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

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IAEA

Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

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Mission

The mission of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture is to support and promote the safe and appropriate use of nuclear and related technologies by the FAO/IAEA Member States in food and agriculture, with the aim to contribute to peace, health and prosperity throughout the world, especially to global food security and sustainable agricultural development.

The FAO Strategic Objectives

- **Help eliminate hunger, food insecurity and malnutrition**
- **Make agriculture, forestry and fisheries more productive and sustainable**
- **Reduce rural poverty**
- **Enable inclusive and efficient agricultural and food systems**
- **Increase the resilience of livelihoods to disaster**

Milestones in the History of the Joint FAO/IAEA

1960s

1964 - The Joint FAO/IAEA Division of Atomic Energy in Agriculture established on 1 October

1964 - Publication of the first manual on the use of isotopic technologies for animal production and health

1966 - First pilot project for the use of isotopes and radiation in studies on the etiology, effects and control of parasitic diseases in domestic animals

1968 - First sterile insect technique (SIT) field pilot project for Mediterranean fruit fly suppression in Capri, Italy

1969 - The first FAO/IAEA international training course on crop mutation breeding

1970s

1970 - Publication of the first *Manual on Mutation Breeding*

1972 - Nitrogen-15 labelled fertilizer methodology developed for agriculture production

1972 - First SIT pilot project against the tsetse fly (*Glossina morsitans*) in Tanzania

1972 - First animal production and health symposium on environmental adaptation of animal ecosystems

1977 - Publication of the 2nd edition of *Manual on Mutation Breeding*

1978 - Concepts of nitrogen-15 usage in biological nitrogen fixation studies released

1980s

1980 - Introduction of tissue culture (biotechnology) for *in vitro* mutation induction

1980 - The Joint FAO/IAEA/World Health Organization (WHO) Expert Committee approves food irradiation as safe

1980 - Nitrogen-15 isotope dilution methods developed for the assessment of biological nitrogen fixation

1982 - Eradication of Mediterranean fruit fly from southern Mexico

1983 - Establishment of nuclear-related diagnostic platforms (RIA/ELISA) for animal reproduction and disease diagnoses

1989 - Guidelines for the control of foods contaminated by radionuclides adopted as international Codex standards

1989 - First temperature-sensitive lethal genetic sexing strain developed for SIT application against Mediterranean fruit fly

History

The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture was established by the Food and Agriculture Organization of the United Nations (FAO) and the International Atomic Energy Agency (IAEA) on 1 October 1964. It was designed as a strategic partnership to mobilize the talents and resources of both organizations. Working together would broaden and deepen the cooperation between the two organizations and benefit their Member States in the peaceful application of nuclear science and technology in a safe and effective manner. In turn, this would enhance efforts to provide the global community with increased production of better quality and safer food, while sustaining natural resources.

Prior to 1964, both FAO and IAEA each had their own programmes for the application of atomic energy in food and agriculture: FAO in the Atomic Energy Branch of its Agriculture Department and the IAEA in its Unit of Agriculture in the Department of Research and Isotopes. In order to better coordinate this work, the FAO and IAEA Directors General negotiated "the Arrangements for the Joint FAO/IAEA Division of Atomic Energy in Food and

Division

1990s

1992 - Eradication of New World screwworm in Libya using the SIT

1993 - Utilization of phosphate rock sources through use of phosphorus-32 for agricultural production

1993 - Collaborative centre for ELISA and molecular techniques officially recognized by the World Animal Health Organisation (OIE), FAO and WHO

1994 - Sterile insect programme established for the prevention of Mediterranean fruit fly in Los Angeles Basin, California, USA

1994 - First global evaluation of artificial insemination (AI) service quality using nuclear techniques

1996 - Techniques for Fallout Radionuclides (FRN) developed for the evaluation of soil erosion

1996 - New nuclear and complimentary techniques introduced for the analysis of veterinary drug residues in foods

1997 - Eradication of the tsetse fly (*Glossina austeni*) from Zanzibar, Tanzania using the SIT

2000s

2000 - Commercial phytosanitary irradiation facility for fresh fruits established in Hawaii

2002 - FAO/IAEA/USDA International Product Quality Control and Shipping Procedures for Sterile Mass-Reared Tephritid Fruit Flies introduced

2004 - Partnership agreement with the Austrian Government for research on exotic highly contagious animal pathogens

