Food and Agriculture

Objective

To promote and contribute to the improvement of food security and safety to enhance Member State capabilities in the application of nuclear techniques for sustainable agricultural development.

Animal Production and Health

The value of the early application of rapid and sensitive diagnostic technologies to control transboundary animal diseases (TADs) has been confirmed by the substantial contribution of the Agency in the eradication of rinderpest, a devastating disease of cattle. With the Agency's support through the use of nuclear and nuclear related techniques over a period of more than 20 years, rinderpest has been eliminated with a net benefit to Africa alone of more than $1 billion per year, as estimated by FAO. The last reported rinderpest case was in 2003, and in 2010 data for all countries were prepared and finalized, clearing the way for the official global declaration of rinderpest eradication by FAO and the World Organisation for Animal Health (OIE) in 2011.

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The same nuclear and nuclear related immunological and molecular technologies were successfully used in 2010 to diagnose and control other animal diseases. These included: Rift Valley fever in the Democratic Republic of the Congo and Mauritania; foot-and-mouth disease in Bulgaria, Mongolia and the Republic of Korea; African swine fever in Tajikistan and Turkey; and animal fascioliasis in Bolivia and Mexico.

In working to control other TADs in 2010, the Agency carried out full genome isotope labelling characterization of several field and vaccine strains of Capripox viruses. The technique was used to identify genes associated with virulence factors that can be used in the development of safer and more efficient vaccines. The Agency also made a major advance in the characterization of peste des petits ruminants (PPR) by developing a new, highly efficient and rapid system for isolating the virus in vitro, which will aid in investigations of this re-emerging infectious disease. This technology is being field tested in several Member State laboratories (for example, in Côte d'Ivoire and Mali). Also in 2010, Botswana, China, Uganda and Zambia participated in field testing of the loop mediated isothermal amplification technology, a nuclear related isothermal amplification technology to increase the possibility to detect PPR, avian influenza and contagious bovine pleuropneumonia. Additionally, in conjunction with partners in Member States, the Agency began developing protocols for radiation attenuation to produce improved vaccines against TADs.

Genetic approaches are being used to understand the mechanisms of disease resistance in indigenous poultry. A radiation hybrid map, using radioisotope tracers and labels, was developed to facilitate rapid, large scale physical mapping of the goat genome to assist in identifying genes involved in economically important traits and genes associated with infectious disease resistance. In Cameroon, for example, more than 200 farms received assistance in 2010 to improve facilities for health, management, feeding and artificial insemination. Brucellosis has been controlled, an Artificial Insemination Centre was established and veterinary services were provided using integrated farm management approaches.

In Mongolia, the Agency improved animal nutrition and reproductive management using radioimmunoassay technologies to assess fertility and isotopic tracing and labelling methods to evaluate the nutritive value of feed. These Agency inputs have assisted not only in providing more animal feed for the winter, but also in reducing overall dairy input costs by almost 67%. Through the Agency's artificial insemination and genetic breeding programme, Mongolia is in the process of selecting animal traits and locally adapted breeds that will be more tolerant to the harsh local environmental conditions. Great efforts were made by the Agency to mitigate the devastating foot-and-mouth disease outbreak that threatened the hoofed livestock industry of Mongolia in 2010. The highly

FIG. 1. A study site in Vietnam testing the use of the CSSI technique to identify critical areas of land degradation.

sensitive and specific nuclear and nuclear related technologies helped in identifying, monitoring and characterizing the specific serotype (type O) involved in the epidemiological spread of the outbreak. The improved diagnostic technologies were essential in selecting the appropriate vaccine candidate to contain the outbreak and to control the rapid spread of the foot-and-mouth virus in Mongolia.

Soil and Water Management and Crop Nutrition

In 2010, fallout radionuclide (FRN) techniques to assess land degradation and improve land productivity were transferred to 40 countries. In Cuba, for example, 2400 hectares of farmland with varying degrees of degradation in the western and southern parts of the country was assessed and appropriate land use measures were developed to restore soil health, leading to a 10% increase in crop productivity. Another success was the use of FRN through a collaborative project led by UNEP and UNU, and including the Agency, Germany, the Russian Federation and Switzerland, to establish a databank of land degradation and soil erosion in Tajikistan and the vast mountainous territories (High Pamir and Pamir-Alai Mountains) of Central Asia. This databank currently forms the basis for the development of policy on conservation measures adapted to the agro-ecological conditions in the region to increase land productivity and socioeconomic conditions of poor farmers.

An innovative isotopic tool was developed by an Agency coordinated research network to identify areas of critical land degradation in agricultural landscapes for effective implementation of precision conservation measures. The tool involves the use of both the compound specific stable isotope (CSSI) technique (for example, carbon-13 signature of fatty acids) and FRNs (caesium-137, lead-210 and beryllium-7) (Fig. 1). Nine countries (Australia, Austria, Canada, China, New Zealand, Poland, Russian Federation, United Kingdom and Vietnam) joined a network initiated by the Agency to provide plant samples for establishing a library of CSSI 'fingerprints'. This databank was used, together with the innovative tool described above, to identify the main sources of soil erosion in degraded landscapes. For example, in eastern Australia, cropland and pasture were identified as a minor source of land degradation, compared with forestland, in a coastal catchment of 370 000 hectares.

