Critical Role of Alternative Nuclear Application Technologies in Food Security in a Changing Climate

Prof. Suresh Pillai
Professor of Molecular Microbiology
Director, National Center for Electron Beam Research
Outline

• Why alternative technologies?
• eBeam and X-ray technologies for food security
• Proposed strategies
Motivation

• Food safety, food security, quarantine issues, and food defense are shaping national priorities worldwide

• Global sourcing of ingredients and foods makes adoption of food security and food defense technologies almost a necessity

• Cobalt-60, electron beam and X-ray technologies are the only proven non-thermal technologies that countries and the food industry have.
Governing Principles

• Countries should have access to safe nuclear technologies
  – Health, agriculture, & environmental applications

• Cobalt-60 and cesium-137-based technologies are unsustainable
  – Economics, availability, and security perspectives

• Alternative technologies (electron beam and X-ray) have matured and commercially sustainable
Ionizing Irradiation Technologies

- Isotope based radiation
  - Gamma radiation (cobalt-60 and cesium-137)

Machine generated (linear accelerators)
Electron Beam (eBeam): electrons
X-ray: photons
Alternative Technologies (eBeam and X-ray technologies)

**Energy:** Penetration capability  
**Dose:** Grays (Gy) or Kilograys (kGy)  
**Dose rate:** Grays per unit time

**eBeam Technology for Cleaning, Healing, Feeding, and Shaping this World and Beyond…**
Commercially Available eBeam and X-ray Technologies

- **Low Energy** (80 keV - 300 keV)
  - Beam Power (kW): 560 kW, 245 kW, 100 kW, 40 kW, 20 kW, 15 kW

- **Medium Energy** (1 MeV – 3 MeV)
  - Beam Power (kW): 100 kW, 60 kW, 40 kW, 20 kW, 15 kW

- **High Energy** (3 MeV – 10 MeV)
  - Beam Power (kW): 560 kW, 245 kW, 100 kW, 40 kW, 20 kW, 15 kW

**Energy:** Penetration capability

**Dose:** Grays (Gy) or Kilograys (kGy)

**Dose rate:** Grays per unit time
eBeam and X-ray Technologies are Available Globally and Expanding
Alternative Technology Applications for Food Security

- Plant mutation breeding
- Surface sterilization of seeds
- Soil treatment as seed dressing

- Storage pest control
- Long-term storage of grains and cereals
- Improved bioplastics for packaging

- Elimination of food borne pathogens
- Increasing shelf life of food by eliminating spoilage organisms
- Elimination of insects and pests (phytosanitation)

- Sterile Insect Technology
- Animal and Poultry Vaccines
- Water Reuse
Scientific Evidence for eBeam & X-ray Technologies for Crop Mutation

<table>
<thead>
<tr>
<th>Mutagen</th>
<th>Number of mutant cultivars released</th>
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<tbody>
<tr>
<td>Gamma rays</td>
<td>910</td>
</tr>
<tr>
<td>X-rays</td>
<td>311</td>
</tr>
<tr>
<td>Fast neutrons</td>
<td>48</td>
</tr>
<tr>
<td>Thermal neutrons</td>
<td>22</td>
</tr>
<tr>
<td>Ethylmethane sulphonate</td>
<td>106</td>
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<tr>
<td>Sodium azide</td>
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FAO, 2015 - Adapted from Raina et al., 2016

**eBeam for Crop Mutation**

  - Higher mutation frequency; 2.57 times higher than gamma radiation

Mevex “Beams in a Box”
1.0 MeV / 1.9 MeV eBeam and X-ray capability in a self-shielded unit
Seed Treatment by eBeam Technology

**eBeam technology on wheels**

**HOW THE ELECTRON TREATMENT WORKS**

- Free-fall of seeds
- Electron beam lamp
- Cloud of electrons
Case Study - Partnering with Mexico & Pakistan for Advancing eBeam technology

Growth trends in ionizing technology processed fresh produce exports from Mexico to the US

Mexican mangoes: ~ 3,500,000 lbs of Mexican mangoes treated in 3 months

Increasing mango exports from Pakistan to the United States

- Karachi ➔ Dubai ➔ Houston ➔ Texas A&M eBeam facility

~ 30-40 hours
Proposed Strategy –
Strategic Stockpiles of Food Around the World

Bring together key stakeholders into research, development, and commercialization
Mark your calendars!!

Texas A&M University Hands-on eBeam Workshop

April 25-29th, 2022

Texas A&M University Campus
College Station, Texas

s-pillai@tamu.edu

http://ebeam-tamu.org