Food and Agriculture

Objective

To support Member States in improving efficiency and sustainable intensification of agricultural production and the improvement of global food security through capacity building through technology transfer to Member States. To use nuclear technique to increase the resilience of livelihoods to threats and crises that impact agriculture, livestock and food security, including climate change, biothreats, food safety risks, and nuclear or radiological emergencies.

Support for International Standards on Application of Irradiation Technology

Phytosanitary irradiation has opened the way for fruit exports from Viet Nam to the United States of America worth US $20 million a year. In 2020, Viet Nam entered into bilateral agreements allowing trade in irradiated fruits with Australia. This trade is only possible because gamma, electron beam and X ray irradiation provides a chemical free way to prevent hitch-hiking pests from establishing themselves in importing regions while ensuring that high quality fruits retain their appearance, texture and taste (Fig. 1).

In 2020, the Agency focused on revising the International Standard for Phytosanitary Measures No. 18, which provides guidance on the use of irradiation as a phytosanitary measure, to give technical requirements for the process and raise the maximum permitted X ray energy for food irradiation from 5 MeV to 7.5 MeV. The proposed change to 7.5 MeV X rays would approximately double the efficiency with which an electron beam is converted into X rays, with no implications for efficacy or food safety. This would allow more commodity throughput and reduce processing costs, making X rays more economical and sustainable.

Enhancing Agricultural Water Management

Soil moisture is an important variable in irrigation management, hydrological modelling, and flood and drought forecasting. In 2020, the Agency developed the cosmic ray neutron sensor (CRNS) nuclear technology by combining it with satellite images from Sentinel-1 synthetic aperture radar to produce high resolution soil moisture maps to support better agricultural water management.

This major step in the monitoring of soil moisture at a high spatial and temporal resolution by combining remote sensing and CRNS nuclear technology can improve the soil moisture data estimated by remote sensing. These research and development activities, carried out at the IAEA Seibersdorf laboratories, constitute an important element of the coordinated research project entitled 'Enhancing Agricultural Resilience and Water Security Using Cosmic-Ray Neutron Technology'.

FIG. 1. Boxes filled with lychee fruits being prepared for irradiation in Viet Nam. (Photograph courtesy of the Hanoi Irradiation Center.)

Impacts of Phosphorus Fertilizers on Agriculture and the Environment

Phosphorus fertilizers are known to increase crop productivity; however, they can cause serious environmental pollution when applied excessively. Monitoring phosphorus pollution in natural environments using stable isotopes has proven difficult because phosphorus has only one stable isotope (phosphorus-31), meaning tracing is not an option.

To assess phosphorus pollution in freshwater ecosystems and the environment, the Agency, through technical support from a coordinated research project and applied research and development at the IAEA Seibersdorf laboratories, modified a technique developed in 2018 involving the stable isotopes of oxygen in phosphate ($\delta^{18}O_p$). The method involves extracting phosphorus from the soil, purifying it and converting it to silver phosphate (Ag_3PO_4). Member States have begun using the modified technique in water quality investigations to identify the origin of phosphorus, allowing them to develop appropriate remediation strategies.

Development of a DNA Chip for Camel Improvement

Traditionally, livestock improvement has relied on the slow, expensive process of selecting and breeding superior animals. Today, advances in nuclear and related genomic technologies make it possible to estimate the breeding potential of an animal on the day of its birth, simply by looking at its deoxyribonucleic acid (DNA).

Genome maps pinpoint the location of specific features on an animal's chromosomes — so-called DNA markers — that are important for food production. These genome maps are produced using a nuclear technique known as radiation hybrid mapping. Once the full genome is mapped, tens of thousands of such markers are combined onto a DNA chip, which can then be used to determine an animal's breeding potential as soon as it is born. This can help to speed up the annual genetic gain and increase animal productivity in a short time.

In 2020, the Agency, in collaboration with the University of Veterinary Medicine Vienna (Austria), Cardiff University (United Kingdom) and International Camel Consortium for Genetic Improvement and Conservation (ICC-GIC) (Algeria, China, Egypt, Mongolia, Morocco, Pakistan, Sudan and the United Arab Emirates), developed a multispecies camelid DNA chip for selection and breeding of high producing camels and increased productivity (Fig. 2). The chip is now being validated and field tested through the ICC-GIC.

FIG. 2. Double humped domestic Bactrian camels in Mongolia. (Photograph courtesy of Mohammed Shamsuddin.)

Strengthening the Plant Mutation Breeding Network

In 2020, technical support from the Agency resulted in the development of 25 new and improved crop varieties in Member States. These results led to the formation of the pilot Plant Mutation Breeding Network in the Asia-Pacific region. Member States in the Latin America and Caribbean region also expressed their interest in forming a similar network. Induced genetic variation through irradiation and physical mutagenesis facilitates steep changes in crop performance that are beyond the feasible limits of conventional breeding, using a clean non-chemical approach. Coupled with precise phenotyping for selection using phenomic tools developed and tailored to each trait of interest, the technology offers great potential for improved crop performance and food security in the face of a rising population and changing climate.

Developments in the Sterile Insect Technique and Post-harvest Treatments

Five years ago, the Agency began developing the sterile insect technique (SIT) package for spotted wing drosophila. Since then, the radiation biology and dose responses for this package have been established and methods for rearing the fruit flies have been developed. In 2020, the Agency began pilot trials to assess the feasibility of integrating the SIT with other control methods to manage spotted wing drosophila populations in confined cropping systems.

Since early 2018, the Agency has been supporting Chile in developing the SIT package for the European grapevine moth (Lobesia botrana) (Fig. 3), integrated with other pest control measures. During 2020, in a pilot trial more than 750 000 sterile moths were released over a selected area of infestation.

Agency research on post-harvest treatments contributed to the development of international standards to facilitate fruit trade. Such standards support safer trade, which allows exporting countries easier market access, and reduce the risk of pest introduction to importing countries.

FIG. 3. Damage caused by Lobesia botrana *larvae. (Photograph courtesy of Hernán Donoso, Agriculture and Livestock Service, Chile.)*