Benefits of Biotech Specialty Crops: the Need for a New Path Forward

Tony Shelton, Ph.D.

ams5@cornell.edu

http://shelton.entomology.cornell.edu/
Global Area of Biotech Crops, 1996 to 2012: By Crop ( Million Hectares, Million Acres)

Source: Clive James, 2012
The Agricultural Biotechnology Support Project II

A USAID-funded project in the International Program of the College of Agriculture and Life Sciences at Cornell University
Characteristics of Vegetable Production

- Essential for well-balanced diets, supplying many essential nutrients not found in staple crops such as rice, wheat and corn.
- Vegetable farmers usually earn much higher farm incomes compared to cereal producers, with per capita farm income up to 5-fold higher.
- High value commodities with high cosmetic standards; many eaten fresh.
- Intensely managed with frequent use of traditional insecticides.
2010 Worldwide Insecticide Use on Major Crops (millions of US dollars)

- Fruits & Vegetables: $4774 (45.0%)
- Rice: $1279 (12.1%)
- Other: $2249 (21.2%)
- Corn: $811 (7.6%)
- Cotton: $1500 (14.1%)

Total insecticide use is ca. $10.6 billion

Cropnosis Limited. Courtesy of R. Hautea and ISAAA.
Bt (Bacillus thuringiensis)

- Bt is a common soil bacterium which produces a protein toxic to some insects
- Many different strains of Bt
- Safer to humans and the environment
- Bt products used since 1930s but account for <1% of all insecticides
Brief History and Future of Bt Vegetable Crops

- Past
- Present
- Future
- Domestic
- International
Transgenic Bt Potatoes

- Express Cry 3A protein from *Bacillus thuringiensis tenebrionis*
- Target: Colorado potato beetle, primary defoliator in NA and Europe, and resistant to many insecticides. Control costs of $140-300 per acre.
- Bt potatoes 1st commercially available in 1995

From George Kennedy
The Agricultural Biotechnology Support Project II
A USAID-funded project in the International Program of the College of Agriculture and Life Sciences at Cornell University

Rise and Fall of Bt Potatoes

From George Kennedy
Biological, Business and Social Reasons for Demise of Bt Potatoes

- Only controlled CPB
- Only used in one variety
- Sporadic yield problems and refuge requirements
- GMO debate and market consolidation
- Technology fee higher in some areas
- Imidacloprid (neonicitonoid) registered in 1995

From George Kennedy
Bee deaths: EU to ban neonicotinoid pesticides

The European Commission will restrict the use of pesticides linked to bee deaths by researchers, despite a split among EU states on the issue.

There is great concern across Europe about the collapse of bee populations.

Neonicotinoid chemicals in pesticides are believed to harm bees and the European Commission says they should be restricted to crops not attractive to bees and other pollinators.

But many farmers and crop experts argue that there is insufficient data.

Fifteen countries voted in favour of a ban - not enough to form a qualified majority. According to EU rules the Commission will now have the option to impose a two-year restriction on neonicotinoids - and the UK cannot opt out.

The Commission says it wants the moratorium to begin no later than 1 December this year.

The UK did not support a ban - it argues that the science behind the proposal is inconclusive. It was among eight countries that voted against, while four abstained.
Bringing GM Technology to Vegetables in Developing Countries: Eggplant in India
Activists Gift 'last GM free Brinjals' to 150 Tamil Nadu legislators
January 28, 2009. Activists present the GM-free Brinjal Bouquet to MLAs in the State to protest against GM food crop commercialization and research in Tamil Nadu University

-One Seminar per month planned with American / European speaker against the eggplant (Gilles-Eric Séràlini, CRIIGEN, Jeffery Smith, USA, others)
-Eight studies commissioned to bring out research publications that will highlight purported negative impact of Bt eggplant
-TNAU field trial trespassing attempted – University filed police complaint against an NGO affiliated with Greenpeace.
What Is the Final Story?

Meanwhile, Philippines and Bangladesh are still on track to have Bt eggplant commercialized.

What did we learn from the Bt eggplant project in India?

1. You can’t outspend Greenpeace
2. If there is no political will, registration will not happen
3. If farmers have the will, things will happen. If Bt eggplant gets approved and commercialized in other countries, it will make its way into India, just like Bt cotton did.
Bt Sweet Corn in the US
Bt Sweet Corn Product Adoption

WHAT HAPPENED?

- Growers liked the product
- Export concerns for processors
- Fresh market adoption continues
- In 2008, it was about 9% of total fresh market acreage

D. Plaisted, Syngenta
### Evaluation of Bt Sweet Corn Varieties Combined with Warrior II Applications against Lepidoptera, 2010

**Clean ears (%) vs frequency of Warrior II application**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Applications of Warrior II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Obsession Plus (Bt)</td>
<td>100.0 ± 0.0a</td>
</tr>
<tr>
<td>Obsession</td>
<td>6.0 ± 3.5b</td>
</tr>
</tbody>
</table>

Means (±S.E.) followed by the same lower-case letters within a column are not significantly different (Fishers LSD means separation test, \( P > 0.05 \)).
Walmart vs. Whole Foods

Walmart
Save money. Live better.

