Bringing Bt Eggplant to Resource-poor Vegetable Farmers in Bangladesh and the Philippines

Anthony Shelton, Vijay Paranjape, Jahangir Hossain, Desiree Hautea, Abul K. Azad
The Eggplant Fruit and Shoot Borer

*Leucinodes orbonalis* Guenée
Farmers in Bangladesh and the Philippines spray insecticides frequently to protect the crop from infestation, but still suffer significant losses.
Objectives

Feed the Future South Asia Eggplant Improvement Partnership
(Sept 30, 2015 to Sept 30, 2018)

1. **Bangladesh:** Post commercial support focusing on: a) IRM, Stewardship and ERA, b) communication support, c) seed quality and commercialization.

2. **Philippines:** a) Support UPLB to develop, submit and shepherd regulatory dossier, b) support farmer training, c) strengthen extension, d) build capacity
Bt brinjal Timeline in Bangladesh

- **2004 - 2012**: Mahyco developed Event EE-1 expressing Cry1Ac. BARI backcrossed the event into 9 Bangladeshi varieties. Agencies conducted agronomic trials, nutritional assessments, molecular analysis, toxicology test, allergenicity test, etc.

- **2012 - 2013**: BARI applied to release 4 varieties.

- **2013**: On 30 October 2013, 4 varieties were approved as BARI Bt Begun-1 (Uttara), BARI Bt Begun-2 (Kazla), BARI Bt Begun-3 (Nayantara) and BARI Bt Begun-4 (ISD-006).

- **2014**: Bt brinjal provided to 20 farmers.
Damage to Bt Uttara vs. non-Bt Uttara
Bangladesh Ministry of Environment and Forest released 4 Bt brinjal varieties for limited cultivation.

- BARI Bt begun-1
- BARI Bt begun-2
- BARI Bt begun-3
- BARI Bt begun-4
Honorable Minister for Agriculture
Begum Matia Chowdhury MP
distributing seedlings of Bt Brinjal to 20 selected farmers on January 22, 2014
Bt brinjal adoption in Bangladesh (No. of farmers)

- 2013-14: 20
- 2014-15: 108
- 2015-16: 250
- 2016-17: 6512
- 2017-18: 27612

Legend:
- BARI
- DAE
- BADC
Bangladesh Success Story

1. Bt eggplant infestation was 0.04–0.88% compared to 48–57% in non-Bt eggplant (Mondal and Akter 2018).
3. Farmers realized a 6-fold increase in the net returns (Rashid et al. 2018)
4. Studies have shown no harmful effects of Bt brinjal on non-target arthropods (Prodhan et al. 2018).
5. Thousands of farmers have been trained
6. BARI has adopted more rigorous stewardship practices in producing Bt brinjal seed
RESEARCH ARTICLE

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

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Sustaining the Technology #1

1. Maintain seed **quantity** and **quality** to meet the demands of farmers
2. Continue to educate farmers and consumers
3. Develop lines with wilt resistance, better acceptance and enhanced resistance to the insect
4. Assess changes in susceptibility in the insect to Cry1Ac
5. Adhere to refuge planting to delay resistance to Cry1Ac.
Resistance to Bt Crops Occurs!
Can we delay it in Bangladesh?

