family. Brinjal also provides a stable stream of income for most of the year, more particularly during the Ramadan and other festivities. Although, BARI released brinjal varieties with a promise of improved yield, the productivity of brinjal is under constant threat of crop losses due to insect-pests, particularly

the fruit and shoot borer (*Leucinodes orbonalis*). Over the years, the area under brinjal production, especially in winter season, has declined significantly compared to other vegetables because of the significant losses caused by the fruit and shoot borer (FSB). In 2012-13, Bangladesh planted approx 50,000 hectares of brinjal with a total production of 345,000 metric tons, against the country's total vegetable output of 3 million tons from 459,000 hectares. Brinjal occupies approximately 10% of the total area under vegetables in Bangladesh. Figure 1 shows the distribution of area under brinjal in Kharif and Rabi seasons in Bangladesh from 2000 to 2013.

**Figure 1. Area of brinjal in Kharif and Rabi Seasons in Bangladesh from 2000 to 2013**



Source: BBS, 2013; Compiled by ISAAA, 2014

The FSB is a major insect-pest of brinjal, which causes losses of up to 70% in commercial plantings. It not only damages shoots but also infests fruits, rendering them unfit for sale in the market. It is estimated that the fruit and shoot borer alone reduces marketable produce by about two-thirds (ABSP-II, 2007; Rahman, *et al.* 2002 and 2009). As a result, farmers are left with little choice except controlling it with insecticides, which invariably prove ineffective. Notably, farmers are often forced to apply insecticides every other day, amounting in some cases up to 80 sprays per season, at an unacceptable environmental cost and an unaffordable price of up to around US\$180 per hectare (Kabir *et al.* 1996; Meherunnahar and Paul, 2009). A socio-economic study on the impact of fruit and shoot borer conducted by the AVRDC - the World Vegetable Centre - in Jessore district of Bangladesh indicated that 98% of farmers relied exclusively on the use of pesticides and more than 60% sprayed their crop 140 times or more in the 6-7 months cropping season (Alam *et al.*

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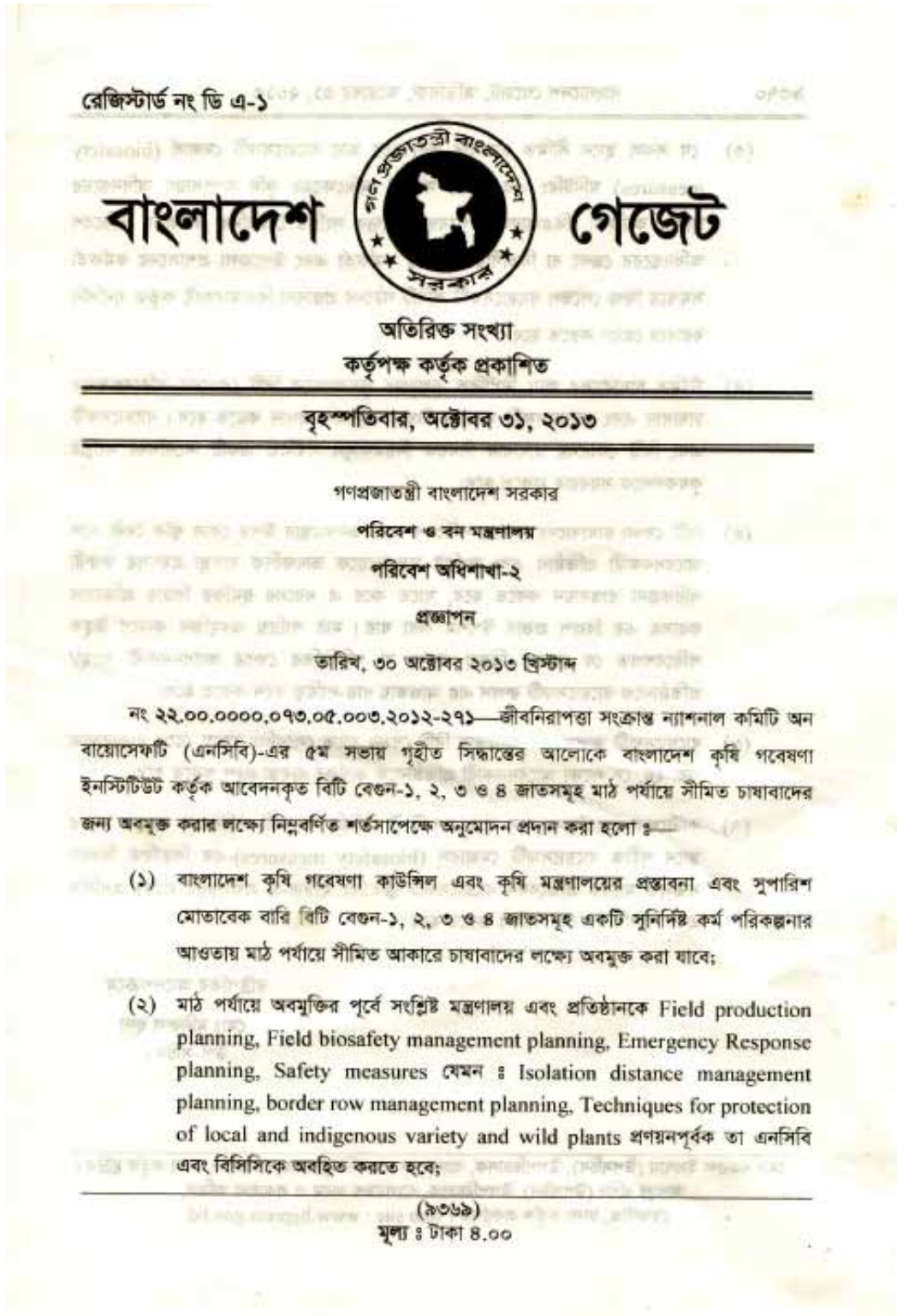
2003). AVRDC estimated that the pesticides alone contribute to one third (approximately 32%) of the total cost of production of brinjal, thus, constituting a major cost component of brinjal cultivation in Bangladesh. Significantly, farmers indiscriminately spray insecticides disregarding the recommendation, based on the economic threshold level (ETL), of spraying at an interval of 7-14 days or whenever necessary (Rashid and Singh, 2000). It is reported that the decision of farmers to spray is influenced more by subjective assessment of visual presence of FSB rather than by the more objective science-based methodology of economic threshold levels. This leads to gross over-application of insecticides, higher pesticide residues and needless increase in the farmers' exposure to chemical based insecticides (Choudhary and Gaur, 2009). This is wholly untenable for resource-poor small farmers, their families, environment and unwary consumers who unknowingly purchase and consume brinjal that have often been immersed in insecticides prior to sale in local markets. Readers are referred to ISAAA Brief 38 "The Development and Regulation of Bt Brinjal in India (Eggplant/Aubergine)" that carries the details of insecticides and a cocktail of other pesticides applied to control the menace of fruit and short borer. It also provides details of the origin, genetic diversity and biology of brinjal (Choudhary and Gaur, 2009).

## OFFICIAL RELEASE OF Bt BRINJAL IN BANGLADESH

In a historic decision, the Government of Bangladesh approved the official release of four varieties of insect resistant Bt brinjal for commercial cultivation in the country on 30 October 2013 (MOEF, 2013). The Ministry of Environment and Forests (MOEF) issued an official notification, following the approval, for limited cultivation in the fields of four Bt brinjal varieties developed by the Bangladesh Agricultural Research Institute (BARI) of the Ministry of Agriculture, Government of Bangladesh. These four Bt brinjal varieties, named Bt Brinjal-1, Bt Brinjal-2, Bt Brinjal-3 and Bt Brinjal-4, were approved based on the proposal and recommendation of the Bangladesh Agricultural Research Council (BARC), the Ministry of Agriculture (MOA) and the National Committee on Biosafety (NCB) of the Ministry of Environment and Forests. The commercial release notification issued by MOEF directed BARI to comply with the conditions stipulated in the order before release of Bt brinjal varieties in the field. The stringent conditions stipulated in the release order include;

1. preparation of field production planning, field biosafety management planning, emergency response planning, safety measures like isolation distance, border row management planning and techniques for protection of local and indigenous variety and wild plants;
2. formation of the field level biosafety committee for monitoring the biosafety measures to be taken in the area of limited Bt brinjal cultivation;
3. training of farmers for cultivation of Bt brinjal considering environment & biosafety measures;
4. marketing of Bt brinjal as per the seed labeling under the preview of biosafety rules;
5. contingency plan for any potential threat to environment and human health; and
6. proper and regular reporting to the National Committee in Biosafety (NBC) and the Biosafety Core Committee (BCC) regarding the details of biosafety measures taken in the area of release

Picture 5. MOEF'S Gazette Notification Permitting Cultivation of Four Varieties of Bt Brinjal in Bangladesh