Whole Foods Market
Brazilian virus-resistant beans
by Lucia de Souza on 18 October 2011

A homemade, high potential benefit-driven development from the public sector

Beans are an important food item, mostly in the developing world. Unfortunately, the golden mosaic virus infection is a serious constraint causing severe grain losses in Brazil and South America. The National Technical Commission on Biosafety (CTNBio) approved the genetically modified golden mosaic virus-resistant beans developed by the Brazilian public Agricultural Research Corporation (Embrapa) linked to the Ministry of Agriculture, Livestock and Supply. This work is an example of a public-sector effort to develop useful traits, such as resistance to a devastating disease, in an “orphan crop” cultivated by poor farmers throughout Latin America. It is a milestone as it is the first fully “publicly funded homemade” recombinant biotechnology crop improvement strategy that has reached this stage in a developing country.
Why Are GE Specialty Crops Not More Widely Used?

Event Based Regulations?

- Costly for ‘orphan crops’ like vegetables
- Current Bt vegetables piggy-backed on field crops

Public Acceptance/Anti-GM Activity?

- Studies suggest consumers in North America will accept Bt sweet corn

Public Sector Production of GM Crops?
<table>
<thead>
<tr>
<th>Crop</th>
<th>Target</th>
<th>LGU</th>
<th>Process</th>
<th>Reg. Status</th>
<th>Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>Scab</td>
<td>CU</td>
<td>Intragenic</td>
<td>Not applied</td>
<td>Partner</td>
</tr>
<tr>
<td>Apple</td>
<td>Fire blight</td>
<td>CU</td>
<td>Gene express.</td>
<td>Not applied</td>
<td>Partner</td>
</tr>
<tr>
<td>Apple</td>
<td>Ornamental</td>
<td>CU</td>
<td>Knockout</td>
<td>Not applied</td>
<td>Partner</td>
</tr>
<tr>
<td>Apple</td>
<td>Flowering</td>
<td>IL</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Partner</td>
</tr>
<tr>
<td>Blueberry</td>
<td>Cold Tolerance</td>
<td>MSU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Consumer</td>
</tr>
<tr>
<td>Blueberry</td>
<td>Herbicide Tol.</td>
<td>MSU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Regulation</td>
</tr>
<tr>
<td>Blueberry</td>
<td>Early Flowering</td>
<td>MSU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Regulation</td>
</tr>
<tr>
<td>Blueberry</td>
<td>Cold Tolerance</td>
<td>MSU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Consumer</td>
</tr>
<tr>
<td>Blueberry</td>
<td>Early Flowering</td>
<td>MSU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Consumer</td>
</tr>
<tr>
<td>Brassica</td>
<td>Salt tolerance</td>
<td>MSU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Partner</td>
</tr>
<tr>
<td>Brassica</td>
<td>Anti-cancer</td>
<td>IL</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Consumer</td>
</tr>
<tr>
<td>Celery</td>
<td>Herbicide Tol.</td>
<td>MSU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Regulation</td>
</tr>
<tr>
<td>Cherry</td>
<td>Virus resistance</td>
<td>MSU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Consumer</td>
</tr>
<tr>
<td>Citrus</td>
<td>Disease/Insect</td>
<td>TAMU</td>
<td>Transgenic</td>
<td>Applied</td>
<td>Regulation</td>
</tr>
<tr>
<td>Citrus</td>
<td>Insect res.</td>
<td>CU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Partner</td>
</tr>
<tr>
<td>Grape</td>
<td>Fruit rot</td>
<td>CU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Consumer</td>
</tr>
<tr>
<td>Grape</td>
<td>Bacterial res</td>
<td>CU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Consumer</td>
</tr>
<tr>
<td>Grape</td>
<td>Disease res.</td>
<td>MO</td>
<td>Knockout</td>
<td>Not applied</td>
<td>Consumer</td>
</tr>
<tr>
<td>Peanut</td>
<td>Virus res.</td>
<td>MSU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Consumer</td>
</tr>
<tr>
<td>Potato</td>
<td>Drought tol.</td>
<td>MSU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Consumer</td>
</tr>
<tr>
<td>Potato</td>
<td>Late blight</td>
<td>MSU</td>
<td>Intragenic</td>
<td>Not applied</td>
<td></td>
</tr>
<tr>
<td>Potato</td>
<td>Disease/Insect</td>
<td>TAMU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Regulation</td>
</tr>
<tr>
<td>Tomato</td>
<td>Nematode res.</td>
<td>NCSU</td>
<td>Amplification</td>
<td>Applied</td>
<td>Partner</td>
</tr>
<tr>
<td>Tomato</td>
<td>Virus res.</td>
<td>NDSU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Licensing</td>
</tr>
<tr>
<td>Tomato</td>
<td>Disease res.</td>
<td>NCSU</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Licensing</td>
</tr>
<tr>
<td>Tomato</td>
<td>Vaccine</td>
<td>IL</td>
<td>Transgenic</td>
<td>Not applied</td>
<td>Partner</td>
</tr>
</tbody>
</table>
Future for GM Specialty Crops

- Transgenic specialty crops can dramatically reduce the use of traditional pesticides, but does the public care?
- Are there other characteristics that are more important to the public?
- Public education will be essential but challenging. Maybe a crisis will be needed (beans in Brazil, oranges in FL).
- Perhaps the fastest growth will be in developing countries where food security issues are most acute.
Thank you