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

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eBeam Technology for Cleaning, Healing, Feeding, and Shaping this World and Beyond…

an International Atomic Energy Agency Collaborating Centre for Electron Beam Technology

National Center for Electron Beam Research

Texas A&M AgriLife Research

TAMU

Outline

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

Motivation

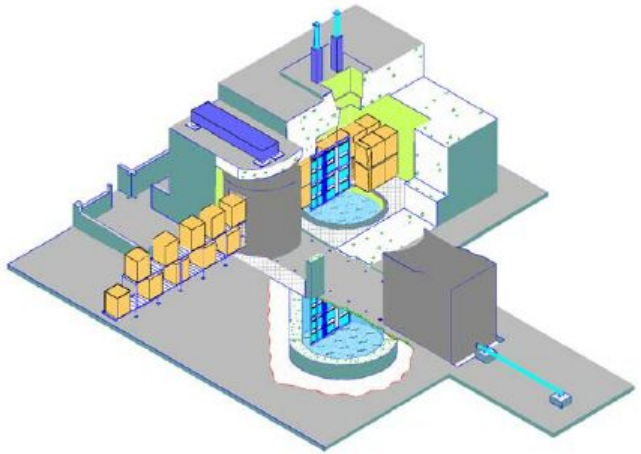
- Food safety, food security, quarantine issues, and food defense are shaping national priorities worldwide
- Global sourcing of ingredients and foods makes adoption of food security and food defense technologies almost a necessity
- Cobalt-60, electron beam and X-ray technologies are the only proven non-thermal technologies that countries and the food industry have.

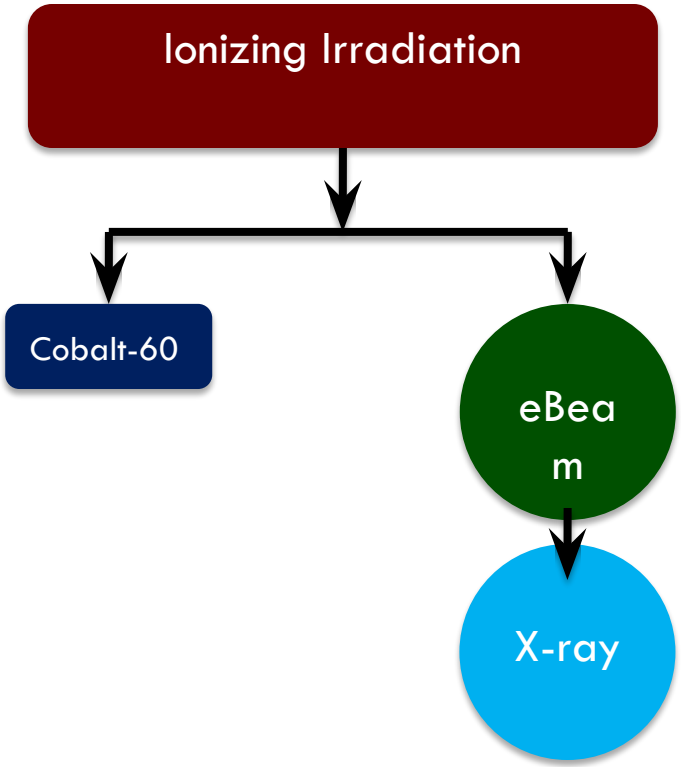
Governing Principles

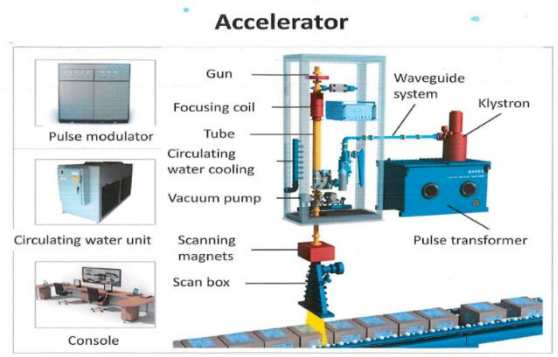
- Countries should have access to safe nuclear technologies
  - Health, agriculture, & environmental applications
- Cobalt-60 and cesium-137-based technologies are unsustainable
  - Economics, availability, and security perspectives
- Alternative technologies (electron beam and X-ray) have matured and commercially sustainable

