

## Food and Agriculture



# Boosting Food Security with Nuclear and Related Techniques

### SUMMARY

1. Social, economic and environmental pressures have implications for the sustainable production and availability of sufficient, safe and nutritious food, and hence have an impact on global food security.
2. Over the coming decades, about 50% more food must be produced on agricultural land that is already limited in area or marginalized because of degradation and extreme weather events, in order to meet the needs of the world's growing population.
3. Nuclear and related techniques are used to develop climate-smart agricultural practices, which can enhance resource use efficiency, sustainably increase crop and livestock productivity, and help curtail farming costs.
4. The IAEA, in partnership with the Food and Agriculture Organization of the United Nations (FAO), supports and promotes the safe and efficient use of nuclear and related techniques in food and agriculture, with the aim of contributing to global food security and sustainable agricultural development.

### INTRODUCTION

Globally, more than 800 million people suffer from hunger; yet the world's population is expected to rise by a further 2 billion by 2050. To end poverty and hunger everywhere, as expressed in the United Nations 2030 Agenda for Sustainable Development, global food production needs to increase by 50%. This challenge has never been greater: freshwater supply is decreasing, arable land is dwindling, emerging and re-emerging transboundary animal and plant diseases and agricultural pests are spreading, resources are progressively overexploited, and harsher and more unpredictable climatic conditions jeopardize food outputs. All these factors have an adverse impact on food security worldwide.

The IAEA, in partnership with FAO, helps Member States to implement sustainable, climate-smart agricultural practices for the enhancement of food security. This partnership was established in 1964 with the creation of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (Joint Division).

The Joint Division, through coordinated research and technical cooperation projects, provides Member States with assistance on the transfer and



implementation of nuclear techniques, related biotechnologies and conventional methods and practices that can be used to enhance agricultural productivity, food quality and sustainability while protecting the environment.

## HOW NUCLEAR TECHNIQUES HELP

Member States are supported by the Joint Division in building capacities, networking and partnerships for the peaceful application of nuclear science and technology in food and agriculture.

**Food and environmental protection:** food irradiation provides a safe and environmentally friendly method for controlling food-borne diseases and insect pests and maintaining food quality at the post-harvest level. Analytical nuclear techniques are used to trace and authenticate food products and combat food fraud. Nuclear and related techniques are also used to detect, monitor and track the presence and fate of chemical residues and other contaminants in foods and the environment to ensure that agrochemicals and veterinary drugs can be used effectively to produce high-quality food and maintain food safety.

**Soil and water management and crop nutrition:** nuclear and related methods are used to measure and monitor nutrients and water in the soil–crop and soil–crop–livestock systems, and thus serve as the basis for developing strategies and climate-smart soil–water–nutrient management practices. For example, the oxygen-18 signature of water can help determine how much water is being lost because of soil evaporation and plant transpiration in different settings, which, in turn, helps improve the efficiency of water use and strengthens plant resilience. Isotopic techniques are also used to determine the sources of greenhouse gas emissions and thus support the adoption of suitable mitigation options, as well as to help minimize soil erosion, ensure optimum conservation of natural resources, and promote sustainable agriculture with high resilience and adaptability to climate change and variability. For example, fallout radionuclides and carbon-13 signatures in soils make

it possible to determine the extent of soil erosion and sedimentation, as well as to identify the causes of land degradation in agricultural areas, so that appropriate steps can be taken to control soil erosion and improve resilience.

**Plant breeding and genetics:** radiation techniques are used both to induce genetic variation (and thus produce desired traits in crops), and to accelerate the breeding of varieties that have higher yields, improved resistance to disease and tolerance to environmental stresses such as drought and high salinity. Such techniques involve the use of gamma rays, X-rays, fast neutrons or ion beams to irradiate seeds, organs and tissues of plants, thereby enhancing their genetic diversity. Plant breeders screen several offspring generations of mutated plants for desired traits. Biotechnologies, including molecular and in vitro techniques, can help to speed up this process. Once selected and thoroughly checked for their agronomic performance, they are officially registered as new varieties and disseminated to farmers. Thanks to this technology, thousands of mutant varieties of more than 210 plant species have been officially released worldwide.

**Animal production and health:** isotopic techniques are used to evaluate the reproductive efficiency of farm animals and the nutritional value of animal feeds in order to improve livestock productivity, as well as to develop tools for the identification of genetic markers of economically important traits so that breeding animals can be selected that are resistant to major diseases and better adapted to harsh climatic conditions. They are also used in immunoassays and molecular diagnostic tests for the early and rapid detection and control of transboundary animal and zoonotic diseases. Irradiation with X-rays, gamma rays and electron beams is being used to establish pathogen inactivation techniques for the development of vaccines against animal and zoonotic diseases. The Joint Division's important contribution to the worldwide eradication of rinderpest is well known. Another irradiation-based technique – radiation hybrid mapping – is making it possible to construct





**40% of our land is used for agriculture; land threatened by desertification, salinity, and loss of nutritional content, thereby threatening the food security of millions. The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture is using nuclear science to track carbon through the plant cycle because healthy soil has more carbon, and healthy soil produces much more nutritious food.**

(Photo: M. Madsen/IAEA)

and characterize the whole genome of livestock species such as goat and camel.

**Insect pest control:** the sterile insect technique (SIT) offers an environmentally friendly means of suppressing, containing and, in some cases, even eradicating major insect pests such as various species of fruit flies, moths, disease-transmitting tsetse flies and mosquitoes. The SIT has been applied to control major insect pests on an area-wide basis, thus benefiting small subsistence farmers as well as intensive agriculture production aimed at supplying local and international markets. This technique has also become an important tool for containing and eradicating outbreaks of high-profile invasive pests, for which the risk of introduction has been exacerbated by the increase in global travel and trade, as well as the more favourable environmental conditions for the establishment and spread of pests brought about by

climate change. At present, 25 Member States have sterile insect mass rearing and sterilization facilities in place, with a total weekly production capacity of over three billion sterile insects. From these facilities, sterile insects are also shipped across borders to support pest control programmes in other Member States.

## ROLE OF THE IAEA AND FAO

The application of nuclear and related techniques contributes to Member States' efforts directed at the strategic utilization and management of resources to boost food production in a sustainable way. Many countries require technical support in their endeavours to improve sustainable agriculture and food security and safety. The IAEA, through its close partnership with FAO, has a unique mandate and capacity to support the safe and appropriate use of nuclear techniques for food and agricultural development.





Tracking contaminants at the FAO/IAEA Food and Environmental Laboratory, Seibersdorf, Austria. (Photo: IAEA)

Applied and adaptive research and development activities in this field are carried out at the FAO/IAEA Agriculture and Biotechnology Laboratories in Seibersdorf (Austria). These laboratories provide Member States with support in the form of training, technology transfer and laboratory capacity building, which is delivered through the IAEA's technical cooperation projects.

## AREAS WHERE MEMBER STATES MAY BENEFIT FROM IAEA ASSISTANCE

- Improving food security and sustainable agriculture by using nuclear and isotopic techniques.

- Capacity building through expert services, training, research and development, transfer of technologies, laboratory support and networking.
- Conducting research and development at the FAO/IAEA Agriculture and Biotechnology Laboratories (run by the Joint Division), leading to results that countries can adopt, validate and apply in order to enhance their food security strategies.

## MORE INFORMATION

Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture

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