Source: MOEF, 2013

- (৩) যে সকল স্থানে সীমিত চাষাবাদ করা হবে তার বায়োসেফটি মেজার্স (biosafety measures) মনিটরিং এর লক্ষ্যে সংশ্লিষ্ট অধিদপ্তরের কৃষি সম্প্রসারণ অধিদপ্তরের স্থানীয় কর্মকর্তা, বিএআরআই গবেষণাকেন্দ্রের সংশ্লিষ্ট বৈজ্ঞানিক কর্মকর্তা, পরিবেশ অধিদপ্তরের জেলা বা বিভাগীয় পর্যায়ের কর্মকর্তা এবং উপজেলা প্রশাসনের কর্মকর্তা সমন্বয়ে ফিল্ড লেভেল বায়োসেফটি কমিটি গঠনের প্রস্তাবনা বিএআরআই কর্তৃক এনসিবি বরাবরে প্রেরণ করতে হবে;
- (৪) সীমিত চাষাবাদের জন্য নির্ধারিত এলাকার কৃষকগণকে বিটি বেগুনের পরিবেশসম্মত চাষাবাদ এবং বায়োসেফটি সংক্রান্ত বিষয়ে প্রশিক্ষণ প্রদান করতে হবে। বায়োসেফটি এবং বিটি বেগুনের চাষাবাদ বিষয়ক নিয়মকানুন সম্বলিত একটি নির্দেশিকা সংশ্লিষ্ট কৃষকগণকে সরবরাহ করতে হবে;
- (৫) বিটি বেগুন চাষাবাদের কারণে পরিবেশ এবং জনস্বাস্থ্যের উপর কোন ঝুঁকি তৈরী হলে আবেদনকারী প্রতিষ্ঠান এবং সংশ্লিষ্ট মন্ত্রণালয়কে তাৎক্ষণিক ব্যবস্থা গ্রহণসহ জরুরী পরিকল্পনা বাস্তবায়ন করতে হবে, যাতে করে এ ধরনের হুমকির বিস্তার প্রতিরোধ করা হয় এর বিরূপ প্রভাব উপশম করা যায়। মাঠ পর্যায়ে অবমুক্তির কারণে উদ্ভূত পরিবেশগত যে কোনো বিরূপ প্রভাব বা পরিস্থিতির ক্ষেত্রে আবেদনকারী সংস্থা/ প্রতিষ্ঠানকে বায়োসেফটি রুলস এর আওতায় দায়-দায়িত্ব বহন করতে হবে;
- (৬) বায়োসেফটি রুলস এর আওতায় বিটি বেগুন যাতে লেবেলিং বজায় রেখে বাজারজাত করা হয়, সে লক্ষ্যে আবেদনকারী প্রতিষ্ঠানকে কার্যকর ব্যবস্থা গ্রহণ করতে হবে;
- (৭) কার্টাগেনা প্রোটোকল অনু. বায়োসেফটি টু সিবিডি অনুযায়ী পরিবেশে অবমুক্ত করার স্থানে গৃহীত বায়োসেফটি মেজার্স (biosafety measures)-এর বিস্তারিত বিবরণ সম্বলিত মাসিক প্রতিবেদন বায়োসেফটি স্ক্রয়ারিং হাউজ-এ প্রকাশনার লক্ষ্যে এনসিবি এবং বিসিসি বরাবরে দাখিল করতে হবে।

রাষ্ট্রপতির আদেশক্রমে

মোঃ মনিরুল হুদা

উপ-সচিব।

মোঃ নজরুল ইসলাম (উপসচিব), উপপরিচালক, বাংলাদেশ সরকারি মুদ্রণালয়, তেজগাঁও, ঢাকা কর্তৃক মুদ্রিত।  
আবদুর রশিদ (উপসচিব), উপপরিচালক, বাংলাদেশ ফরম ও প্রকাশনা অফিস,  
তেজগাঁও, ঢাকা কর্তৃক প্রকাশিত। web site : www.bgpress.gov.bd

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of Bt brinjal on monthly basis for publication in the biosafety clearing house according to the Cartagena Protocol on Biosafety of the Convention of Biological Diversity (CBD).

Subsequently, Bangladesh's Ministry of Agriculture along with the Bangladesh Agricultural Research Institute (BARI) and USAID organized Bt brinjal seedlings distribution program which was attended by the Union Minister of Agriculture Ms. Matia Chowdhury, Ms. Janina Jaruzelski the Mission Director of USAID Bangladesh, Dr. Md Kamaluddin the Executive Chairman of BARC, Md SM Nazmul Islam the Agriculture Secretary and Dr. Md Rafiqul Islam Mondal the Director General of BARI. Also present were hundreds of participants, including policy makers, scientists, farmers and media personnel in the function held on 22 January 2014 at the auditorium of the Bangladesh Agricultural Research Council (BARC), Dhaka. The Union Agriculture Minister, Ms. Matia Chowdhury, distributed seedlings of Bt brinjal to selected 20 farmers, five farmers each from Gazipur, Pabna/ Ishurdi, Jamalpur and Rangpur – the four important brinjal growing regions of Bangladesh. Each farmer was given Bt brinjal seedlings for planting one bigha (about 0.13 hectare). These seedlings were sufficient to plant a total of 2 hectares of Bt brinjal in the spring season of 2014 (Financial Express, 2014; Daily Star, 2014; Dhaka Tribune 2014; New Age, 2014; BD News 24, 2014).

After the limited commercial release of Bt brinjal by MOEF on 30 October 2013, BARI raised 30-35 days old Bt brinjal seedlings of four Bt brinjal varieties to ascertain the purity and quality of Bt brinjal seedlings to be distributed for the first time to farmers in Bangladesh. The distribution and planting of Bt brinjal seedlings on a limited area of 2 hectares distributed equally on 5 bighas each in four different brinjal growing regions complied strictly with the MOEF notification issued on 30 October 2013 that allowed limited cultivation of four Bt brinjal varieties under a well-defined work plan (MOEF, 2013).

Addressing the gathering while distributing Bt brinjal seedlings to farmers, the Agriculture Minister maintained that there was no alternative to the genetically modified (GM) crops to ensure food security (SABP, 2014). *"We have decided to start cultivation of Bt brinjal after conducting different necessary tests at home and abroad. We have taken a long time to experiment with the pros and cons of introducing the cultivation of this variety,"* said Ms. Chowdhury (Daily Star, 2014). Adding that the government was always alert to any negative impact on public health and environment from the cultivation of Bt brinjal, Ms. Chowdhury said that the conventional brinjal farming required extensive use of insecticides, which posed a serious threat to farmers, consumers and environment. She observed that to protect brinjal from FSB, farmers generally sprayed pesticides up to 60 to 180 times in a season, posing a grave threat to agro-ecology and the vegetable itself. *"Bt Brinjal came as a remedy to that as it had the built-in capacity to fight FSB and would require no pesticides"*, emphasized Minister Chowdhury.

The USAID Bangladesh Mission Director, Ms. Janina Jaruzelski, while participating in the distribution of Bt brinjal seedlings, stated that commercial release and cultivation of Bt brinjal would offer a choice for farmers and consumers. USAID has supported the development of Bt brinjal in



Picture 6. Bangladesh Union Minister of Agriculture Ms Matia Chowdhury Distributing Bt Brinjal Saplings to Farmers

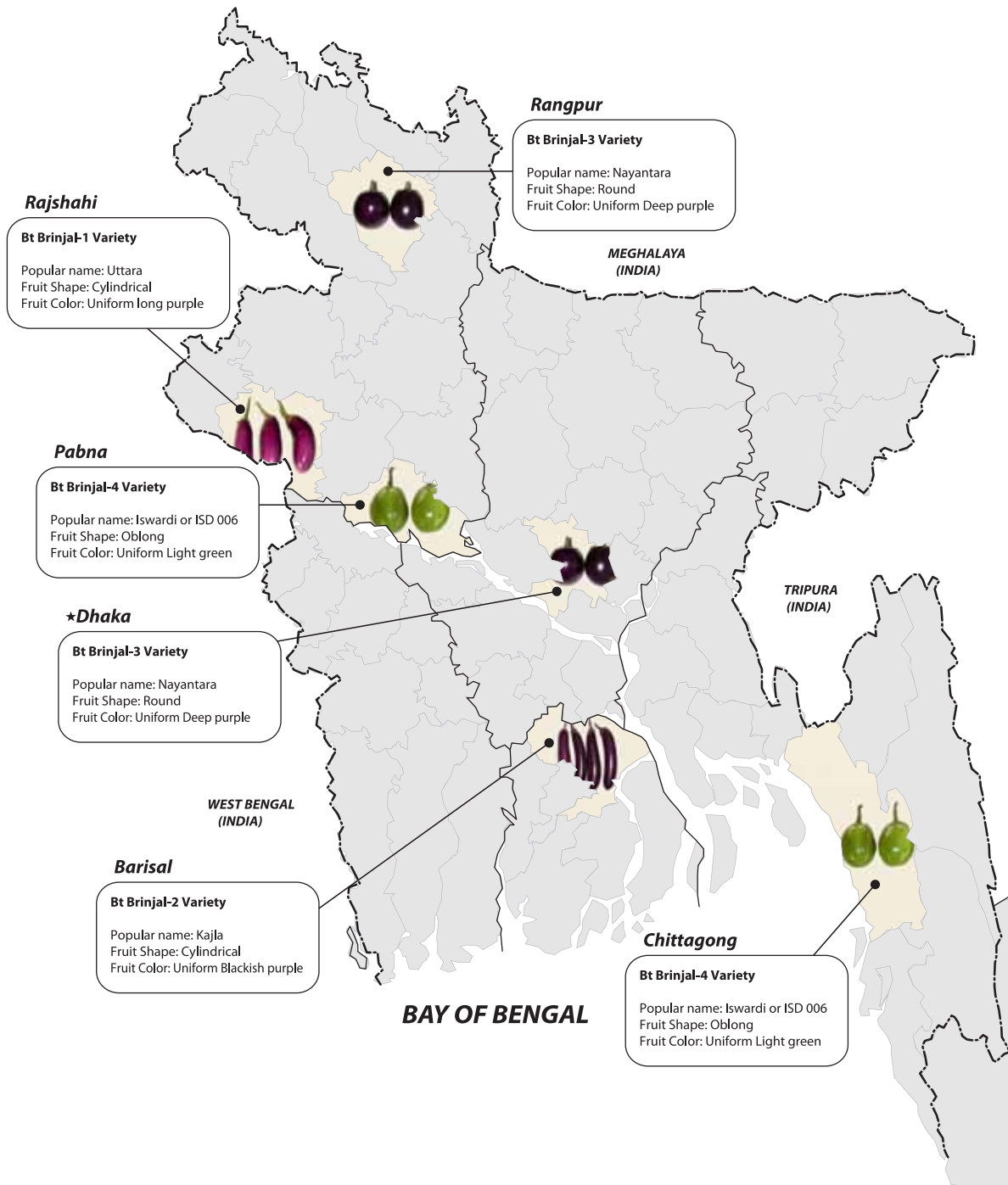


Photo Credit: Mahin Rashid/USAID

Bangladesh through the Agricultural Biotechnology Support Project II (ABSP-II) of the Cornell University in partnership with the BARI. *“It is the country’s own choice whether to use or not to use bio-tech products or Bt brinjal. It is also individual farmer’s choice whether they find it comfortable”*, said Ms. Jaruzelski. Citing the importance of biotechnology in vegetables Ms. Jaruzelski pointed out that *“The use of huge amount of pesticide on a single crop in order to try to save it from insects affects the safety of the food. It also gets into the ground water, goes into the lakes, into the streams, into the rivers, and affects other plants. It affects wildlife, fish, and birds. The advantage (in Bt) is its special seed which is resistant to insects. So it can be used by farmers, with much less fertilizer and, more importantly, much less pesticides,”* (BD News 24, 2014).

