Contribution of Nuclear Applications to Food Security in a Changing Climate

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Food Security and Climate Change

Hunger and malnutrition levels worsened dramatically last year because of the COVID-19 pandemic. Between 720 and 811 million people live in hunger, an increase of about 161 million since 2019. The world is not on track to achieve Zero Hunger by 2030, according to the United Nations (UN). The UN Food and Agriculture Organization (FAO) estimates that global food production will have to increase by as much as 70 percent to feed the world by 2050. The agricultural sector is vital to ending hunger, achieving food security, improving nutrition, and promoting sustainable development. However, climate change is increasingly affecting agriculture production as rising temperatures and extreme weather events impact negatively on the productivity of crops, livestock, forestry, fisheries and aquaculture. The changing climate also influences the emergence and re-emergence of insect pests that transmit diseases and impact on human and animal health. Peaceful applications of nuclear science and technology enable climate-smart agriculture practices that build resilience in food security systems by improving outputs and mitigating the impact of climate change.

Improving resilience to drought through mutation breeding, Tsumeb in Namibia. Photo Credit: Hussein Shimelis

The Link Between Nuclear Applications and Climate Mitigation

Together with the FAO, the International Atomic Energy Agency (IAEA) supports countries to optimize and strengthen their capacities to apply nuclear science and technology in improving agricultural resilience and adaptation to climate change. Applying a nuclear technique known as plant mutation breeding, scientists use radiation to produce seeds and plant material that are resistant to diseases, increased soil salinity, and adverse weather conditions. These crops have higher yields, shorter crop cycles, and use less water. Bangladesh is one of many countries that has benefited from plant mutation breeding through the development of new rice varieties which has helped to increase its rice production threefold in the last few decades. In Peru, improved barley varieties that are adaptable to climatic conditions in high altitudes contribute roughly US$32 million annually to the income of poor, high-altitude Andean farmers. With the Sterile Insect Technique (SIT), male insects are sterilized to eradicate or contain invasive pests without leaving an ecological footprint. This is important because climate change also impacts the distribution of pest species, increasing the survival and establishment of invasive pests which can destroy crops and livestock and affect human health. SIT protects farms in Guatemala, Mexico, Belize and the USA from Mediterranean fruit flies, contributing to the development of multibillion dollar export industries in these countries. In Zanzibar the eradication of the Tsetse fly significantly enhanced agriculture and livelihoods of farmers.

Nuclear science and technology and the UN Sustainable Development Goals (SDGs): plant mutation breeding and SIT are examples of two nuclear applications that contribute directly to these six SDGs, assisting countries in meeting their development objectives in poverty reduction, agriculture production and food security, and environmental protection.

Fruit fly pupae sterilized using a gamma irradiator at the Guatemala insect mass rearing and sterilization facility, which produces 1.2 billion sterile medflies a week. Photo credit: Dr Pedro Redon/MOSCAMED - Guatemala.

Access to Technologies

Access to Nuclear Technologies: Source-Based and Non-Isotopic Alternatives

The radiation required for these techniques is commonly produced by gamma irradiators that use radioactive sources like cobalt-60, which requires commensurate safety and security measures. While these irradiators are hardy, easy to use and maintain, need little electricity and are ideal for use in remote areas, costs related to the protection, transportation, secure storage and end-of-life management of radioactive sources are high. Despite the strong safety and security record for shipments of radioactive materials, many carriers and ports choose not to engage in radioactive material product transportation, which is increasing the cost of the sources and reducing their accessibility. There are alternative technologies available that use electricity to produce radiation like electron beams (E-beams) and X-rays that have none of the security concerns associated with radioactive sources. These technologies have the potential to replace gamma irradiators. X-rays are already being used to irradiate mosquitos that transmit diseases like dengue and the Zika virus. However, more research and development is required to adapt these technologies for effective application in agriculture by especially low-and middle-income countries.

Role of the IAEA

The IAEA's Division of Nuclear Security assists its Member States, upon request, in strengthening the security of radioactive material in use, storage and transport. It supports them in the research, development and use of these technologies and related techniques and in the safe and secure application thereof. The Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture helps countries apply radiation-induced mutation breeding. The Joint Centre also spearheads global research in the development and application of SIT and provides support to over 70 countries through the IAEA's Technical Cooperation Programme. The Insect Pest Control Laboratory in Seibersdorf carries out applied research, helping Member States adapt and integrate SIT and area-wide integrated pest management programmes.

Arial dispersal of an organic fruit fly bait spray that lowers populations to augment the effectivity of the SIT programme in Guatemala. Used as part of an area-wide integrated pest management programme, SIT is a climate-smart technique that suppresses, eradicates, contains or prevents pests from endangering people and their livelihoods. Photo credit: Dr Pedro Rendon/MOSCAMED Guatemala.

Key Takeaways

Expanding the use of Nuclear Science and Technology in Climate-Smart Agriculture: What is Needed

* Awareness-raising efforts and advocacy on the benefits and cost effectiveness of climate-smart nuclear applications in agriculture.
* Improved communication about the transport of radiological material with regulators, carriers, handling agents, and others within the supply chain to ensure that radioactive sources remain accessible for peaceful uses.
* Investment in research and development of E-beam and X-ray technologies to ensure their effective use for SIT and plant mutation breeding in especially low-and middle-income countries.
* Countries should adhere to the IAEA *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards,* and implement the provisions contained in the *Code of Conduct on the Safety and Security of Radioactive Sources and Supplemental Guidance on the Management of Disused Radioactive Sources.*

For Further Reading

IAEA Climate Smart Agriculture
* https://www.iaea.org/topics/climate-smart-agriculture

VCDNP Case Study on the Contribution of Innovative Nuclear Technology to Sustainable Agriculture
* https://vcdnp.org/the-contribution-of-innovative-nuclear-technology-to-sustainable-agriculture/

VCDNP Fact Sheet on the Sustainable Use of Radioactive Sources for Agriculture and Food Security
* https://vcdnp.org/vcdnp-fact-sheet-on-the-sustainable-use-of-radioactive-sources-for-agriculture-and-food-security/

VCDNP Panel Discussion on the Contribution of Nuclear Applications to Food Security in a Changing Climate
* https://vcdnp.org/contribution-of-nuclear-food-security-changing-climate/