Ionizing Irradiation Technologies

- **Isotope based radiation**
  - **Gamma radiation (cobalt-60 and**





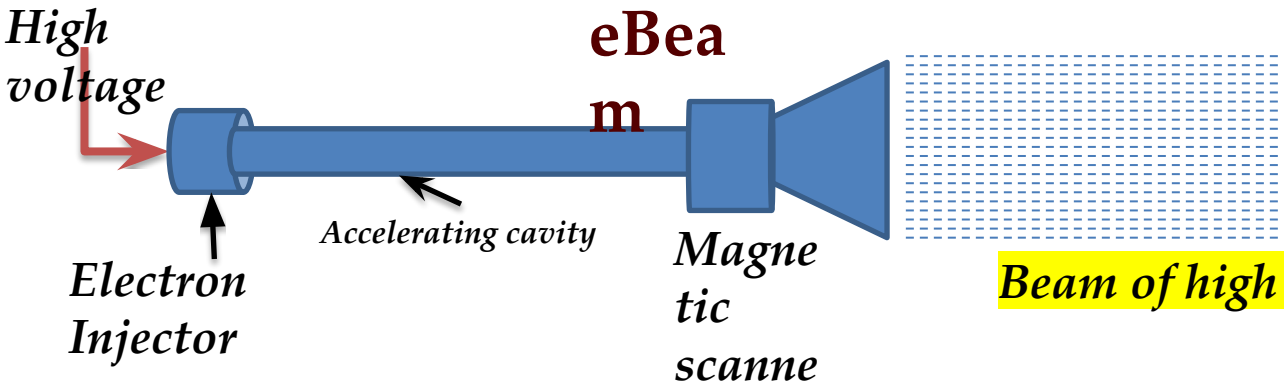


Machine generated (linear accelerators)

Electron Beam (eBeam): electrons

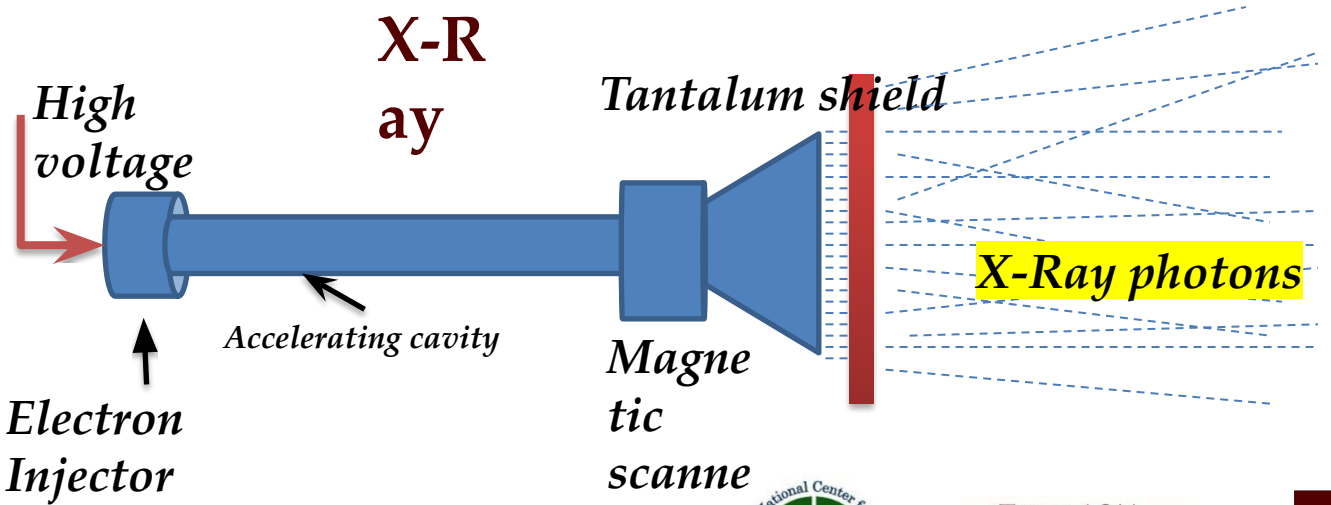
X-ray: photons

Alternative Technologies (eBeam and X-ray technologies)



