Sustainable Use of Radioactive Sources in Agriculture and Food Security

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What is the sustainable use of radioactive sources?

The safe and secure use of radioactive sources for peaceful purposes while minimising risk to workers, the public and the environment.

The International Atomic Energy Agency (IAEA) provides a risk-based ranking of radioactive sources to enable a graded approach to regulatory control.

IAEA RANKING

Category 1, most dangerous to human health and the environment

Category 5, least dangerous

Radioactive Sources Used in Agriculture

The Category 1 sources, such as cobalt-60 and cesium-137, are most commonly employed in gamma irradiators used for insect sterilisation and plant mutation breeding.

Benefits of Radioactive Sources

Contributing to SDG 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Sterile Insect Technique (SIT)

Insect pests have a significant impact on agricultural production and food security. Plant pests, such as fruit flies, account for 40% of the world's pre- and post-harvest food losses, whilst livestock pests, which include screwworm and tsetse flies, have a substantial impact on livestock production.

The SIT is an environmentally-friendly pest control that uses ionising radiation to sterilise male insects in special rearing facilities. The sterilised males are released in infested areas to mate with wild females but do not produce offspring. The SIT is a central component of integrated pest management approaches that suppress or eradicate insect pest populations.

The Joint FAO/IAEA Division spearheads global research in the development and application of SIT and provides support to over 70 countries through the IAEA's Technical Cooperation Programme.

Snapshot of successes

Tsetse fly

Eradicated from Zanzibar by 1997. Within three years the proportion of small farmers rearing indigenous cattle increased by more than 60% and sales of milk from indigenous cattle increased by more than 50%.

Mediterranean fruit fly (Medfly)

Medfly-free and low-prevalence areas established in Guatemala contribute to the development of multibillion-dollar fruit, vegetable and horticulture industries in Guatemala, Mexico, Belize and the US.

Screwworm

The US Department of Agriculture estimated in 2018 that the US livestock industry benefited by more than USD 900 million annually from screwworm eradication. The screwworm was eradicated in the US, using the SIT, in 1966 and again in 2017 after it re-emerged in 2016.

Plant mutation breeding

The FAO estimates that one in nine people suffered from chronic undernourishment in 2017.

Radioisotopes and radiation used in food and agriculture are helping to reduce these figures.

The Joint FAO/IAEA Division helps countries apply radiation-induced mutation breeding technologies, which produce crops with higher yields, improved quality and greater tolerance to environmental stress. The resulting significant increase in locally produced food crops is vital to global food security.

Snapshot of successes

The National Nuclear Energy Agency of Indonesia has released six mutant rice varieties and five mutant soybean varieties since 2012, resulting in a 22.8% increase in farmers' incomes.

In Peru, improved barley varieties contribute roughly EUR 30 million annually to poor, high altitude Andean farmers.

GLOSSARY

Gamma irradiation	Electromagnetic radiation with a short wavelength emitted by atomic nuclei
Ionising radiation	A type of short wavelength radiation that can modify physical, chemical and biological properties of the irradiated materials
SDGs	The Sustainable Development Goals for 2030 adopted by all United Nations Member States in 2015
The Joint FAO/ IAEA Division	The Joint Food and Agriculture Organisation (FAO) / IAEA Division of Nuclear Techniques in Food and Agriculture

Challenges Related to the Use of Radioactive Sources

Safety and security concerns

Preventing human exposure. If not safely managed, cesium-137 and cobalt-60 (Category 1 sources) would likely cause serious or permanent injury. Unshielded, these sources could prove fatal after just a few minutes of exposure.

Protecting sources from people. Terrorist or criminal groups could use these Category 1 sources in a radiological dispersal devise (RDD), also known as a dirty bomb or a radiation exposure devise (RED).

Economic and psychological consequences. If dispersed in an RDD, these radioactive sources are unlikely to affect people beyond a hundred metres away. However, such an incident would result in wide spread panic, ultimately turning public opinion against the use of nuclear technology. The necessary clean-up of the area could also amount to millions of euros.

Continued availability of radioactive sources

After the events of 11 September 2001, concerns that radioactive sources would be used for malicious purposes resulted in efforts to increase security measures for these sources, including regulations for their import, export and transportation. In 2003 delays and denials of radioactive shipments affecting the delivery of sources used in lifesaving applications for cancer diagnosis and treatment were brought to the IAEA's attention. The delays and denials were due to growing refusal by some carriers, ports and handling facilities to transport radioactive material. Reasons for this included carriers not wanting to invest in the necessary training, ports not having designated storage areas for radioactive cargo, lack of information about the safety of handling such materials and complex local or national regulations.

Photo: Self-contained gamma irradiation unit

What the IAEA and its Member States are Doing to Address These Challenges

Safe and secure use of radioactive sources

The IAEA Code of Conduct on the Safety and Security of Radioactive Sources and its Supplementary Guidance, together with IAEA Safety Standards, and Nuclear Security Series publications provide international requirements, consensus recommendations and guidance for an appropriate and sustainable regulatory system to control these radioactive sources.

Standard security measures in irradiation facilities include access control and intrusion detection systems and the IAEA supports physical security upgrades of these facilities upon request.

Self-contained irradiators, used for SIT and plant mutation breeding, deny human access to the irradiation chamber that houses the source within a protective shield of lead or other material protecting the operator. Fixed to the ground these units are heavy (4 to 8 tonnes) and difficult to dismantle and remove.

Cobalt-60 is replacing cesium-137 in the agriculture sector as cesium has a longer half-life and is more dispersible than cobalt-60, which makes cobalt-60 less attractive for use in a dirty bomb.

Continued availability of radioactive sources

The IAEA International Steering Committee on the Denial of Shipment, which ran from 2006 to 2013, was established to unblock global transport routes. Despite these efforts and regardless of industry's compliance with national and international regulatory requirements and good transportation practices, denials and delays of radioactive materials remain a problem. Of grave concern to shippers of these materials, as recently noted by the International Maritime Organization, is the decreasing number of carriers willing to transport radioactive cargo since shipping companies that historically accepted this cargo have been bought or merged with shipping companies that have policies against accepting radioactive materials. In a 2018 side-event on denials and delays at the IAEA General Conference, the International Irradiation Association warned that significant consolidation within the shipping industry had resulted in a reduced number of shipping companies and routes available for the transport of cobalt-60.

Alternative technology

X-ray irradiators (using electricity) are being developed as an alternative to gamma irradiators. However, X-ray irradiators are not yet robust enough for medium size SIT production (50 million insects a week). The production facility in Guatemala, for example, sterilises 1.2 billion medflies a week. Other challenges relate to maintenance, procurement and the dependence of X-ray irradiators on electricity, which limits their use in countries where a consistent power source is not guaranteed. Research to provide alternatives to radioactive sources continues.

Ensuring Sustainable Use

As long as radioactive sources are safely used and adequately secured and there is no viable alternative, every effort should be made to ensure the continued availability of these sources for SIT programmes and plant mutation breeding.

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