In the first year of approval, Bangladesh planted a limited area of approximately 2 hectares under commercial cultivation and seed production of four Bt brinjal varieties, including Bt Brinjal-1 (Uttara), Bt Brinjal-2 (Kajla), Bt Brinjal-3 (Nayantara) and Bt Brinjal-4 (Iswardi/ISD 006). These varieties were planted in the spring season of 2014, covering 2 hectares out of the total brinjal area of 50,000 hectares planted by about 150,000 farmers. Notably, Bt brinjal varieties were planted for seed multiplication and limited cultivation in the country’s four intensive brinjal growing regions. Bt brinjal-1 variety (Uttara) was planted in Rajshahi region, Bt brinjal-2 (Kajla) in Barisal region, Bt brinjal-3 (Nayantara) in Rangpur and Dhaka regions and Bt brinjal-4 variety Iswardi/ISD006 in Pabna and Chittagong regions. Figure 2 depicts the map of Bangladesh illustrating four Bt brinjal varieties approved for planting in six regions.

**Figure 2. Map of Bangladesh Illustrating Insect Resistant Bt Brinjal Varieties Approved for Planting in Six Regions**



Source: Compiled by ISAAA, 2014

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## CHARACTERISTICS OF COMMERCIALY RELEASED Bt BRINJAL VARIETIES IN BANGLADESH

Table 1 shows the characteristics of different Bt brinjal varieties approved for commercial planting in four major brinjal growing regions of the country. The Cornell University-led Agricultural Biotechnology Support Project II (ABSP-II), facilitated the transfer of Bt brinjal event EE-1 from Indian private seed company Mahyco to the BARI (ABSP-II, 2007; ABSP-II, 2014). BARI later introgressed Bt brinjal event EE-1 into locally adapted and commercially popular open-pollinated brinjal varieties (OPVs) of Bangladesh. Interestingly, the country's Bt brinjal project is primarily a public sector initiative led by the BARI of the Ministry of Agriculture to develop pro-poor brinjal varieties resistant to FSB (*Leucinodes orbonalis*). Out of the nine popular varieties which were introgressed with Bt event EE-1, four popular ones were approved for commercial cultivation in October 2013. Other five varieties namely Dohazari, Shingnath, Chaga, Islampuri and Khatkatia are field tested for their agronomic performance and environmental impact assessment and will be considered for commercial release in near future.

In fact, the commercially approved Bt brinjal varieties as well as their non-Bt counterparts are the proprietary commercial varieties of the BARI. The selection of non-Bt brinjal varieties for introgression with Bt trait was based on their agronomic performance, consumer preference for different characters like color and shape and popularity in different brinjal growing regions. These non-Bt brinjal varieties, approved for commercial cultivation by BARI in different zones, include Uttara (released in 1985), Kajla (in 1998), Nayantara (in 1998) and Iswardi/ISD 006 (in 2002). By introgressing Bt trait in these varieties, Bangladeshi farmers now have access to the same popular brinjal genotypes with additional advantage of being more durable, blemish-free and resistant to insect-pests. To dispel the notion that farmers would have to purchase expensive Bt brinjal seeds, BARI, a premier public sector institution, has been entrusted with the responsibilities to multiply and distribute the open-pollinated Bt brinjal varietal seeds at low cost through the public distribution system. Farmers would be able to retain, re-sow and reuse the seeds of these open-pollinated Bt varieties season after season (BARI, 2013). Table 1 shows the characteristics and status of commercially released Bt brinjal varieties in Bangladesh. The characteristics of each of these four approved Bt brinjal varieties are briefly described below;



**BARI Bt Brinjal-1 (Uttara)** - This variety was approved for commercial cultivation in Rajshahi region of North-Eastern Bangladesh. Bt Brinjal-1 plants are bushy and yield a uniform long, purple colored and cylindrical fruits in clusters. Both, the original non-Bt brinjal variety Uttara and its Bt version Bt Brinjal-1, were developed and released by BARI in 1985 and 2013, respectively.



**BARI Bt Brinjal-2 (Kajla)** - This Bt brinjal variety of the BARI approved for commercial cultivation in Barisal region of Bangladesh, yields uniform blackish purple fruits of cylindrical shape. Both, non-Bt brinjal variety Kajla and its Bt version Bt Brinjal-2, were developed and released by BARI in 1998 and 2013, respectively.



**BARI Bt Brinjal-3 (Nayantara)** - This Bt brinjal variety was approved for commercial cultivation in Rangpur and Dhaka regions of the country. It bears round fruits of dark purple color. The non-Bt brinjal variety Nayantara as well as its Bt version Bt Brinjal-3 were developed and released by BARI in 1998 and 2013, respectively.



**BARI Bt Brinjal-4 (Iswardi or ISD 006)** - This Bt brinjal variety was approved for commercial cultivation in Pabna and Chittagong regions of Bangladesh. It yields uniform light green colored oblong fruits. Both, non-Bt brinjal variety Iswardi and its Bt version Bt Brinjal-4, were developed and released by BARI in 2002 and 2013, respectively (Rashid and Singh, 2000; Chowdhury and Hassan, 2013 and MOEF, 2013).

**Table 1. Commercial Release of Four Bt Brinjal Varieties in Bangladesh**

Variety/ Popular name	Gene/ Event	Developer	Fruit shape	Fruit color	Region of Bt brinjal release	Date of release	Status
Bt Brinjal-1/ Uttara	Cry1Ac/ EE-1	Bangladesh Agricultural Research Institute (BARI)	Cylindrical	Uniform Light purple	Rajshahi	30 Oct 2013	Seed multiplication & limited planting
Bt Brinjal-2/ Kajla	Cry1Ac/ EE-1	Bangladesh Agricultural Research Institute (BARI)	Cylindrical	Uniform Blackish purple	Barisal	30 Oct 2013	Seed multiplication & limited planting
Bt Brinjal-3/ Nayantara	Cry1Ac/ EE-1	Bangladesh Agricultural Research Institute (BARI)	Round	Uniform Deep purple	Rangpur and Dhaka	30 Oct 2013	Seed multiplication & limited planting
Bt Brinjal-4/ Iswardi or ISD 006	Cry1Ac/ EE-1	Bangladesh Agricultural Research Institute (BARI)	Oblong	Uniform Light green	Pabna and Chittagong	30 Oct 2013	Seed multiplication & limited planting

Source: Rashid and Singh, 2000; Chowdhury and Hassan, 2013; MOEF, 2013; Compiled by ISAAA, 2014

Picture 7. Bt Brinjal Field in Gazipur, Bangladesh



Photo Credit: ABSP-II/Cornell University

Picture 8. Bt Brinjal Field in Rangpur, Bangladesh



Photo Credit: ISAAA, 2014

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## ADOPTION OF Bt BRINJAL IN BANGLADESH

On 30 October 2013, in a historic decision, Bangladesh officially approved the release of four biotech varieties of insect resistant Bt brinjal for seed production and initial commercialization. The planting of Bt brinjal started in early 2014 in the spring (*basanta*) season. The seedlings of four Bt brinjal varieties were distributed by Hon'ble Union Minister of Agriculture, Ms. Matia Chowdhury, to 20 small brinjal farmers on 22 January 2014. They became the first Bangladeshi farmers to grow Bt brinjal in the country.

In the first year of sowing, Bangladesh planted a limited area of approximately 2 hectares for commercial cultivation and seed multiplication of four Bt brinjal varieties including Bt Brinjal-1 (Uttara), Bt Brinjal-2 (Kajla), Bt Brinjal-3 (Nayantara) and Bt Brinjal-4 (Iswardi/ISD 006). These four varieties were planted in spring season 2014 covering 2 hectares of the estimated 50,000 hectares of total brinjal planted by estimated 150,000 farmers across the country. Brinjal is primarily grown in two main seasons, Rainy season (*Barsa*) from mid-June to mid-August and winter season (*Sharat*) from mid-October to mid-December. However, in many areas, farmers also extend growing brinjal in the remaining seasons including autumn (*Sharat*) from mid-August to mid-October and spring (*Basanta*) from mid-February to mid-April. To begin with, each of the 20 farmers were given Bt brinjal seedlings to be planted on one bigha (about 0.13 hectare) totaling 2 hectares in the spring season 2014 (Financial Express, 2014; Daily Star, 2014; Dhaka Tribune 2014; New Age, 2014; BD News 24, 2014).

After the initial limited commercial release on 30 October 2013, BARI raised 30-35 day old Bt brinjal seedlings of four Bt brinjal varieties to ensure their purity and quality for distribution to farmers for the first time. These seedlings were planted on a limited area of 2 hectares, spread equally on 5 bighas each in four different brinjal growing regions. The cultivation complied strictly with the Ministry of Environment and Forests notification issued on 30 October 2013 that allowed limited cultivation of four Bt brinjal varieties under a well-defined work plan (MOEF, 2013). Farmers began harvesting Bt brinjal fruits in early June 2014. A large quantity of Bt brinjal fruits were procured by the BARI for seeds processing, grading and packaging for distribution to large number of brinjal farmers for growing in rainy and subsequent seasons. It is expected that a modest quantity of Bt brinjal fruits would be marketed for consumption.

The experience of initial limited planting of Bt brinjal in spring season 2014 shows that Bt technology is set to mitigate economic losses to the farmers and substantially increase the marketable yield. The country would have a bountiful vegetable harvest. Besides, the Bangladeshi consumers would, for the first time, have access to blemish-free brinjal fruits. Previous experimental data indicates that Bt brinjal can enhance yield by at least 30% and reduce the number and cost of insecticide applications by a massive 70-90%. This would result in a net economic benefit of US\$1,868 per hectare. This is a princely sum for some of the world's poorest farmers in a country where the

**Picture 9. Farmer Mansur Sarkar in his Field with Fellow Farmers in Gazipur, Bangladesh**



*Photo Credit: ABSP-II/Cornell University*

**Picture 10. Farmer Mansur Sarkar with his Family Members in his Bt Brinjal Field**



*Photo Credit: ABSP-II/Cornell University*

annual per capita income is only US\$700. At the national level, Bt brinjal is estimated to have the potential to generate a net additional economic benefit of US\$200 million per year for the country's 150,000 brinjal farmers. The consumers would benefit from a cleaner, better and more affordable food product. Table 2 and 3 show the variety and location wise distribution and adoption of Bt brinjal in the spring season 2014.