Beam of high energy electrons

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



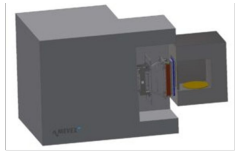
Commercially Available eBeam and X-ray Technologies

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

Buhler, Inc

SKAN, Inc

ITHPP-ALCEN

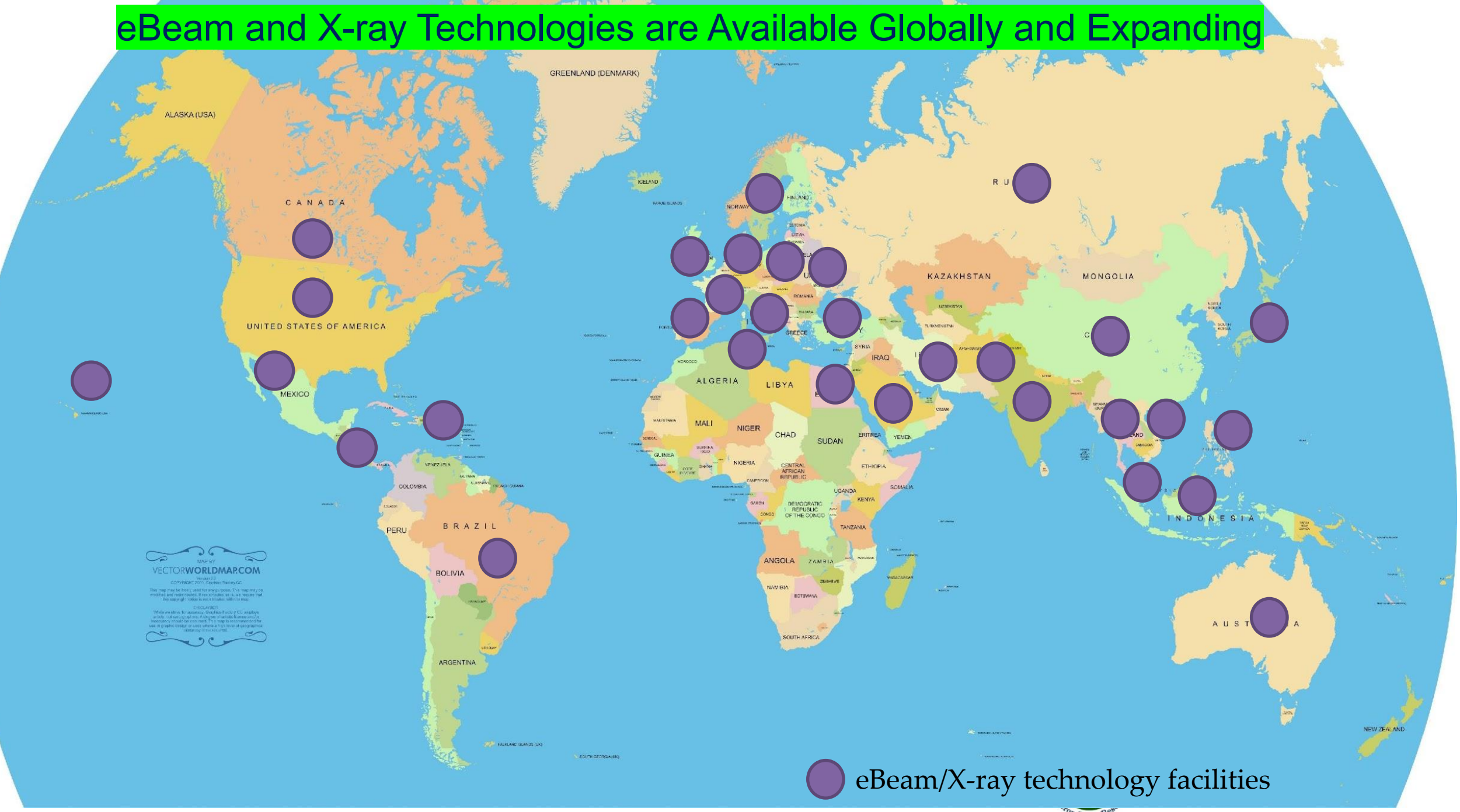


Mevex **"Beams in a Box"**
1.0 MeV / 1.9 MeV eBeam and X-ray capability in a self-shielded unit

High Energy Electron Beam
High Energy X-ray

PCT Ebeam Xbeam System
> 100 kg/hr

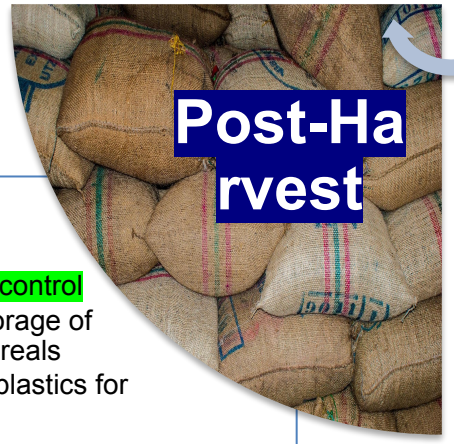
eBeam and X-ray Technologies are Available Globally and Expanding



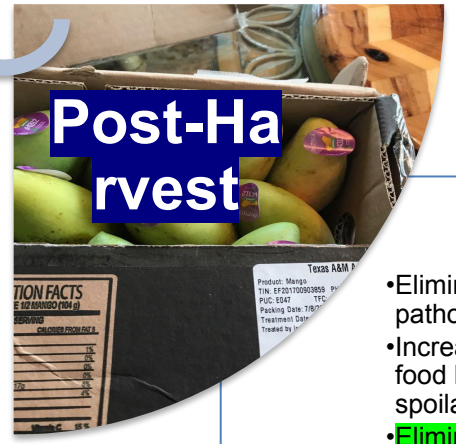
Alternative Technology Applications for Food Security