2005 - Eradication of the Mediterranean fruit fly from Chile using the SIT

2005 - First molecular nuclear diagnostic tests in animal health validated and distributed to Member States

2008 - Oxygen-18 stable isotopic technique developed to improve water use efficiency in cropping systems

2008 - Mediterranean and other fruit flies eradicated from southern Argentina and southern Peru using the SIT

2009 - Invasive cactus moth eradicated using the SIT in Yucatan, Mexico

2010s

2010 - Analytical methods for food traceability and authenticity established

2010 - Goat genome mapped using nuclear techniques to characterize indigenous goat breeds

2010 - Mosquito mass-rearing system transferred to Member States for field pilot tests

2010 - False codling moth successfully managed in South Africa using the SIT

2011 - Awards received for contributions to the global freedom from rinderpest campaign

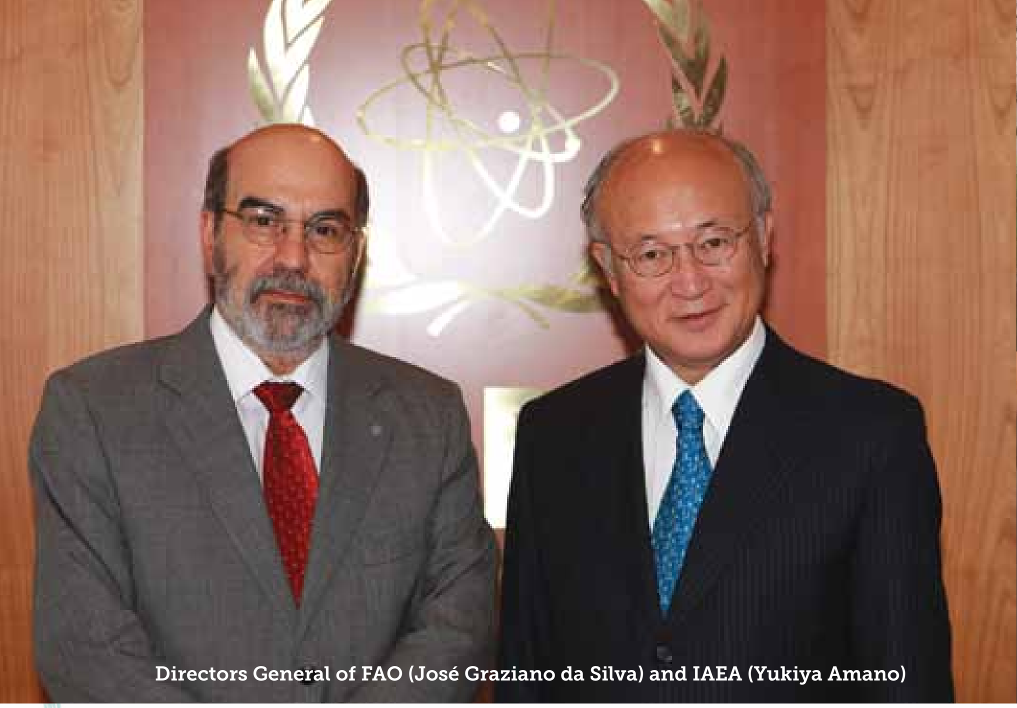
2013 - Mediterranean fruit fly eradicated from western Guatemala

2013 - Compound specific stable isotope techniques developed for assessing sediment source and soil erosion

Agriculture". The associated FAO/IAEA agriculture laboratories were then established in 1964 within the IAEA laboratories, hosted at the Austrian National Laboratories in Seibersdorf, Austria – about 35 km from Vienna.

The Arrangements provide for the Joint Division to be housed at IAEA Headquarters in Vienna, with the laboratory facilities nearby. The Joint Division staff are members of one of the parent organizations, and report to both FAO and IAEA. The Joint Division merges the mandates of both organizations and carries out the activities of the Joint FAO/IAEA Programme. FAO is the lead organization in the United Nations (UN) for agriculture, forestry, fisheries and rural development, while the IAEA is the world's centre of cooperation in the field of nuclear technology. The Joint Division's programme and activities are problem-oriented and focus on developing and transferring technologies in response to real, practical needs. This programme identifies where appropriate nuclear techniques can enhance, improve or increase agricultural production, protect natural resources and facilitate agricultural trade.