Table 1 Practical resistance to Bt crops

<table>
<thead>
<tr>
<th>Insect</th>
<th>Crop</th>
<th>Toxin</th>
<th>Country</th>
<th>Year marketed</th>
<th>Years</th>
<th>High dose</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. fusca</td>
<td>Corn</td>
<td>Cry1Ab</td>
<td>S. Africa</td>
<td>1998</td>
<td>8</td>
<td>No</td>
<td>87,88</td>
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<tr>
<td>D. saccharalis</td>
<td>Corn</td>
<td>Cry1A.105</td>
<td>Argentina</td>
<td>2010</td>
<td>4</td>
<td>?</td>
<td>51,89–91</td>
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<tr>
<td>D. v. virgifera</td>
<td>Corn</td>
<td>Cry3Bb</td>
<td>USA</td>
<td>2003</td>
<td>6</td>
<td>No</td>
<td>28,86</td>
</tr>
<tr>
<td>D. v. virgifera</td>
<td>Corn</td>
<td>Cry34/35Ab</td>
<td>USA</td>
<td>2006</td>
<td>7</td>
<td>No</td>
<td>28,92,93</td>
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<tr>
<td>D. v. virgifera</td>
<td>Corn</td>
<td>mCry3A</td>
<td>USA</td>
<td>2007</td>
<td>4e</td>
<td>No</td>
<td>28,94</td>
</tr>
<tr>
<td>D. v. virgifera</td>
<td>Corn</td>
<td>eCry3.1Ab</td>
<td>USA</td>
<td>2014</td>
<td>0e</td>
<td>No</td>
<td>28,30,31</td>
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<tr>
<td>H. zeae</td>
<td>Corn</td>
<td>Cry1Ab</td>
<td>USA</td>
<td>1996</td>
<td>8</td>
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<td>95,96</td>
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<tr>
<td>H. zeae</td>
<td>Corn</td>
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<td>USA</td>
<td>2010</td>
<td>6e</td>
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<td>95</td>
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<tr>
<td>H. zeae</td>
<td>Cotton</td>
<td>Cry1Ac</td>
<td>USA</td>
<td>1996</td>
<td>6</td>
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<td>24,97,98</td>
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<tr>
<td>H. zeae</td>
<td>Cotton</td>
<td>Cry2Ab</td>
<td>USA</td>
<td>2003</td>
<td>2e</td>
<td>No</td>
<td>24,32,99</td>
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<tr>
<td>P. gossypiella</td>
<td>Cotton</td>
<td>Cry1Ac</td>
<td>India</td>
<td>2002</td>
<td>6</td>
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<td>50,100–102</td>
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<tr>
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<td>Cotton</td>
<td>Cry2Ab</td>
<td>India</td>
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<td>8</td>
<td>?</td>
<td>75</td>
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<tr>
<td>S. albicosta</td>
<td>Corn</td>
<td>Cry1Fa</td>
<td>USA</td>
<td>2003</td>
<td>10</td>
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<tr>
<td>S. frugiperda</td>
<td>Corn</td>
<td>Cry1Ab</td>
<td>Brazil</td>
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<td>2e</td>
<td>No</td>
<td>40</td>
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<tr>
<td>S. frugiperda</td>
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</tr>
<tr>
<td>S. frugiperda</td>
<td>Corn</td>
<td>Cry1F</td>
<td>USA</td>
<td>2003</td>
<td>4</td>
<td>No</td>
<td>60,108</td>
</tr>
</tbody>
</table>

aFirst year of commercial planting of a Bt crop in the region monitored. bYears from the first commercial planting of a Bt crop in the region to the first sampling of field populations in the region yielding evidence of resistance. cTest for the high-dose standard based on direct or indirect evidence (Box 1). If both types were available, the table reflects the direct evidence. dIndicates data not available. eCross-resistance suspected or known as a factor contribution to resistance.

Tabashnik and Carriere 2017
Bt brinjal

One line non-Bt brinjal refuge crop

One line non-Bt brinjal refuge crop

One line non-Bt brinjal refuge crop

One line non-Bt brinjal refuge crop
Susceptibility of Field Populations of Eggplant Fruit and Shoot Borer (*Leucinodes orbonalis* Guenée) to Cry1Ac, the Protein Expressed in Bt Eggplant (*Solanum melongena* L.) in Bangladesh

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Transgenic plants expressing two *Bacillus thuringiensis* toxins delay insect resistance evolution

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Preventing insect pests from developing resistance to *Bacillus thuringiensis* (Bt) toxins produced by transgenic crops is a major challenge for agriculture. Theoretical models suggest that plants containing two dissimilar Bt toxin genes (‘pyramided’ plants) have the potential to delay resistance more effectively than single-toxin plants used sequentially or in mosaics. To test these predictions, we developed a unique model system consisting of Bt transgenic broccoli plants and the diamondback moth, *Plutella xylostella*. We conducted a greenhouse study using an artificial population of diamondback moths carrying genes for resistance to the Bt toxins Cry1Ac and Cry1C at frequencies of about 0.10 and 0.20, respectively. After 24 generations of selection, resistance to pyramided two-gene plants was significantly delayed as compared with resistance to single-gene plants deployed in mosaics, and to Cry1Ac toxin when it was the first used in a sequence. These results have important implications for the development and regulation of transgenic insecticidal plants.
Sustaining the Technology #2

Create an atmosphere for private sector participation
1. Incorporate dual Bt genes into new lines!
2. Encourage MoA/Government to work with private sector to increase adoption and sustainability
3. Create pathway for private sector participation
4. Develop an environment for protecting IP
5. Move to event-based regulation
WHAT WILL HAPPEN IN INDIA?
Thanks for Your Attention! 
Questions?