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

- Sterile Insect Technology
- Animal and Poultry Vaccines
- Water Reuse



- 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)

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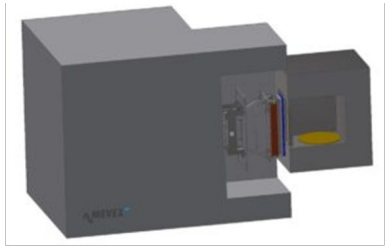
Scientific Evidence for eBeam & X-ray Technologies for Crop Mutation

Mutagen	Number of mutant cultivars released
Gamma rays	910
X-rays	311
Fast neutrons	48
Thermal neutrons	22
Ethylmethane sulphonate	106
Sodium azide	11

FAO, 2015 - Adapted from Raina et al., 2016



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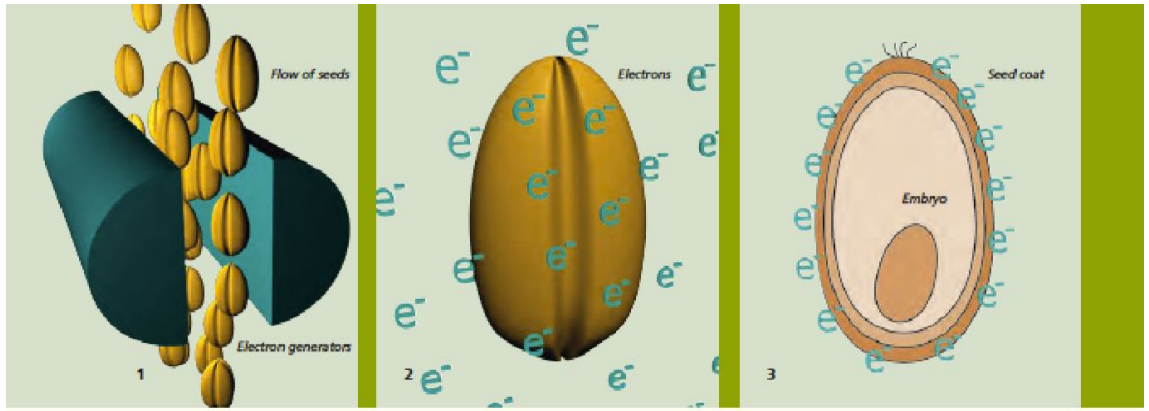
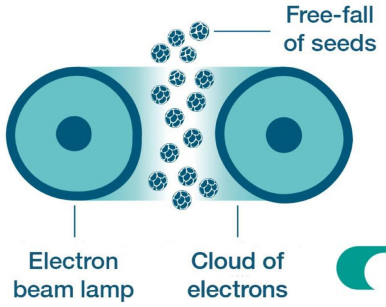
eBeam for Crop Mutation