Since 1964, the Joint Division has continuously evolved its programme to meet the world's changing needs. It has always focused on expanding its ongoing contribution to agricultural development and global food security, and proactively embraced and added its expertise to efforts to adapt to and mitigate the effects of climate change, respond to globalization, conserve ecosystem services and broaden biodiversity. Today, both FAO and IAEA strive to mobilize commitment and concerted action towards meeting the Millennium Development Goals and the Sustainable Development Goals through the appropriate integration of nuclear and related technologies for sustainable agriculture and food security.


Directors General of FAO (José Graziano da Silva) and IAEA (Yukiya Amano)

FAO/IAEA Partnership

The FAO/IAEA partnership is a powerful example of interagency cooperation, unique in the UN family – a fusion of complementary mandates, common targets, joint programming, co-funding and coordinated management. Its close cooperation has brought with it greater efficiency and shared approaches, responding to the needs of Member States and providing services and results to them and the international community at large.

The Joint Division and its associated laboratories are operated through arrangements signed by the Directors General of FAO and IAEA. The programme and budget are approved by the Governing Bodies of FAO and IAEA, and planning is carried out in close consultation and cooperation with Member States and with other branches of both organizations. The Joint Division ensures that the technical capacities of both organizations are fully used in the joint operations with Member States.

Joint Programme: The work of the Joint Division is based on the biennial programmes of FAO and IAEA, oriented by demand-driven and result-based approaches, and adopted by their respective Governing Bodies. The joint programme is organized in line with a programmatic structure and the implementation modalities of both organizations.

Co-funding: The Joint Division and its programme costs are borne by both organizations in a manner as agreed upon by the two Directors General. The work is financed from the assessed budgets of the Member States to FAO and IAEA and extra-budgetary funding.

Co-management: Overall guidance for the Joint Division is provided by a steering committee, consisting of representatives of senior management from both organizations, where programming, budgeting, organizational structure and staffing matters, as well as appropriate recommendations to the Directors General of both organizations are discussed.

Joint staff: The Joint Division operates with a team of about 100 scientists, technical experts and support personnel divided among offices, sections and laboratories. Both FAO and IAEA staff, including those funded by FAO, are stationed at IAEA headquarters and laboratories, and work for both organizations. The Joint Division also hosts consultants, fellows, interns and students from Member States, offering the opportunity to work in Vienna or at the FAO/IAEA Laboratories at Seibersdorf conducting research or learning new techniques that they can then take back to their countries to validate, adapt and apply.

Organizational Structure and Function

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

The Joint FAO/IAEA Programme in Food and Agriculture is implemented through five sections of the Joint Division and corresponding laboratories at the FAO/IAEA Agriculture and Biotechnology Laboratories.

The activities of the Joint FAO/IAEA Division centre around four major pillars:

1 Support and coordination for R&D activities: Over 500 research institutions and experimental stations in Member States cooperate in more than 30 coordinated research projects (CRPs) annually. Through these CRPs, and in order to ensure effective output and useful solutions to challenges in national and global agricultural development, the Joint Division plays a leading or central role in these research and development (R&D) activities.