**Table 2. Adoption of Bt Brinjal in Bangladesh in Spring Season 2014**

Year	Adoption of Bt Brinjal (ha)	Total Brinjal Area (ha)	Nos of Bt brinjal Farmers	% Adoption
2014 (spring season)	2	50,000	20	<1

Source: Compiled by ISAAA, 2014

**Table 3. Distribution of Bt Brinjal in Bangladesh in Spring Season 2014**

Bt Brinjal Variety	Location	Area per Trial (m <sup>2</sup> )	No. of Bt Brinjal Farmers	Distribution of Bt Brinjal Seedlings per Farmer	Distribution of Bt Brinjal Seedling per Location	Total Bt Brinjal Area (m <sup>2</sup> )
BARI Bt Brinjal-1	Rangpur	1000	5	1140	5700	5000
BARI Bt Brinjal-2	Gazipur	1000	5	1140	5700	5000
BARI Bt Brinjal-3	Jamalpur	1000	5	1140	5700	5000
BARI Bt Brinjal-4	Ishurdi/ Pabna	1000	5	1140	5700	5000
<b>Total</b>	<b>4</b>	<b>4000</b>	<b>20</b>	<b>4560</b>	<b>22800</b>	<b>20000</b>

Source: Adapted from BARI, 2014

## PUBLIC PRIVATE PARTNERSHIP AND REGULATORY DEVELOPMENTS

The Bt brinjal project in Bangladesh is a good example of a successful public-private partnership in technology transfer. The technology was generously donated by Mahyco: an Indian company and brokered under the aegis of USAID Program - the Agricultural Biotechnology Support Project II (ABSP-II) managed by the Cornell University (ABSP-II, 2014). Mahyco also donated Bt brinjal technology to public sector institutions in India and the Philippines. In Bangladesh, Mahyco donated the Elite Event (EE-1) to BARI in a public-private partnership arrangement in 2005. This event expresses insecticidal protein *cry1Ac* in brinjal that effectively controls the infestation of target insect-pest, the fruit and shoot borer (FSB). Supported by ABSP-II, the BARI scientists in collaboration with Mahyco, developed Bt brinjal by introgressing EE-1 event into 9 brinjal varieties of Bangladesh. These 9 open pollinated brinjal varieties are the most popular varieties of brinjal among small holder farmers in the country. Bt brinjal varieties were evaluated for their agronomic performance, safety and efficacy in consonance with the biosafety regulatory requirement of the Bangladesh government.



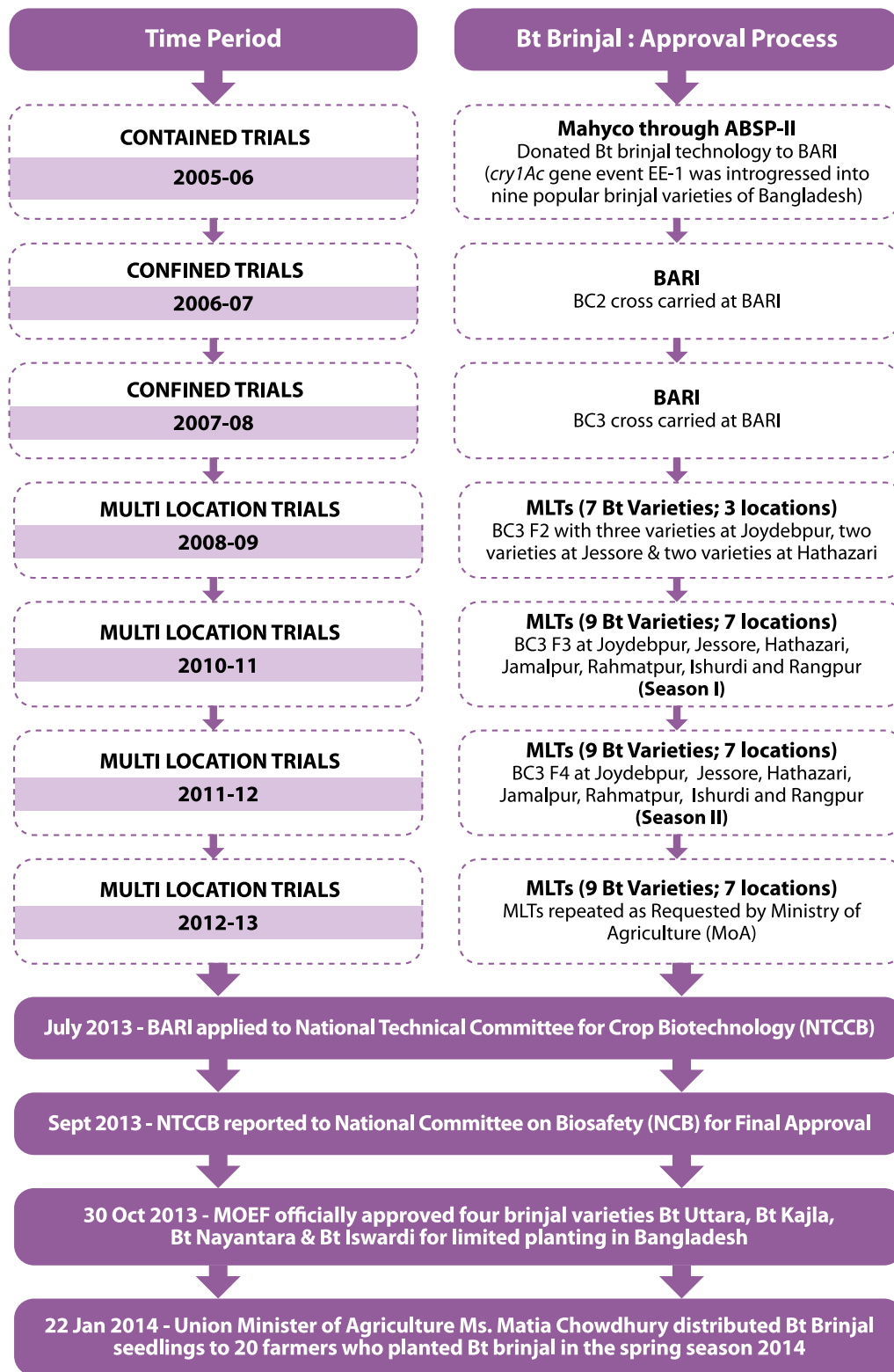
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Figure 3 describes the chronology of development of Bt brinjal in Bangladesh. Bt brinjal was field tested under contained, confined and open field condition for 7 consecutive seasons from 2005-06 to 2013-14. The contained and confined field trials were undertaken for 9 Bt brinjal varieties from 2005-06 to 2007-08. The first set of multi-location field trials were carried out in 2008-09 for 6 Bt brinjal varieties, Uttara, Dohazari, Nayantara, Shingnath, ISD006 and Chaga at three distinct brinjal growing areas of Joydebpur, Jessore and Hathazari. Subsequently, in 2010-11 and 2011-12, two-season multi-location field trials were carried out involving all 9 Bt brinjal varieties including additional three Bt brinjal varieties - Kajla, Islampuri and Khatkatia, These trials were held in seven locations of Joydebpur, Jessore, Hathazari, Jamalpur, Rahamatpur, Ishurdi and Rangpur that represented major brinjal growing areas of the country. This apart, multi-location field trials of 9 Bt brinjal varieties were conducted again in 2012-13 in response to the instructions from the Ministry of Agriculture to revalidate the agronomic performance and environmental effects of Bt brinjal. These 7 years of rigorous field testing of Bt brinjal were conducted under the direct supervision of the public sector scientists of the BARI of Ministry of Agriculture in compliance with the biosafety and regulatory guidelines of the Ministry of Environment and Forests.

To comply with the Bangladeshi regulatory process, a set of biosafety studies were conducted to confirm that Bt brinjal causes no adverse effects on humans, wild and domesticated animals, birds, fishes and non-target insects, including beneficial insects. The nutritional studies carried out by the Dhaka University confirmed that Bt brinjal is substantially equivalent to its non-Bt counterpart. In addition, the feeding studies on chicken, cow and fish showed no sign of toxicity and allergenicity and found it to be safe for consumption. The studies also confirmed that Bt protein was undetectable in cooked brinjal fruits. On the whole, the biosafety studies have shown no significant differences between Bt brinjal and its non-Bt counterparts.

On completion of all the biosafety studies on Bt brinjal in Bangladesh, BARI submitted the biosafety dossier of Bt brinjal to the National Technical Committee for Crop Biotechnology (NTCCB) of the Ministry of Agriculture seeking approval of Bt Brinjal in 2013. The NTCCB constituted an expert committee to evaluate and review the biosafety data submitted by the BARI. In Sept 2013, the expert committee reviewed and validated scientific testing and findings as rigorous and technically sound and submitted its report to the Ministry of Agriculture. The NTCCB reexamined the expert committee report and sent its recommendation for approval of Bt brinjal to the National Committee on Biosafety (NCB) of the Ministry of Environment and Forests which is the apex regulatory body empowered to accord the commercial approval to GM crops in Bangladesh. In a landmark decision, the NCB approved limited cultivation of Bt brinjal. Consequently, the Ministry of Environment and Forests issued a notification for the official release of four varieties of Bt brinjal for limited cultivation in the country on 30 October 2013 (MOEF, 2013). Later on, the Union Agriculture Minister, Ms. Matia Chowdhury, distributed seedlings of Bt brinjal varieties to selected 20 farmers, five farmers each from Gazipur, Pabna/Ishurdi, Jamalpur and Rangpur – the four important brinjal growing regions of Bangladesh.