- ***Guo et al., 1982. Studies on the mutagenic effect of 5 MeV electron irradiation on rice. Acta Genetica Sinica 9: 461-467***
- ***Luo et al., 2012. Effects of electron beam radiation on trait mutation in azuki bean (Vigna angularisi). African J. of Biotechnol, 11: 12939-12950***
- ***Promnart et al., 2017. Breeding Thai rice for flood tolerance through electron beam-induced mutations. Intl. J. Gen. Engg. 5: 1-10.***
- ***Dhole and Reddy, 2018. Comparative efficacy of electron beam over gamma rays to induce novel mutations in mungbean (Vigna Radiata L Wilczek) . IAEA. Report IAEA-CN-263***
- ***Gowthami et al., 2021. Efficiency of electron beam over gamma rays to induce desirable grain-type mutation in rice (Oryza sativa L.). Intl. J. Rad. Biol.***
  - ***Higher mutation frequency; 2.57 times higher than gamma radiation***

Seed Treatment by eBeam Technology

eBeam technology on wheels





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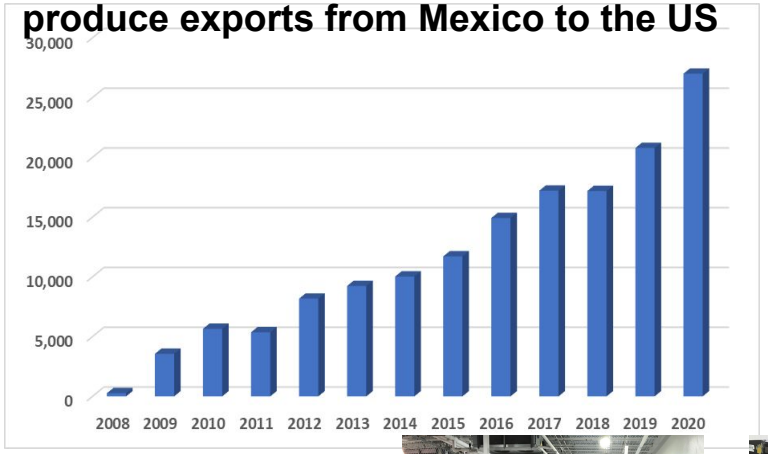
Case Study- Partnering with Mexico & Pakistan for Advancing eBeam technology

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

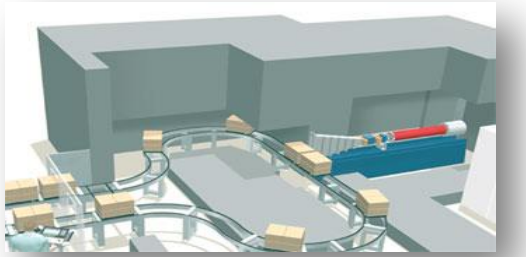
Increasing mango exports from Pakistan to the United States

- 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



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Mark your calendars!!!

Texas A&M University Hands-on eBeam Workshop

April 25-29th, 2022

Texas A&M University Campus
College Station, Texas

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http://ebeam-tamu.org