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Through a regional project on 'Enhancing the Productivity of High Value Crops and Income Generation with Small-Scale Irrigation Technologies', isotopic (nitrogen-15 and oxygen-18) and nuclear (soil moisture probe) techniques were used to

FIG. 2. A drip irrigation setup being demonstrated to farmers in Kenya.

develop timely and accurate applications of low cost drip irrigation scheduling to high value crops in 19 African countries (Fig. 2). In collaboration with the Ghanaian Biotechnology and Nuclear Agriculture Research Institute (BNARI), appropriate irrigation scheduling via drip irrigation was introduced to 130 farming communities, leading to water savings of up to 60–70%. This is equivalent to an economic benefit of $533/hectare, resulting in additional income for the smallholder farmers.

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Sustainable Management of Major Insect Pests

There is increasing demand for biological insect pest management methods that are more sustainable than insecticide based methods. In 2010, the Agency provided assistance to Member States through the development and integrated application of pest control tactics utilizing nuclear techniques. These environment friendly techniques, including the sterile insect technique (SIT), the inherited sterility technique and the release of natural enemies, require large scale rearing of the pest or host. In this regard, the Agency organized the 12th International Workshop on Arthropod Mass Rearing and Quality Control in Vienna, where more than 100 delegates from 29 countries discussed issues related to the rearing and quality assurance of entomophagous and phytophagous insects and mites, and entomopathogenic nematodes (Fig. 3).[1] The meeting resulted in a strengthened network of rearing experts and a worldwide road map for future arthropod mass rearing and quality control.

In Croatia, a new rearing and release facility for the Mediterranean fruit fly, *Ceratitis capitata*, became operational in 2010. The facility has a capacity for the packing, handling and release of 20 million sterile male flies per week and will mainly be used to apply SIT to the Neretva River valley of Croatia, and Bosnia and Herzegovina (Fig. 4). This project has as its objective the suppression of fruit flies, which have caused serious damage to citrus and stone fruits, thereby significantly reducing the use of insecticides and resulting in a larger volume of fresh fruit exports.

Major improvement of sterile male fruit fly performance was achieved as a result of a five year CRP completed in 2010 that benefitted operational

[1] *Entomophagous*: feeding mainly on insects, insectivorous; *phytophagous*: feeding mainly on plants; *entomopathogenic nematodes*: lethal obligatory parasites of insects.

FIG. 3. Parasitoid female of Diachasmimorpha longicaudata *probing into fruit to inject her eggs into the pest host infesting the commodity. These biological control agents and other mass reared insects were the subject of an international workshop on arthropod mass rearing and quality control.*

SIT programmes in all continents. The project's main focus was to improve the post-factory management of mass produced sterile fruit flies until the point of field release using hormonal, nutritional and behaviour modifying supplements, ultimately reducing the cost and increasing the effectiveness of operational SIT programmes in Member States.

Mutation Breeding

The Agency supports national breeding programmes through technology transfer, training and the provision of radiation and expert services. As a result, seven new mutant varieties were registered in 2010 in the Agency's mutant variety database (*http://mvgs.iaea.org*). These included a commercial tomato variety, 'Lanka Cherry', developed in Sri Lanka that is currently in high demand. Hybrid maize mutation breeding was a great success in eastern Europe in 2010. Through the Agency's support,

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FIG. 4. The citrus production area in the Neretva River valley, Croatia, where an SIT pilot project is being implemented.

about 300 advanced mutant lines of 11 plant species are being utilized in national breeding programmes to develop improved varieties. This includes two mutant hybrid tomatoes in the Republic of Moldova, which were evaluated in 2010 during second year national pre-release trials, prior to the expected official release in 2011.

The Agency developed and distributed technology kits based on in vitro and molecular techniques, which will allow scientists in Member States to enhance the results of crop mutation induction. In 2010, kits for low cost mutation detection developed at the Agency's Laboratories in Seibersdorf were transferred to six Member States for integration into their mutant breeding programmes. In Algeria, for example, the techniques were applied to barley fungal resistance, reducing the mutant germplasm screening from weeks to half a day (biological assay with life pathogen), obviating the need for a screen house and quarantine. In Mauritius, this inexpensive technology package allowed for quick discrimination among local accessions and thus selection of parent varieties for a mutation breeding programme, something which formerly could not be done. The method can also be used in seed propagated crops.

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Food Safety and Food Control

The information obtained from biomonitoring through the use of nuclear techniques, such as radiotracers and stable isotopes, provides analytical laboratories with a wide range of options for integrated monitoring of agricultural practices within agricultural catchments that is cost effective for the mitigation of adverse environmental impacts at the source. Specific protocols for the biomonitoring of contaminants in water were finalized in 2010 through a regional project for Latin America and the Caribbean on 'Implementing a Diagnosis System to Assess the Impact of Pesticide Contamination in Food and Environmental Compartments at a Catchment Scale'. The two different protocols addressed the biomonitoring of water quality related to aquatic macroinvertebrate diversity and bioassays in the field (in situ) and in the laboratory.

In 2010, a food safety laboratory from the University of Peradeniya, Sri Lanka, with Agency assistance, achieved accreditation in line with the ISO 17025 standard for calibration and testing laboratories. This is the only laboratory in Sri Lanka accredited for testing veterinary drug residues that provides testing of locally produced aquaculture and poultry products, both for domestic consumption and for export, using nuclear and related methods. Laboratory accreditation means that the analytical results, which provide assurances of food safety and the effectiveness of their food safety systems, are credible and acceptable by regulatory bodies worldwide.