**Bt BRINJAL**

• Bt brinjal — eggplant that has been genetically modified (GM) to provide effective protection against the devastating fruit and shoot borer without the application of pesticides — is currently under cultivation in Bangladesh and proposed for commercialization in the Philippines and India.

**•** Bt brinjal was developed through a collaborative partnership that was funded by USAID and managed by Cornell University and its India-based Sathguru Management Consultants, with the Bangladesh Agricultural Research Institute conducting research trials, shepherding the four GM varieties through the government approval process, and ultimately sharing the improved seeds at no charge with smallholder farmers while the University of the Philippines-Los Baños developed a regulatory dossier for the Philippines that meets international standards.

**•** Since entering the market in 2014 as Bangladesh’s first GM crop, Bt brinjal has helped at least 27,000 smallholder farmers achieve higher yields, a 60 percent reduction in pesticide costs, and a six-fold increase in net returns — documented results that offer hope for increasing production of the popular vegetable while curtailing the human and environmental health impacts associated with high pesticide use.

**Bt Brinjal Defined**

Bt brinjal is eggplant (also known as talong in the Philippines and aubergine in Europe) that has been genetically engineered to include genes from the *Bacillus thuringiensis* (Bt) bacterium. This gives the plants inherent resistance to attack by the eggplant fruit and shoot borer (EFSB), the crop’s primary insect pest. Bt has been used as a foliar insecticide for decades, particularly in organic farming, and has a stellar safety record for humans and the environment. It has also been used in numerous other feed and food GM crops globally, such as maize, for over two decades. Its effectiveness is greatly increased when the insecticidal genes are incorporated into Bt crops, as opposed to the use of foliar sprays. Given the experience in Bangladesh, the benefits of Bt brinjal are clear: increased yield and economic return to farmers, decreased pesticide use and more sustainable production.

**Bt Brinjal: A Short History**

Brinjal is a popular vegetable in South Asia. However, its cultivation has been severely limited by the EFSB, prompting the India-based Maharashtra Hybrid Seed Co. (Mahyco) to initiate development of an EFSB-resistant variety as an alternative to insecticide use. Mahyco successfully inserted a *Cry1Ac* gene into brinjal and conducted greenhouse trials that demonstrated its effectiveness against EFSB. In late 2003, USAID entered into the Agricultural Biotechnology Support Project II (ABSPII) partnership with Mahyco, Cornell University, Sathguru Management Consultants, the Bangladesh Agricultural Research Institute (BARI) and the University of the Philippines Los Banos to advance the development and introduction of Bt brinjal in India, the Philippines and Bangladesh. Since Mahyco had done the initial research, BARI scientists traveled to India to work with Mahyco scientists to develop varieties suitable for Bangladesh. As a result of this collaboration, they successfully introduced insecticidal crystal (*Cry1Ac*) proteins from *Bacillus thuringiensis* (Bt) bacterium into brinjal cultivars that are popular in Bangladesh. The Bangladeshi government has been very supportive, allowing BARI to conduct confined field trials of these new cultivars in different parts of the country and complete the regulatory review process. The government approved the release of four lines of Bt brinjal in late 2013, making Bangladesh the first developing country to adopt a genetically modified food crop specifically aimed at smallholder farmers. Government leaders have shown less political will in India and the Philippines, primarily due to anti-GMO activism that initially constrained research and commercialization. Following the resolution of lawsuits, research and the regulatory review process have resumed in the Philippines, while in India, farmers have resorted to civil disobedience in a bid to secure legal access to Bt brinjal seeds.