Figure 3: Chronology of the Regulatory Approval of Bt Brinjal in Bangladesh, 2005 to 2014



Source: Compiled by ISAAA, 2014

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It is estimated that Bt brinjal increases yield by at least 30% and reduces insecticide applications and cost by 70-90%, thus, providing a net economic gain of US\$ 1,868 per hectare, which is deemed a princely sum for small poor farmers (Islam and Norton, 2007). At the national level, Bt brinjal is estimated to have the potential to generate a net additional economic benefit of US\$200 million per year for 150,000 brinjal farmers.

## IRM, STEWARDSHIP AND POST RELEASE MONITORING OF Bt BRINJAL

The approval and plantings of Bt brinjal will ensure the effective control of major insect-pest *Leucinodes orbonalis*, which usually requires numerous insecticide sprays and causes heavy losses. However, it is important to note that *Leucinodes orbonalis* is a monophagous pest of brinjal that also uses weedy and wild species of brinjal as an alternate host. Therefore, insect resistance management, stewardship and post release monitoring is vital for durability and long life span of Bt technology in Bangladesh. Farmers and scientific community have to work in tandem to devise on and off farm strategies to keep the insects and insecticides at bay. Bt brinjal farmers need to be educated about the importance of good quality seeds, planting of refuge, compliance with the recommended agronomy and crop management practices and spraying of insecticides based on the objective assessment of economic threshold levels (ETLs). Farmers should also be educated about the importance of scouting for the rare surviving larvae of the fruit and shoot borer on Bt brinjal plants and advised to take up timely pesticides spraying to eradicate resistant larvae.

More importantly, scientific community and the public sector research system should realize their critical responsibility to ensure the availability of quality seeds that are pure and are capable of expressing cry1Ac protein in all parts of plants. They also need to ensure the supply of detection kits, information on package of practices and proper distribution of Bt brinjal seeds to farmers across the country. BARI, too, has to ensure the supply of only those Bt brinjal seeds that have undergone a rigorous testing for expression of insecticidal protein in all parts of flowers, leaves and shoots to confer full protection to brinjal fruits. For proper IRM, stewardship and post varietal release monitoring, the Bangladesh government has outlined stringent conditions for the cultivation of Bt brinjal in its release order issued on 30 October 2013. The Ministry of Environment and Forests, directed BARI in its release order for Bt brinjal to comply with the conditions stipulated in the order before releasing Bt brinjal varieties in the field. Following conditions are stipulated to prolong the life span of Bt technology and maximize return to farmers and consumers:

1. Field production planning, field biosafety management planning, emergency response planning, safety measures like isolation distance, border row management planning and techniques for protection of local and indigenous variety and wild plants;
2. Formation of the field level biosafety committee for monitoring the biosafety measures to be taken in the area of limited Bt brinjal cultivation;
3. Training of farmers for cultivation of Bt brinjal considering environment and biosafety

measures;

4. Marketing of Bt brinjal as per the seed labeling under the preview of biosafety rules;
5. Contingency plan for any potential threat to environment and human health; and
6. proper and regular reporting to the National Committee in Biosafety (NCB) and the Biosafety Core Committee (BCC) regarding the details of biosafety measures taken in the area of release of Bt brinjal on monthly basis for publication in the biosafety clearing house according to the Cartagena Protocol on Biosafety of the Convention of Biological Diversity (CBD).

**Picture 11. BARI Bt Brinjal-4 (ISD006) in Field at Ishurdi, Bangladesh**



*Photo Credit: ABSP-II/Cornell University*

Complying with the release order of Bt brinjal, BARI developed a comprehensive list of guidelines for field production, biosafety management and safety measures plan to be deployed in limited cultivation of Bt brinjal in Bangladesh. BARI has assigned the highest priority to insect resistance management and refuge planting in Bt brinjal fields. Farmers have to plant a structured refuge of 5% with non-Bt brinjal varietal seeds around Bt brinjal plot to prevent the development of resistance in the targeted insect-pest, the FSB. In other words, Bt brinjal farmers are advised to plant the border strip of 0.05 acre with non-Bt brinjal varietal seeds around every acre of Bt brinjal plot. Given the recommended spacing of 100cm x 80cm, farmers should plant approximately 5,060 seedlings of Bt and non-Bt brinjal plants in the ratio of 19:1. Therefore, irrespective of the size of the Bt brinjal plot, farmers are advised to plant one non-Bt brinjal seedling for every 19 Bt brinjal seedlings. The mandatory border refuge of approximately 250 non-Bt brinjal seedlings need to be planted around 4,800 Bt brinjal seedlings in one acre of plot. The refuge has to be maintained and planted

by farmers on all sides of the plot. In case of small farms isolated by bunds and neighboring fields of other crops, too, Bt brinjal farmers should not ignore the mandatory requirement of refuge plantings due to monophagous nature of the targeted insect.

Thus, the refuge is essentially a border strip of brinjal crop without the Bt gene meant to prevent the fruit and shoot borer from developing resistance to the Bt technology. Contrary to polyphagous insect-pests that feed on alternate hosts (Dhillon and Sharma, 2007), the targeted fruit and shoot borer feeds on different parts of brinjal plant and, therefore, planting of only non-Bt brinjal would help stave off resistance. The role of the refuge is that it allows the targeted fruit and shoot borer to feed on non-Bt brinjal to remain susceptible to Bt technology while the insects feeding on Bt brinjal might produce resistant progeny. When the susceptible pest population mates with the rare resistant population that survives after feeding on Bt brinjal, they would produce offspring that is susceptible to Bt brinjal technology and thus imparts season-after-season protection against insect. The refuge planting therefore is a must to preserve the effectiveness of Bt brinjal technology, which would help farmers to reap benefits of Bt technology on a sustained basis (EPA, 2002 and 2006; UCSD, 2014).

In addition to refuge management strategy, the BARI has also come out with comprehensive guidelines for field production plan, biosafety management plan and safety measures plan for limited cultivation of Bt brinjal on farmer's fields. The BARI recommends that Bt brinjal farmers should regularly monitor their fields for insect infestation and undertake insecticide sprays based on the objective assessment of the economic threshold level (ETL). Besides, the BARI has stipulated measures to ensure biosafety compliance by farmers cultivating Bt brinjal in Bangladesh. Table 4 shows the proposed IRM strategy and biosafety compliance measures of Bt brinjal (BARI, 2014).

**Table 4. Proposed IRM Strategy and Biosafety Compliance Measures of Bt Brinjal**

Proposed Strategy/Studies	Measures
Farmer Compliance Assurance Program	To Ensure that Bt brinjal seeds/seedlings is planted by farmer as per BARI's recommendations & IRM plan.
Farmer's Trainings Programs	Training to farmers on field layout, biosafety issues and crop management practices.
Monitoring for Biosafety Compliance	To ensure on farm refuge compliance, to monitor resistance management, post-harvest monitoring of Bt brinjal field.
Refuge Design and Placement Resistance Monitoring	To implement refuge as the most promising and practical strategy to ensure long term resistance management.
Integrated pest management (IPM)	To encourage appropriate IPM strategy to address specific regional resistance management concerns.

Source: BARI, 2014

Moreover, BARI has also outlined an emergency response plan not only to assess the effectiveness of Bt technology but also observe any adverse effects of Bt brinjal on plants, animals and humans. Table 5 shows steps that are proposed to ensure environment safety and product efficacy in farmers' field.

**Table 5. Emergency Response Plan of Bt Brinjal**

Proposed Strategy for Environment Safety	Proposed Strategy for Product Failure
Survey and sampling from affected Bt brinjal field for observed environmental hazard.	Establish non-performance of Bt brinjal-high FSB infestation level.
Uprooting and incineration of Bt brinjal crop from region of observation of adverse effects.	If non-performance is established, spray field with insecticides; adopt all IPM measures to reduce FSB infestation; assay insect populations for susceptibility levels.
Farmer education and awareness to address safety aspects of Bt brinjal cultivation.	Provide any report of resistance to the existing regulatory authority.

Source: BARI, 2014

## FIRST HAND FIELD LEVEL EXPERIENCES WITH FARMERS CULTIVATING Bt BRINJAL

Despite Bt technology being developed, tested and regulated by public sector institutions in Bangladesh, the opponents of the Bt brinjal technology camped in the country to delay and derail the regulatory process before and after the official release of Bt brinjal on 30 Oct 2013. During the development of Bt technology, 2005-06 to 2013-14, the activists mobilized enormous resources, filed litigation in the High Court and the Supreme Court to thwart this technology. They resorted to all kinds of delaying tactics, such as inviting activists from around the world, invoking religious sentiments, accusing scientists of having conflict of interest, finding faults with every step of regulatory processes, scaring people of perceived ill-effects of Bt technology, producing and distributing distorted information, organizing rallies and mass protests and maneuvered media to influence the decision on the release of Bt brinjal in Bangladesh (Chakraborty, 2013; Financial Express, 2013; Daily Star, 2013 and 2014a; Bangladesh Chronicle, 2014; UBINIG, 2014). The magnitude of resources, both human and capital, deployed in the protests against Bt brinjal was enormous though it was for a cause that contradicted the protesters' philosophy of sustainable agriculture and environmental protection. Those who wanted to suppress science and benefits of Bt brinjal technology, undoubtedly, disregarded rational justification of the technology meant to develop open pollinated pro-poor brinjal varieties aimed at reducing cost of cultivation, increasing marketable yield and farmers' income.

Undeterred by mis-judged and mis-guided campaign by anti-GM activists, the Union Agriculture Minister, Ms. Matia Chowdhury, went ahead to distribute seedlings of open-pollinated varieties of Bt brinjal to selected 20 farmers of Gazipur, Pabna/Ishurdi, Jamalpur and Rangpur – the four important brinjal growing regions of Bangladesh on 22 Jan 2014. These 20 Bt brinjal growers became the first farmers to successfully grow and nurture Bt brinjal seedlings to healthy and vigorous brinjal plants to benefit from the technology. These 20 farmers demonstrated the on-farm performance, safety and efficacy of Bt brinjal by successfully cultivating it and reaping the enormous benefits. The experiences of these 20 Bt brinjal farmers shall go down in history as a

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landmark in the process of adoption and spread of Bt technology. It will also spur other farmers to grow Bt brinjal in subsequent seasons. They will be the role models not only for Bangladeshi farmers but also for Bt brinjal cultivators in India and the Philippines. Although both India and the Philippines had completed regulatory and biosafety assessment of Bt brinjal before Bangladesh did so, the farmers there were denied access to superior Bt brinjal seeds due to policy and regulatory constraints.