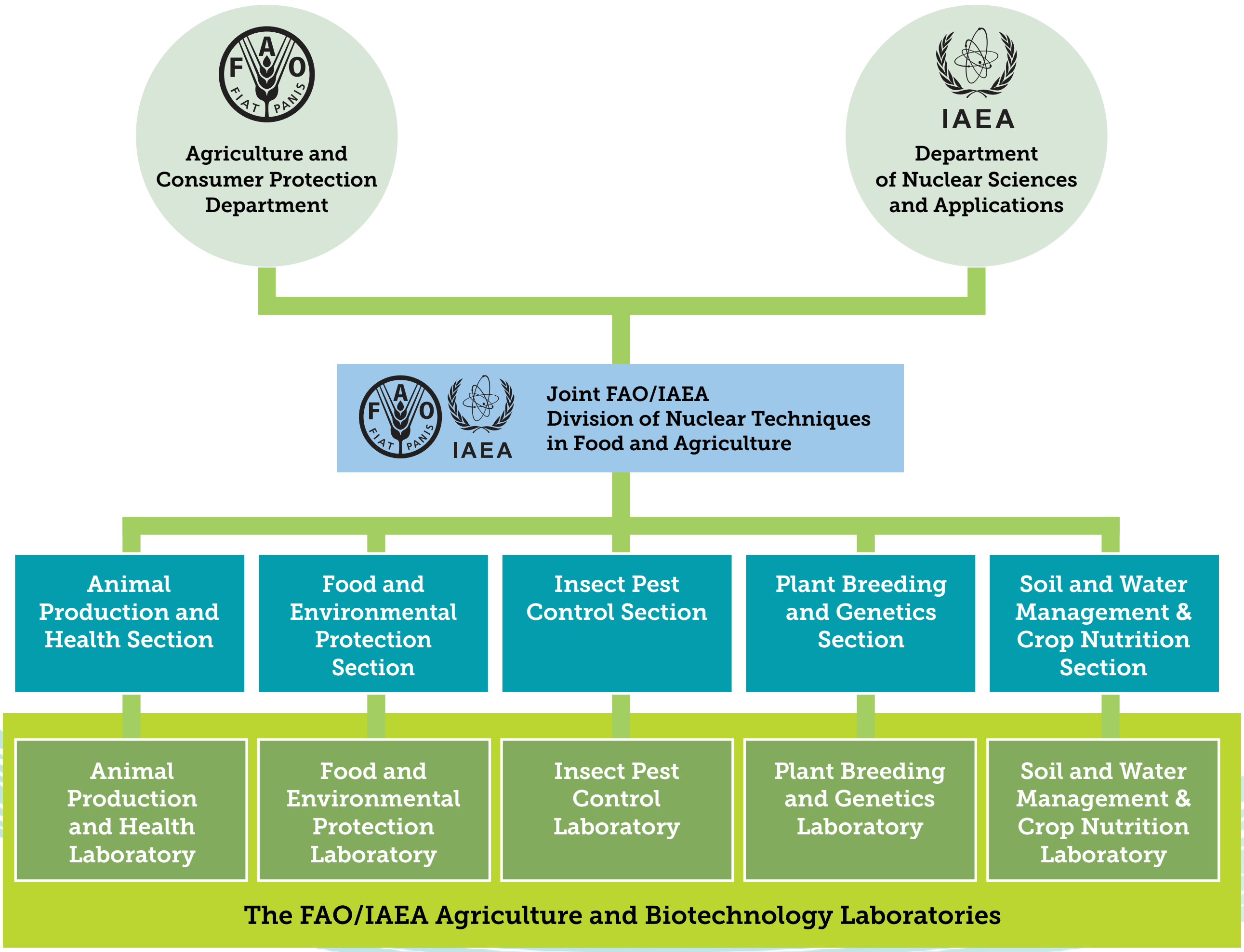
2 Capacity building and technology transfer: The Joint Division is currently responsible for over 200 national and regional technical cooperation projects (TCPs) with an annual expenditure of some US $14 million channelled to recipient countries for the purpose of technology transfer and capacity building.

3 Laboratory support and technical assistance: Besides carrying out applied R&D, the laboratories provide a broad range of specialized services and train scientists through courses in various disciplines that are supported by fellowships and scientific visits. They also provide guidance on the introduction of analytical quality controls and assurance into counterpart laboratories, and training in the maintenance of laboratory equipment and instruments. They are also a repository of reference and special biological materials that are made available to Member States.

4 Policy advice and knowledge dissemination: In addition to encouraging the direct transfer of skills and technology, the Joint FAO/IAEA Division provides technical and policy advice to policymakers, as well as a variety of information services. These include conferences, symposia, seminars and advisory group panels. It also issues both technical and general public information documents which arise from these meetings as well as from CRPs and TCPs. The Division also maintains contact with Members States through the publication of periodic newsletters, reviews and web sites.

FAO/IAEA Agriculture and Biotechnology Laboratories

The FAO/IAEA Agriculture and Biotechnology Laboratories, situated at Seibersdorf, 35 km south of Vienna, are global leaders in the research, development and transfer of nuclear methods in animal production and health, food and environmental protection, insect pest control, plant breeding and genetics, and soil and water management. Their applied research is an integral part of the Joint FAO/IAEA programme. The laboratories, a unique entity in the United Nations system, are cooperatively managed by FAO and IAEA, through the Joint Division. The activities of the laboratories focus on applied research and development, training and capacity building, and technical and analytical services.