**Bt Brinjal in Bangladesh: The Farmers’ Perspective**

The first Bt brinjal seedlings were distributed to just 20 Bangladeshi farmers in four districts in early 2014. Within four years, some 27,000 farmers — about 17% of the nation’s brinjal growers — had tested the crop, though that number is likely higher since the approved varieties are open pollinated and farmers can and do share seeds. Farmers frequently credit “seeing is believing” experiences with influencing their decision to try the seed. Bt brinjal also has been well-received in the market, often fetching higher prices due to its high fruit quality and reduced pesticide inputs. A 2016-17 study by BARI scientists found that farmers who grew Bt brinjal experienced a six-fold increase in their net returns over those growing non-Bt varieties. This is due to both increased yield and virtually complete protection against the EFSB. Non-Bt brinjal farmers in contrast apply as many as 84-100 insecticidal sprays per season in an attempt to control the EFSB and other insect pests. Those growing Bt brinjal were able to reduce their insecticide costs by 60% while experiencing no losses from EFSB, thus significantly reducing their production expenses and pesticide exposure. Some spraying is still required to control other insects such as whiteflies, thrips, and mites that are not affected by *Cry1Ac*. BARI scientists are now developing treatment guidelines for this complex of “sucking insects” that can reduce plant vigor and subsequent fruit weight.

**Stewardship and Safety**

Extensive international research has documented that *Cry1Ac* proteins are safe for human food and livestock feed, and both the Indian and Bangladeshi governments have determined that Bt brinjal is safe to eat. Rigorous food and feed safety studies, including toxicity and allergenicity evaluation and nutritional studies, confirmed that Bt brinjal is as safe as its non-Bt counterparts. Other studies have found Bt brinjal has no adverse environmental effects. Pollen flow, effects on soil microflora, agronomy, germination, and weediness studies indicate the safety of Bt brinjal with no unintended effects and no negative impact on beneficial insects, which instead benefit from the reduced use of pesticides.

In Bangladesh, the Bt lines of eggplant were tested under contained, confined, and open field conditions for seven consecutive seasons, after which BARI applied to the National Technical Committee on Crop Biotechnology (NTCCB) for their release. Scientists in the Philippines conducted contained use experiments on Bt talong from 2007 to 2009 and then received a biosafety permit to pursue confined field testing at four approved trial sites, all of which were completed in August 2012. India conducted extensive field tests of Bt eggplant between 2004-2008, using more than 50 trial locations and documenting a 77 percent reduction in pesticide use. Following safety evaluations conducted by the Indian biosafety body, the Genetic Engineering Appraisal Committee (GEAC) recommended commercialization of Bt brinjal.

Though Bangladeshi farmers can save and share seed, BARI discourages the practice to ensure the continued integrity of the four lines. To meet farmer demand, BARI is expanding its capacity to produce high quality seed under the guidance of internationally recognized stewardship practices. Farmers and extension agents also are trained in stewardship, including the need to grow some non-Bt plants in borders, a strategy that helps prevent insects from developing resistance to Bt. The export of Bt brinjal seeds from Bangladesh is currently not permitted since the crops has not been commercially approved in other countries.

**Bt Brinjal Impacts**

Research conducted by BARI and Cornell scientists has documented that the farmers who grow Bt brinjal have achieved higher yields than those growing non-Bt varieties primarily because they are losing less fruit to EFSB attacks. Additionally, they have achieved a 60 percent reduction in pesticide costs, which translates to lower production expenses and human and environmental health benefits, since those spraying pesticides frequently fail to wear protective clothing and are not trained in proper use of the chemicals. Lower production costs, coupled with higher yields and in some cases, better market prices for the Bt brinjal, have resulted in a six-fold increase in net returns. Net returns were $2,151/ha for Bt brinjal as compared to $357/ha for non-Bt varieties. This additional income is significant for smallholder farmers, allowing them to pay school fees for their children and otherwise improve their standard of living. A study done a decade ago estimated that widespread cultivation of Bt brinjal would result in a benefit of $200 million annually for Bangladeshi farmers, a figure that would be far higher today. Given that EFSB pressure is intense in both India and the Philippines, where it can cause 80 percent crop loss, it is anticipated that the adoption of Bt brinjal in those countries would result in similar economic and health benefits. This is particularly true for the Philippines, where eggplant accounts for one-third of all vegetable production. Eggplant is also an important source of cash for resource-poor farmers in the Philippines, where the gross national income per capita was just $3,830 in 2018.