**Picture 12. Policy Makers, Scientists and Farmers During BARI Bt Brinjal (ISD006) Field Day at Ishurdi, Bangladesh**



*Photo Credit: ISAAA, 2014*

In the spring season of 2014, five farmers each from four Bt brinjal growing regions of Bangladesh who had ventured to plant Bt brinjal were pressurized by anti-GM activists not to acknowledge the benefits of technology despite its remarkable performance in their fields. Some misleading stories have been written, tweeted and re-tweeted to cast shadow over the safety and efficacy of Bt brinjal, to denigrate its performance and benefits and to misinform the people about the potential of this technology. (New Age, 2014a and 2014b; Warded, 2014; Akhter, 2014a and 2014b; UBINIG, 2014). Misleading pictures and videos showing insect infestation in non-Bt brinjal plants, which were planted as refuge around Bt brinjal plot, have also been circulated to connive people of failure of Bt technology in the field conditions. In response to the alarming news stories, a number of experts from within and outside Bangladesh visited Bt brinjal farmers in May and June 2014 to ascertain the status of Bt brinjal in the farm conditions in Gazipur, Rangpur, Ishurdi and Jamalpur regions in Bangladesh.

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In the following section, we present a summary of the field performance and socio-economic benefits of Bt brinjal based on inputs received from the experts who obtained first-hand information and experiences by interacting with Bt brinjal growers in Bangladesh.

### **Prof. Anthony M. Shelton's Visit to Farmers Growing Bt Brinjal in Bangladesh**

A world renowned expert on Bt plants and Cornell University Professor of Entomology, Prof. Anthony Shelton, visited farmer Haidul Islam's Bt brinjal farm in Sripur Upazila under Gazipur District, Bangladesh, on 9 April 2014. His visit was in response to newspaper article "Pest resistant Bt brinjal comes under pest attack" published by Financial Express Bangladesh on 7 April 2014. This article alleged that Bt brinjal was attacked by insects and reported that 25-30% plants were lost and the remaining were struggling for survival. The article also reported that Bt brinjal farmer, Mr. Haidul Islam, was spraying more insecticides on Bt brinjal crop than on conventional brinjal (Financial Express, 2014a).

**Picture 13. Prof. Anthony Shelton, Cornell University Professor of Entomology with Farmer Islam in Bt Brinjal Field in Gazipur, Bangladesh**



*Photo Credit: Anthony Shelton*



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To his surprise, Prof. Shelton found that the reporting in these articles was inaccurate and allegations were misplaced. Following is the summary of the observations made by Prof. Shelton after thoroughly investigating the Bt brinjal field and interacting with farmer Haidul Islam in Gazipur, Bangladesh;

- On inspection of the farmer's field, Prof. Shelton confirms that Haidul Islam's Bt brinjal farm was free of pest damage.
- Farmer Haidul Islam was very pleased with the crop and happily showed Bt brinjal farm free of pest damage. Prof Shelton observed that farmer Islam would have already sprayed insecticides on brinjal to control the fruit and shoot borer had he not planted Bt brinjal that resisted the insect-pest attacks.
- There was no injury to fruits and shoots of Bt brinjal plants by FSB insect.
- Prof. Shelton stated that Bt brinjal was a far safer and healthier option for farmers to control the pest and market their healthy fruits.
- Bt brinjal also allowed farmers to use "integrated pest management" (IPM) to control other minor brinjal pests like aphids, thrips, leafhoppers, and whiteflies. By using resistant plants, instead of pesticides to control the borers, farmers allowed the beneficial insect populations to flourish, Prof. Shelton observed. (Shelton, 2014 and 2014a).

### **Mr. Mark Lynas' Visit to Farmers Growing Bt Brinjal in Bangladesh**

British environment campaigner and journalist Mark Lynas along with scientists from ABSP-II project of the Cornell University and the BARI visited Bt brinjal field in Gazipur district of Bangladesh on 5 May 2014. His visit coincided with another newspaper story "Bt brinjal farming ruins Gazipur farmers" published by New Age Bangladesh on 7 May 2014. It alleged that Bt brinjal was ruining farming in Gaziupur region (New Age 2014a). Mark Lynas visited same farmers who were quoted in the news article and shared the first-hand experience with them. He also recorded statements of these farmers on the performance of the crop in their field. The first field Mark Lynas visited belonged to farmer Mansur Sarkar of village Baraid of Kaliganj Upazila in Gazipur. Mansur Sarkar is one of the 20 farmers in four regions of Bangladesh who grew the first generation of Bt brinjal. He received 1,140 seedlings of Bt brinjal from the Union Minister of Agriculture during the Bt brinjal seedlings distribution ceremony organized by BARI on 22 January 2014. Mark Lynas noted the following points after visiting Bt brinjal grower Mansur Sarkar;

- Brinjal farmers in Bangladesh are very smallholder farmers – at most they have just a few acres. Brinjal is an important cash crop to lift their livelihoods above the absolute poverty line.
- Farmers growing conventional brinjal reported as many as 150-180 pesticide sprays during the growing season.
- In farmer Sarkar's Bt brinjal field, Mark observed that Bt brinjal crop was standing in good health and that Sarkar was happy to grow it.

- Farmer Sarkar confirmed that he had only sprayed once (to control sucking pests when the plants were younger and more vulnerable) whereas neighbours growing brinjal sprayed twice a week or even every day.
- Mark noted that Bt brinjal plants were healthy and pest-free. No need was felt by farmers to spray pesticides for the control of FSB.
- Mark observed that farmer Sarkar also planted non-Bt brinjal as refuge around Bt brinjal plot which helped him to compare performance of Bt and non-Bt brinjal in the same field.
- Mark noted that the FSB infestation in Bt brinjal field was almost nil whereas it was noticeable in the control crop – the refuge planted around Bt brinjal crop.
- Mark described the first Bt brinjal crop in the field of farmer Mansur Sarkar as successful (Mark Lynas, 2014a; Mark Lynas, 2014b).

**Picture 14. Scientists from ABSP-II and BARI accompanying Mr. Mark Lynas to Bt Brinjal Fields in Gazipur, Bangladesh**



*Photo Credit: ABSP-II/Cornell University*

Mark Lynas along with scientists from BARI also visited Rangpur region - North West region of Bangladesh - where five farmers planted Bt brinjal. They were Likhon Miah, Md. Afzal Hossain, Abdullah Miah, Chandra Roy and Anil Mohanty. Mark interacted with them and shared with them his observations and exclusive first-hand testimonials of Bt brinjal

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farmers. Mark also prepared a documentary video of his visit, recording live testimonials of Bt brinjal farmers in Rangpur region, which is available on Youtube for public viewing. Mark made following observations about his visit to Bt brinjal fields in Rangpur region;

- All five farmers were satisfied with the agronomic performance of Bt brinjal in their field.
- Mark observed that there was no spraying of insecticides to control the fruit and shoot borer. It resulted in the net saving of Bangladeshi Taka 10,000 equivalent to US\$130.
- Mark noted that there was no infestation in Bt brinjal field. However, bordering non-Bt brinjal refuge was noticeably infested with FSB.
- Farmers were extremely satisfied as they were free from pesticide spraying (Mark Lynas, 2014a; Mark Lynas, 2014b).

## TESTIMONIALS BY EXPERTS AND FARMERS

Besides inviting the local and foreign experts, we also invited testimonials from selected Bt brinjal growers in their own words about the performance and economic benefits of Bt brinjal. Following section carries testimonials from the experts who met Bt brinjal farmers in their fields. These experts belong to public and private sector institutions of Bangladesh, the USA, Britain and India.

### **Dr. Md Rafiqul Islam Mondal: We Are Proud To Be A Bt Brinjal Country**

*Dr. Md Rafiqul Islam Mondal is the Director General of BARI, Bangladesh*

Brinjal is an important vegetable in Bangladesh grown all over the country throughout the year and is liked by all. It is the second most important vegetable in terms of acreage and production after potato and plays a significant role in Bangladeshis' daily diet, livelihood and farm income.

The crop is generally damaged severely by the notorious insect called brinjal fruit and shoot borer (FSB), and the damage due to this insect ranges from 30-70% depending upon the locality and edaphic conditions. FSB is only vulnerable to sprays for a few hours before it bores into the plant, forcing farmers to spray insecticides as often as every 2-3 days. The unrestrained spraying of chemical pesticides adversely affects the health of farm workers. Moreover, pesticide residues from such concentrated use tend to remain for longer periods on vegetable, ultimately affecting consumers' health.

BARI started transgenic studies since 2005 through the introgression of *cry1Ac* gene (from *Bacillus thuringiensis*) into 9 popular brinjal varieties of Bangladesh. These varieties have been passed through multilocation trials (MLT) for several years with the approval of the government following the biosafety guidelines. All tests confirmed that Bt brinjal helps tackling the menace of the FSB (98% mortality) and is not damaged by the insect and thus the technology has proven its efficacy.

**Picture 15. BARI DG Interacting with Journalists and Local People during BARI Bt Brinjal (ISD006) Field Day at Ishurdi, Bangladesh**



*Photo Credit: ISAAA, 2014*

We have successfully organized press conferences, seminars, workshops, different group discussions where we provided all facts regarding Bt brinjal. Farmers often go for prophylactic use of insecticides spraying over 80 times during the crop season without much success. However, our studies indicated that no insecticide is required for control of the fruit and shoot borer in Bt brinjal. Farmers will be economically benefitted as the cost for use of insecticides and the loss of crop due to the insect will be zero or negligible. Exposure of insecticides to the farmers and the environment will be zero or negligible. Consumers will get fruits free from insecticides thus providing them with good health. Contamination of the native population of brinjal will not occur as it is self-pollinated crop. Field tests have shown that there are no adverse effects resulting from pollen transfer from Bt brinjal to other plants because of genetic incompatibility. Unlike hybrids, Bt brinjal is open pollinated variety (OPV) and the seeds can be kept or be easily made affordable by public sectors to the farmers. Safety tests have been conducted from accredited labs confirming that Bt brinjal is safe for human consumption. Bt brinjal is harmless to the beneficial insects and non-target organisms. Bt brinjal is substantially equivalent to non-Bt brinjal which has the same compositional and nutritional value and has no allergenicity and toxicity to human and animal, and no environmental adverse effect.