Delivery Mechanisms

The Joint FAO/IAEA Division's activities are carried out through two major delivery mechanisms: coordinated research projects and technical cooperation research projects. Coordinated research projects are funded by the Joint Division's regular budget and are implemented through research networks; technical cooperation projects are funded by the IAEA's technical cooperation programme through voluntary contributions from Member States to carry out technology transfer and capacity building.

A key strength of the capacity building and technology transfer tools supported by the Joint Division comes from establishing links between demand in the field for applications and adaptive research, as well as between institutions and farmers in Member States. This allows for continuous feedback between R&D activities and field validation, as well as remedial action if necessary, at any stage in the capacity building and technology transfer process.

Coordinated Research Projects (CRPs)

Over 500 research institutes in Member States are cooperating in over 30 coordinated research projects annually. Each project aims to solve specific, practical problems of agricultural significance to developing countries. Key features include:

- CRPs bring together research institutes from both developing and developed countries, creating networks to focus on solutions for specific research challenges. Research is done within a well-defined global or regional thematic or problem focus.
- CRPs are composed of 10 to 15 research contract holders from developing Member States, two to five agreement holders from developed Member States, and one to two technical contract holders that provide specific services to the CRP.
- CRPs last for three to six years years and participants meet every 18 months to share information and plan the next phase of their research.
- A large number of techniques, methods and protocols have been developed, evaluated and validated through CRPs.
- Many young researchers obtain advanced training through participation in CRPs.
- In general, 25 per cent of the chief scientific investigators are female, with efforts continuing to increase the participation of women researchers.

Technical Cooperation Projects (TCPs)

The Joint Division builds capacity and transfers technology to developing Members States through TCPs, which are requested by Member States through official channels. In close liaison with the IAEA's Department of Technical Cooperation (TC), every year the Joint Division provides technical support and policy advice to over 200 TCPs in support of the mandates of FAO and IAEA. The Division also organizes over 150 training courses and workshops, investing about US $14 million annually in these activities. Key features include:

- TCPs are demand-driven and based on Member State development priorities, and therefore contribute to socio-economic impact at a country level.
- Appropriate technologies, often developed, improved or adapted at the FAO/IAEA Laboratories at Seibersdorf, are field tested and extended for further adoption under the environmental conditions of the cooperating countries.
- Capacity development is assisted through training, fellowships and the provision of laboratory equipment and upgrades.
- Each project generally lasts for two years with the option of a two-year extension.

Areas of Work

The Animal Production and Health Section supports Member States in the use of atomic, nuclear and nuclear-related technologies to optimize animal feed resource utilization while protecting the environment, and improve livestock reproduction and breeding. It also develops and transfers molecular and immunological methods for the diagnosis and control of transboundary animal and zoonotic diseases.

The section, with its animal production and health laboratory, contributes to the enhancement of global food security through the implementation of sustainable livestock production systems using isotopic and irradiation techniques.

The section works with sister divisions in FAO and the Animal World Health Organization (OIE), and assists Member States in the use of nuclear and related techniques to improve livestock productivity. It does this through the efficient use of locally available feed resources, adequate management practices and breeding programmes for indigenous and upgraded animals, and the use of diagnostic tools and prophylactic measures for the control and prevention of animal and zoonotic diseases. These activities lead to the production of more and better quality animals and the protection of such animals from diseases and pests.

Support and guidance is provided by the section in formulating and implementing activities that support Member States' national, regional and global livestock development objectives. The main areas of focus are strategic, applied and adaptive research, technology transfer, capacity building, and policy advice and information management.

The Food and Environmental Protection Section

focuses on food irradiation, authenticity and traceability, the analysis and control of chemical contaminants, and nuclear and radiological emergency preparedness, response and management.

The section provides assistance and support to countries in their efforts to ensure the safety and quality of food and agricultural commodities while at the same time facilitating international trade.

These activities primarily focus on strengthening Member State capacity for the application of international standards on irradiation, as well as on the use of nuclear and related analytical technologies and capacity building in the management of food and environmental hazards. These efforts are based on a coordinated and comprehensive 'farm to fork' approach to food production systems that ensures the application of good agricultural practices throughout the food chain.

Food irradiation expert services include the provision of advice and guidelines, and assisting in the adoption and use of technology to maintain food quality and ensure food safety. Expert services also provide quarantine treatment to prevent the spread of invasive insect species in the international trade of fresh produce.