**Bt Brinjal: Status and Outlook in South Asia**

Efforts to advance Bt brinjal in Bangladesh and the Philippines are currently carried out under the USAID-funded Feed the Future South Asia Eggplant Improvement Partnership. Mahyco initially developed an eggplant that expresses Cry1Ac (EE-1) to control EFSB. This EE-1 event was provided to BARI, a government agency, through a public-private partnership between Mahyco, USAID, Sathguru Management Consultants, Cornell University and BARI. Under the partnership, BARI subsequently introgressed the EE-1 event into its own local eggplant lines, which it manages and controls. The ultimate goal of the partnership is to ensure that the process and knowledge of the EE-1 event are properly incorporated into the core practices of Bangladeshi public sector agencies, as well as private sector companies that develop and sell high quality Bt brinjal seeds for increasing productivity.

Farmer adoption continues steadily in Bangladesh, but the four initial varieties should be augmented by additional newer lines that offer increased disease resistance and are better suited to specific locations. BARI has applied for commercial cultivation of three new varieties that are based on cultivars that are very popular among farmers. These new varieties are better performing and less susceptible to wilt disease.

In the Philippines, anti-GMO activists have engaged in a relentless attack on Bt talong, starting with the destruction of two field trials in 2011. When this failed to stop research, they pursued a legal challenge to stop the project. Though they were ultimately unsuccessful, court proceedings that ran from 2012-2016 delayed the development and commercialization process. The Partnership, which includes the University of the Philippines-Los Baños, is now preparing to submit a regulatory dossier for the Philippines, the first step toward commercialization in that country. The dossier meets international standards and will support the introduction of Bt brinjal elsewhere. The Philippines also has continued to conduct research on new varieties.

In India, some farmers have begun growing Bt brinjal that was apparently developed by the Indian Science Institute but is not approved for cultivation. The discovery and destruction of these illicit crops led to national protests, with farmers demanding greater access to GM seeds. Mahyco’s Bt brinjal was fully approved by the relevant scientific committee in India. However, responding to challenges from activist groups, the Indian Minister of Environment and Forests imposed a moratorium on release in 2010 that remains in effect today. It remains to be seen whether the farmer protest will lead to a change in the political climate for GM crops generally. Bt cotton is the only GM crop currently allowed in India and has been widely adopted by farmers.

**Resources**

Feed the Future South Asia Eggplant Improvement Partnership — bteggplant.cornell.edu

“Bt Brinjal in Bangladesh: The First Genetically Engineered Food Crop in a Developing Country”

<http://cshperspectives.cshlp.org>

“Bt eggplant (*Solanum melongena* L.) in Bangladesh: Fruit production and control of eggplant fruit and shoot borer (*Leucinodes orbonalis* Guenee), effects on non-target arthropods and economic returns”

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0205713>

Shelton, A. et al, 2018: ‘Bt Eggplant Project in Bangladesh: History, Present Status, and Future Direction’, *Frontiers in Bioengineering and Biotechnology*, 6, 106 <https://www.frontiersin.org/articles/10.3389/fbioe.2018.00106/full?&utm_>

Rashid, M., et al, 2018: ‘Socio-economic performance of Bt eggplant cultivation in Bangladesh’. *Bangladesh Journal of Agricultural Research*, *43*(2), 187-203. <https://www.banglajol.info/index.php/BJAR/article/view/37313>

“A review of the food and feed safety of the Cry1Ac protein.”

<https://ilsirf.org/wp-content/uploads/sites/5/2017/02/cry1ac_en_ffs.pdf>

Genetically engineered crops help support conservation biological control

<https://www.sciencedirect.com/science/article/pii/S1049964418305103?via%3Dihub>