Ms. Matia Chowdhury, honourable Minister for Agriculture has made her utmost and cordial efforts to let the scientific events go ahead for the betterment and food self-sufficiency of the country.

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The release of Bt brinjal is a timely and bold endeavor which will help in mitigating hunger and malnutrition thereby contributing towards alleviating poverty among brinjal farmers. 20 farmers have planted 4 varieties (BARI Bt brinjal 1 to 4 popularly known as Uttara, Kajla, Nayantara and ISD006) at 4 different geographical regions. We are proud to become the 29th country in the world cultivating GM crop commercially since 2014. We are closely monitoring the cultivation of Bt brinjal complying with conditions stipulated in the Cartagena Protocol on Biosafety (CPB). We have formulated the regulatory mechanisms to ensure that GM crops are tested thoroughly before allowing commercial cultivation in the country.

BARI in collaboration with the Department of Agricultural Extension (DAE) has supplied the seeds of 4 Bt brinjal varieties to the farmers for commercial cultivation at four different regions of Bangladesh. BARI has organized farmers' day at their respective fields at Rangpur, Pirgonj, Kaligonj, Jamalpur and Ishurdi in presence of scientists, policy and regulatory people, farmers, journalists and general people. The performance of Bt brinjal is quite satisfactory so far and lot of awareness and interest has been grown among the farmers and the public in general.

During the season, six out of 20 farmers obtained excellent crop results and harvested 6,500 kg fruits so far (as of 14 June 2014) from 0.13 ha land at each field, 9 farmers found good crop condition who harvested up to 2,350 kg per 0.13 ha Bt brinjal field. Plants in four farmers' fields were not satisfactory and one plot was abandoned mostly due to disease, drought conditions and insufficient care. In whatever cases of less plant stand and growth, no farmers reported those as a consequence of FSB attack rather they need not spray in most of the cases. This is what we consider as the significant efficacy performance of the *Bt* gene in brinjal protecting it from FSB perfectly in all the field conditions.

The neighbouring farmers of Bt brinjal fields were surprised to observe that brinjal can be grown without insecticide sprays that can reduce the production cost substantially. There has been a growing demand for Bt brinjal seeds to be planted for the next season. Moreover, the requests are made from BADC, private seed companies and personnel for seed to be planted for commercial cultivation and large scale seed production for the next season. BARI at its different stations is bulking up of breeders' and certified seeds of all Bt brinjal varieties so that the demand for seeds can be met and we can supply Bt brinjal seeds to all those interested in planting seeds in next season onwards. Hopefully, the marketable yields of Bt brinjal could potentially be doubled in the next few years that will help in mitigating food and nutritional shortage of Bangladesh and benefit the farmers economically, environmentally and socially as it has been evident in the first season of planting (Mondal, 2014).

### **Mr. Mark Lynas: A True Account of Field Reality**

*Mr. Mark Lynas is an environmentalist and a visiting fellow at Cornell University, USA*

There is no doubt that Bt brinjal is a landmark project. After having been blocked in both India and the Philippines by activists opposed to anything involving the dreaded 'GMOs', the stakes were

**Picture 16. BARI Bt Brinjal Field Day at Rangpur, Bangladesh**



*Photo Credit: ISAAA, 2014*

high when the Bangladeshi government decided to allow seeds for pest-resistant brinjal into the hands of resource-poor farmers. With 20 farmers in four regions now growing Bt brinjal, and some already having sold the vegetable into local markets, it has become the first genetically-modified food crop in the whole of South Asia.

Bt brinjal is genetically modified with the Bt gene to express the Cry1Ac protein which kills the most pernicious brinjal pest, fruit and shoot borer, but is entirely non-toxic to other animals and humans. For conventional brinjal, regular treatment with dangerous pesticides is the only way to protect against the borer, resulting in farmers being poisoned, the environment being damaged, and consumers eating a product which is laced with pesticide residues. Farmers conventionally spray up to 140 times during the brinjal growing season, and use little or no personal protective gear. In contrast, the farmers growing Bt brinjal have reported using minimal pesticides - or, in most cases, none at all.

When I visited all five farmers growing Bt brinjal in Rangpur, a region in the northwest of Bangladesh, in May 2014, four of the fields were already fruiting. One farmer had experienced trouble with bacterial wilt and had replanted elsewhere. However, all the farmers had been plagued with calls and visits from journalists and activists eager to hear about the entire crop having failed. Negative reports have regularly appeared in Bangladeshi newspapers, and anti-GMO activists have spread conspiracy theories about Bt brinjal claiming that it is a biopiracy attempt by Monsanto to capture Bangladeshi agriculture. This is untrue - the Bt gene is donated, and the entire project is royalty-

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free and not-for-profit. Activists have even told farmers and villagers that if they eat Bt brinjal they and their children (and even their grandchildren!) will become paralysed.

Fortunately, the farmers are not stupid and appreciate the opportunity to reduce or eliminate their use of pesticides - it saves them money, protects their health, and protects the environment. The signs are good that at the next stage more farmers and consumers in Bangladesh can benefit from Bt brinjal (Mark Lynas, 2014c).

### **Prof. Anthony Shelton: 24x7 In-Built Protection Against Insect-Pests**

*Prof. Anthony Shelton is the renowned Entomologist at Cornell University, USA*

In 2013, insect resistant Bt brinjal became the first vegetable crop approved for commercial release in Bangladesh. The plant produces a protein from a bacterium, *Bacillus thuringiensis* (Bt), that is harmless to people and the environment but kills some species of caterpillars when they consume it. In 2014, 20 commercial fields of Bt brinjal were planted throughout Bangladesh to control the insect pest, *Leucinodes orbonalis*, commonly known as the fruit and shoot borer (FSB). As the name implies, this caterpillar bores into the plant's shoots and withers them, or bores into the fruit and renders them unmarketable. Brinjal farmers spray unacceptably high amounts of insecticides, often as frequently as every other day, in an attempt to control this devastating pest. Such frequent spraying exposes farmers not only to health risks but also harms beneficial insects, reduces insect diversity, contaminates the soil and water and adversely affects agricultural ecosystem. Farm families and consumers are vulnerable to the heavy load of insecticides used in the field. Therefore, Bt brinjal seeds are miracles for resource poor farmers and consumers in Bangladesh.

Growers of Bt brinjal whom I met in Gazipur in April 2014 were enthusiastic and satisfied with the performance of Bt brinjal in their fields. While examining Bt brinjal plants, I neither saw the presence of the FSB pest, nor noticed visible damage to any parts of Bt brinjal plant caused by FSB. As required, Bt brinjal farmers planted non-Bt brinjal plants on the border of Bt brinjal field and these served as an untreated comparison to see how the Bt plants performed. There was a typical infestation of FSB on non-Bt brinjal plants with many of the shoots already dead. Besides serving as a comparison, these plants also serve to lessen the selection pressure for resistance to Bt in the FSB population and are used as part of a sustainable integrated pest management (IPM) program in Bangladesh.

By using FSB-resistant Bt plants, instead of traditional broad spectrum insecticides to control FSB, farmers conserve beneficial insect populations and allow them to remain in the field. This IPM strategy allows farmers to effectively control FSB with Bt brinjal and control other minor brinjal pests like aphids, thrips, leafhoppers, and whiteflies with the conserved natural enemies. Therefore, the large scale adoption of Bt brinjal as a key tool in IPM is a far safer and healthier option for farmers to control pest insects and produce damage-free and healthy fruits desired by consumers (Shelton, 2014c).

## Dr. Usha Zehr: Biotech to Benefit Brinjal Farmers

*Dr. Usha Zehr is the Chief Technology Officer at Mahyco, India*

During my visit to Bt brinjal field in the first week of June 2014, the four varieties of Bt brinjal grown in Bangladesh were 90+ days old, in all the 10 locations. The monsoon had already arrived in area surrounding Dhaka and there was considerable rainfall at all the locations. During my visit to Bt brinjal fields in Gazipur and Jamalpur, the crop condition was found to be excellent and the crop showed excellent control against shoot damage and fruit damage caused by brinjal fruit and shoot borer. According to the farmers, Bt brinjal crop was not sprayed for target pest control whereas the surrounding non-Bt brinjal fields were sprayed on an average twice a week. Several fruit pickings had been made and the fruit was marketed in the local market and labelled as "BARI Bt Begun #, no pesticide used". The fruit quality is similar to the original variety. In Gazipur, the variety grown in one farm was not the preferred fruit type in that area and the farmer requested for the other popular variety in the next season. All farmers had planted refuge around the plot and damage was distinctly visible in the refuge plants. The yields were excellent and farmers harvested 0.5 to over one ton of fruits and sold in the market. One field visited was not well managed and 30%

**Picture 17. Farmers Marketing Bt Brinjal Fruits in Pirganj Market of Rangpur, Bangladesh**



*Photo Credit: ISAAA, 2014*



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plants were affected by bacterial wilt and little leaf diseases. However, the field still showed full control against the target pest and the farmer promised that he would take proper care of the plot in the subsequent season (Zehr, 2014).

### **Md. Afzal Hossain: Bt Brinjal is a Fortune for My Family**

*Md. Afzal Hossain is Bt Brinjal Farmer at Rangpur, Bangladesh*

My family has 9 members including my parents, two brothers, wife, 2 sons and 1 daughter. I possess 1 ha land in Bashpukuria, Pirganj, Rangpur district of Bangladesh. I was given BARI Bt brinjal-2 (Kajla) seedlings by Ms. Matia Chowdhury, Honorable Minister for Agriculture on 22 January 2014. I planted brinjal seedlings according to the suggestions given by the OFRD/BARI and DAE personnel. I followed the cultivation methods of normal brinjal while raising Bt brinjal plants. I did not notice FSB infestation at any growth stage. However, non-Bt brinjal plants that surrounded Bt brinjal were infested. Bt brinjal bore healthy and hole-free fruits. I have harvested 4,200 kg as of 14 June 2014 from 1 bigha (0.13 ha) of land which is highly remunerative. The cost of production was around Tk 20,000. I gained a substantial return of Tk 80,000 and thereby earning the net benefit of Tk 60,000 at around third quarter of the crop season. There was no wastage of brinjal fruits due to insect

**Picture 18: Bt Brinjal-2 (Kajla) in Field of Farmer Md. Afzal, Rangpur, Bangladesh**



*Photo Credit: ISAAA, 2014*

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infestation or other reasons. Although June onwards is the lean period of vegetables, I accrued premium price selling brinjal in off-peak season. Additionally, I obtained high price from selling brinjal in the Ramadan (fasting) month when Muslims consumed high quantity of brinjal during the break of fasting.