The Insect Pest Control Section

develops and transfers environmentally-friendly methods for the integrated area-wide control of key insect pests, such as fruit flies and moths, as well as disease-transmitting tsetse flies and mosquitoes. It is renowned worldwide for its work on the sterile insect technique (SIT).

The section is a global leader in the development and implementation of sterile insect and related biologically-based techniques. They are environmentally-friendly and therefore more sustainable methods for managing the populations of major insect pests of crops and those insects causing animal or human diseases. The section achieves its mandate through strategic and applied research, technology transfer, capacity building, policy advice and information management.

With the increasing intensification of agriculture, pre- and post-harvest losses to insects and other pests remains unacceptably high. At the same time, disease transmission by insect vectors continues to affect millions of humans and livestock. The development of resistance to pesticides by insect pests is also a growing concern. Furthermore, there is an increasing awareness of the negative effects of insecticides to public health, beneficial organisms and the environment, resulting in a growing demand for more environmentally-friendly alternatives.

The efforts of the Insect Pest Control Section are therefore focused on enhancing food security through area-wide approaches that reduce losses and pesticide

In the area of analytical techniques and food controls, the section uses nuclear-related and complementary technologies to detect and monitor chemical residues in food and the environment, and also technologies to trace the geographical origin of food products and to authenticate their composition. The emphasis in this area is on improving Member State laboratory practices in food safety and quality to safeguard health and facilitate international trade.

use, protect ecosystem services and preserve biological diversity, resulting in more sustainable agricultural systems. Efforts also address the increasing problem of invasive insect pests, and promote the development and capacity of animal health and plant protection services in Member States to apply sanitary and phytosanitary standards. This facilitates increased trade among Member States in food and agricultural commodities providing farmers with access to new international markets.

The SIT is a type of birth control for insects, involving the mass rearing and sterilization of large numbers of the target pest insect by subjecting them to ionizing radiation. The sterile insects are then released systematically and preferentially by air over infested target areas where they mate with fertile wild females of the pest population, who then fail to produce offspring. If sterile males outnumber wild males, the wild population can be suppressed. In special situations where the pest population is isolated, the pest population may eventually be eradicated as a result of committed area-wide campaigns that integrate different pest control methods, including the systematic release of sterile insects.

The Plant Breeding and Genetics Section

focuses on mutation breeding to increase the diversity of desired traits for crop production and hence to accelerate the breeding of varieties with higher yields and improved quality, yield stability and greater resistance and tolerance to environmental stresses such as disease, drought and salinity.

The Soil and Water Management and Crop Nutrition Section

uses isotopic and radiation methods to measure and monitor the interaction between soil, water and nutrients in cropping systems as a basis for developing strategies that efficiently use water and nutrients. This ensures sustainable land use and land management that minimizes the environmental impact of agriculture.

The section is a global leader in the use of irradiation for the induction of genetic mutations in plants for breeding purposes, which is an accelerated version of nature's naturally occurring process of spontaneous mutations. To induce mutations, scientists use small doses of radiation that speed up this natural process, thus providing valuable resources to breeders – plants that are disease resistant and resilient to climatic changes, new varieties with higher yields, greater yield stability, higher levels of nutrition, improved resistance to pests and diseases and tolerance to environmental stresses such as drought and salinity. Mutation induction enhances plant breeding by creating genetic variations without the introduction of foreign hereditary material. The technique increases the adaptability of important crops to the negative effects of climate change, making them more resilient in a sustainable way.

The application of nuclear technologies accelerates the plant breeding process by producing desired traits, while preserving most of the genetic background of the adapted or existing commercial varieties or preferred local landraces. It is environmentally-friendly and increases the diversity of desired traits in important crops. As more and more mutant crop varieties are released to farmers, they continue to make great contributions to local, national and regional food security.

Soil, water and nutrient management is fundamental to food security. The section focuses on the development of improved soil, water and crop management technologies and practices (e.g. conservation agriculture, precision irrigation) for sustainable intensification that contributes to increased agricultural production and food security through the use of nuclear and related techniques.

The use of nitrogen-15, a stable isotope of nitrogen and an essential plant nutrient, has helped to determine the fertilizer use efficiency of crops. It is also used to quantify the amount of nitrogen that legume crops can acquire from the atmosphere through a process known as biological nitrogen fixation. This helps to reduce the application of purchased nitrogen for crop and livestock production, saving farmers millions of dollars in costs.