I received many visitors who were surprisingly very eager to know about the success or failure of my Bt brinjal field. The Director General of BARI and other officials also visited my field and guided me during the season. Several scientists, people from NGOs, my neighbors and villagers including general public also visited my field.

I think Bt brinjal is a blessing for us which does not require pesticide spraying. It saves a lot of cost generally incurred on spraying pesticides and labour cost. Bt brinjal will be beneficial in the future as I can save and resow Bt brinjal seeds. I followed the cultivation and other practices similar to non Bt brinjal. My fellow farmers and friends around the locality are asking for Bt brinjal seeds for cultivation in coming season. In my opinion, many farmers will adopt Bt brinjal in the next season and brinjal production will go up significantly. The agriculture personnel have taken good care and were around to help if we faced problems. People from different NGOs visited my field many times, scared me and asked me to discontinue cultivation of Bt brinjal. But, when I saw that there was no insect attack in my field, I understood the fact and now I strongly believe that Bt brinjal is the fortune for me and my family. I have not encountered any specific problems cultivating Bt brinjal. I reaped very high yield and excellent quality of Bt brinjal fruits (Hossain, 2014).

### **Md. Ratan Miah: Many Farmers Will Grow Bt Brinjal**

*Md. Ratan Miah is Bt Brinjal Farmer at Jamalpur, Bangladesh*

I live in a joint family of 8 members including my parents, two brothers, one sister, my wife and one daughter. My family possesses 1.5 ha land in Tanger Alga, Jamalpur, Bangladesh. I received BARI Bt brinjal-3 (Nayantara) from BARI and planted on 27 February 2014 on my field. When I planted Bt brinjal seedlings many of my fellow farmers criticized me saying that it will never be possible to get healthy plants from these seedlings especially at the late season. Nevertheless, I took this as a challenge and made my field covered with vigorous healthy plants although it took little longer due to high temperature this year. NGOs and other people often visited me insisting that I should quit growing Bt brinjal. They even threatened me to uproot Bt brinjal and at some point I was thinking that they may harass and sue me for growing Bt brinjal. Many officials from BARI, two scientists from USA, neighbors and general public visited my farm. BARI and DAE personnel frequently visited and guided me to perform the intercultural operations. I also visited BARI to learn more about Bt brinjal.

I harvested brinjal fruits at different stages and earned substantial income due to the high market price of brinjal at the beginning of Ramadan fasting. For me Bt brinjal proved to be a premium crop

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as it did not require any insecticide spraying. I was spared of filling bottles of pesticides and the smell of pesticides. I didn't spray even once to control the fruit and shoot borer. However, I sprayed *Initab* costing Tk 850 for controlling white flies. Many farmers were surprised to know that I did not use insecticides and even then Bt brinjal plants were healthy and free from insect infestation. However, the refuge plants around Bt brinjal were infested by FSB.

The cost of production was around Tk 25,000. I gained a substantial return of Tk 75,000 and thereby earning the net benefit of Tk 50,000 at around third quarter of the crop season. No wastage was reported for insect infestation but few fruits were rotten due to rain and disease. I would like to inform that brinjal is grown in Jamalpur region in winter season (October planting). We have already processed the seedbed for raising seedling for the forthcoming season. I am keeping Bt brinjal seeds on my own and will request BARI for more seeds. I benefited from growing Bt brinjal and many of my friends are now motivated to grow Bt brinjal in the coming season (Miah, 2014).

**Picture 19: BARI Bt Brinjal-3 (Nayantara) in Field of Farmer Md. Miah, Jamalpur, Bangladesh**



*Photo Credit: ISAAA, 2014*

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## WAY FORWARD

In conclusion, Bt brinjal has shown its worth in the farmers' fields during the limited cultivation by 20 farmers in four brinjal growing regions of Gazipur, Pabna/Ishurdi, Jamalpur and Rangpur in the spring season of 2014. Bangladeshi farmers were the first to grow Bt brinjal in the world. Bt brinjal allowed farmers to raise healthy and vigorous brinjal crop, substantially cut down pesticide spraying to check FSB and significantly reduced cost of cultivation. A few Bt brinjal farmers reported wilting of plants that was primarily caused by the prevalence of pathogen due to offseason planting of Bt brinjal in the spring season (The Guardian, 2014). Others harvested the blemish-free fruits with good marketability. It is noteworthy that Bt brinjal significantly increased the marketable yield\* of brinjal fruits thereby mitigating losses caused by wastage of infested and damaged fruits. In a nutshell, Bt brinjal helped small farmers save Bangladeshi Taka 10,000 on pesticide spraying for controlling FSB, earned income in the range of Taka 75,000 - 80,000 and resulted in the net benefit of Taka 50,000 - 60,000 equivalent of US\$ 650 - 750 per bigha. Indirectly, farmers and their families enjoyed invaluable benefits in terms of escaping health problems due to substantial reduction in direct exposure to insecticides. Higher net benefit, estimated at around US\$ 650 - 750 per bigha, is a huge sum for smallholder farmers. This will motivate brinjal growers across the country to adopt Bt brinjal in the subsequent seasons. At the national level, Bt brinjal is estimated to have the potential to generate a net additional economic benefit of US\$200 million per year for the 150,000 brinjal farmers in Bangladesh. Consumers would benefit from a cleaner, improved and more affordable food product.

However, in the first season of planting Bt brinjal, farmers encountered some teething problems in complying with the conditions outlined in the Bt brinjal approval notification regarding field production and biosafety management of the crop. Many farmers for the first time planted seedlings as they usually sowed the crop through seeds in the past. But distribution of pre-grown seedlings allowed them to raise disease-free and healthy plants which bore fruits early and, thus, reduced the time between planting and marketing. BARI attached the highest priority to production and distribution of seedlings, preparation and implementation of robust biosafety plans, supervision of cultivation and monitoring of Bt brinjal fields for any adverse and unforeseen effects. In the first season, BARI has gained considerable experience. It has trained farmers in Bt Brinjal cultivation and demonstrated the benefits of Bt brinjal to other brinjal growers of the country. The Bangladesh Agricultural Development Corporation (BADC) in collaboration with BARI has undertaken seed multiplication of four Bt brinjal varieties to be distributed to farmers in the forthcoming Kharif season 2014. By the next year, Bt gene will be introduced in five other popular brinjal varieties including Dohazari, Shingnath, Chaga, Islampuri and Khatkatia to meet the growing requirement of Bt brinjal seeds which will be planted in different brinjal growing areas. Notably, in the next five years, the government of Bangladesh plans to bring 20,000 hectares or approx. 40% of total 50,000 hectares across 20 districts under nine Bt brinjal varieties (Down to Earth, 2014).

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The insect resistant management and stewardship will play a significant role in the large scale adoption and acceptance of Bt brinjal in Bangladesh. The planting of refuge of non-Bt brinjal plants on the border of Bt brinjal plot as recommended by BARI is the only new farm practice that farmers need to adopt to their routine cultivation of brinjal to efficiently manage the pest resistance. Experts from BARI and others from national and international institutions including ABSP-II/Cornell University who are involved in Bt brinjal project in Bangladesh may devise strategy to educate and train farmers on refuge requirements in Bt brinjal cultivation. Farmers must exercise diligence in planting of refuge every time they grow Bt brinjal. This will help in prolonging the life of Bt brinjal technology and extending the benefits to farmers in planting Bt brinjal season after season. Similarly, the Government of Bangladesh may launch a country wide communication and outreach program to educate and inform public about the need for new technologies such as biotechnology to overcome the issues related to food production and food security. Additionally, BARI may also involve the private sector seed companies to produce and maintain the purity and quality of Bt brinjal varietal seeds. Over the last couple of years, Bangladesh has attracted many private seed companies to undertake R&D, multiplication and distribution of quality hybrid and varietal seeds of different field and vegetable crops. In concurrence with BARI and agricultural universities, the Government of Bangladesh should also harness the skills and competence of the private seed industry which is actively promoting R&D, production and distribution of high yielding seeds and planting material in the country. The Government of Bangladesh should allow and incentivize the private seed companies to develop brinjal hybrids with Bt technology to maximize the yield potential of brinjal crop. The companies should also come forward to invest into R&D of new genes, pyramiding of genes and stacking of traits to enhance the value and durability of Bt brinjal technology in the country.

Disregarding the pro-poor nature of varietal Bt brinjal seeds and public sector ownership of Bt brinjal in Bangladesh, the activists blindly opposed and disapproved the performance and benefits of Bt brinjal to farmers. During the season, they pronounced Bt brinjal as a failure even before farmers' harvested the fruits. They also alleged ineffectiveness of technology to control insects and found faults in the implementation of the package of practices prescribed in the approval notification for Bt brinjal. In reality, instead of discouraging the farmers, the activists should adopt a coherent approach and work in tandem with public sector institutions to educate and help farmers overcome knowledge deficit associated with new technology. Small brinjal farmers in Bangladesh need to acquire new skills, techniques and farm practices to comply with the conditions that are necessary to reap bountiful harvests of Bt brinjal. The success of small farmers in Bangladesh should be viewed as precursor to the success of all others involved in the sustainable farming and environment protection.

*\*Marketable yield refers to the net yield of non-infested undamaged brinjal fruits that a farmer can sell at a premium price. It is the decrease in marketable yield of fruit, as opposed to total yield of fruit that is the most important yield loss caused by fruit and shoot borer (FSB) of brinjal (Choudhary & Gaur, 2009).*

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