Improving crop water productivity and water conservation in agricultural landscapes is vital to reduce agricultural water use. Stable isotopes of oxygen-18 and hydrogen-2 are useful to characterize different sources of water (groundwater, river and rainfall/runoff). This helps to optimize the capture and storage of such water using farm ponds and wetlands within agricultural catchments. The same isotopes in the surrounding plant canopy can be used to separate evapotranspiration into its individual components of soil evaporation and plant transpiration. This information allows farmers to minimize soil evaporation and optimize water use efficiency. A soil moisture neutron probe accurately measures soil water content to help schedule irrigation when and where it is required.

Techniques involving fallout radionuclides (FRN) such as caesium-137, beryllium-7 and lead-210, are used by the section to assess the magnitude of both short, medium and long term soil erosion and land degradation for designing effective soil conservation measures. Compound Specific Stable Isotope (CSSI) techniques based on the measurements of carbon-13 stable isotopes of organic compounds in soils are used to identify sediment sources and apportion the contribution from different land uses in agricultural catchments. These techniques help to develop site specific land management practices to reduce soil erosion and land degradation.

Technological Achievements

For decades, this unique UN partnership has achieved countless successes with distinct socio-economic impacts at country, regional and global levels. The Joint FAO/IAEA Division work has shown how nuclear applications provide added value to conventional approaches in addressing a range of agricultural problems and issues, including food safety, animal production and health, crop improvement, insect pest control and sustainable use of finite natural resources. Its programme has been responsible for many far-reaching achievements in technology development and improvement, as well as its transfer and validation among Member States. Key achievements include:

1. **Mutation induction:** Mutation induction methodologies have been developed to treat seeds, organs, tissues and cells of plants with chemical and physical mutagens, especially the use of radiation and machine resources such as gamma ray, neutron, and x-ray or ion beam irradiation. At present more than 110 countries are using this technology for plant breeding. Thousands of mutant genotypes/lines with traits of agronomic importance have been developed and shared, broadening the genetic base of the pool of global germplasm.

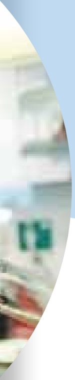
2. **Mutation detection and selection:** New and more effective techniques have been developed and shared to detect and select the mutations induced. These have been less expensive and accelerated the development of varieties by changing single characteristics without affecting the overall phenotype. More efficient biotechnologies and high-throughput screening techniques, as well as advanced field screening technologies have enabled plant breeders to develop new varieties in record time. Since 1964, over 3 200 mutant varieties from over 200 plant species have been officially released in over 90 countries. Their value is measured in the billions of dollars and millions of cultivated hectares.

3. **Radioimmunoassay technology:** Highly sensitive isotopic technologies have been developed to increase the efficiency of artificial insemination and improve animal reproduction. These technologies, together with other conventional techniques, have been adopted by 60 Member States for use in livestock breeding programmes and have significantly improved the productive performances of livestock.

4. **Advanced diagnostic tools and monitoring tests:** Tools and tests have been developed that have proved to be vital for the early detection of animal diseases, even before the onset of clinical signs. These include conventional serological and/or molecular based technologies, as well as advanced technologies with the capacity for direct field application. They have enabled Member States to achieve the rapid enforcement of disease control measures, thus reducing losses caused by animal and zoonotic diseases. These technologies have been used in over 95 Member States and have contributed to the control (and elimination) of important animal diseases such as rinderpest.

5. **Isotopic labelling technologies for animal nutrition:** Technologies have been developed and improved to evaluate the nutritive value of locally available feeds. By using these technologies, a set of nutrition feeding tools have been developed for the production of feed supplements from locally available feedstuffs, which have improved the productive performance of farm animals in Member States from 50 to 350 per cent.

6. **Fallout radionuclides (FRNs) technique:** The FRNs technique has been developed as a tool to assess soil erosion and land degradation so that appropriate soil and water conservation management practices can be effectively targeted to reduce erosion. More than 60 Member States adopted the FRNs techniques to track



soil movement and develop cost-effective soil conservation measures. As a result, soil erosion rates in experimental areas in Chile, China, Morocco, Romania, Tajikistan and Viet Nam, were reduced by up to 50 per cent through the implementation of soil conservation measures.

7 **Nitrogen-15 analytical technique for biological nitrogen fixation (BNF):** The BNF is a process whereby grain, forage and tree legumes acquire nitrogen (N) from the atmosphere, hence reducing the need for nitrogen to be purchased and applied to a crop and/or livestock production; the amount of N acquired by legumes can be accurately determined by using the nitrogen-15 isotopic technique. The Joint Division has developed and improved nitrogen-15 analytical techniques and promoted the extensive use of BNF to capture more N from the atmosphere and to improve soil fertility, enabling farmers to save millions of dollars instead of purchasing nitrogen.

8 **Isotopic tracing techniques for crop nutrition and water management:** Procedures have been refined using the isotopes of carbon, nitrogen, phosphorus and oxygen and related techniques have been developed to provide more efficient tracing methods to understand the movement of nutrients between the soil and plants. This helps enhance fertilizer use efficiency, and identify integrated soil-water management practices for optimizing crop productivity. For example, the stable isotopes of carbon-13 and nitrogen-15 have been used to measure precisely the carbon-nitrogen (C-N) interaction to optimize both C and N capture as well as to reduce greenhouse gas emissions from agriculture, which accounts for 14 per cent of global greenhouse gas emissions.

9 **Sterile insect technique (SIT) for agricultural pest control:** The SIT has been developed to combat major agricultural insect pests that cause significant losses and affect international trade, including several fruit fly and moth pests and screwworm flies. A multilateral approach eliminated the Mediterranean fruit fly in Mexico and parts of Central America, which not only led to investments in horticultural production (in Guatemala this amounted to US $150 million), but also significantly promoted the export of fresh fruit (US $4.3 billion alone in increased annual exports from Mexico).

10 **Sterile insect technique (SIT) for tsetse flies:** New methods have been developed to mass-rear flies and to feed them sterilized blood through a membrane system – instead of using live animals. This has allowed the SIT to be applied against various tsetse fly species, leading to successful eradication programmes in Zanzibar and Senegal.

11 **Sterile insect technique (SIT) for mosquitoes:** As part of an assessment of the feasibility of applying the SIT to selected species of mosquitoes, the Joint Division has recently been developing mass-rearing equipment and quality control techniques for vectors of major diseases. Researchers have also been studying mosquito symbionts, radiation sensitivity and sterile male competitiveness.

12 **Genetic sexing methodologies for sterile insect technique (SIT) application:** The SIT invariably relies on the ability of released sterile male insects to effectively compete and mate with native female counterparts. The Joint Division has developed genetic sexing strains, including one based on female temperature sensitivity in Mediterranean fruit flies. This has enabled the separation of males from females as early as possible in the life cycle on a large industrial scale, thus saving on the cost of mass rearing females and increasing the effectiveness of the SIT as sterile males will only compete for wild females. This strain is currently utilized in all SIT programmes against this pest in the world.

13 **Multi-residue analytical techniques:** Techniques have been developed for the simultaneous detection of various veterinary drugs and pesticides and enabled Member States to monitor trace levels of a range of agro-chemicals, economically and more efficiently. The Joint Division has developed and transferred an analytical method for assessing the residues of 38 veterinary drugs in animal products, and enhanced national residue monitoring programmes in many developing countries.

14 **Food irradiation technology:** This technology has been developed to treat food to ensure improved quality and safety, as well as for quarantine purposes in international trade. Irradiated food is now accepted and approved in over 60 countries.

15 **Technology for nuclear emergency response:** Technology packages have been developed for sampling, analysing and monitoring radio-contamination as well as the remediation of its impact in food and agriculture.

Future Vision

The persistence of widespread food insecurity and malnutrition - especially in the context of the continuing pressure on natural resources and concerns over the sustainability of ecosystems - highlights the need for the continuing safe and appropriate use of nuclear and related technologies in agriculture. Chief among the many challenges are: climate change and the associated extreme weather events; soil fertility degradation and pollution; land-use change; water scarcity; transboundary outbreaks of animal and plant pests and diseases; and the continuing loss of biodiversity needed for agricultural production.

Thanks to the foresight of Member States and their long-standing support of this unique and beneficial partnership, the Joint Division will continue assisting nations in identifying, developing and applying cutting-edge nuclear technologies that will enable them to keep pace with the many agricultural challenges they face and, at the same time, improve food security and the sustainability of natural resources.

Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

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