

Food and Agriculture

Objective

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

FAO/IAEA Agriculture and Biotechnology Laboratory

The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (the Joint Division) has five separate laboratories. Through these facilities, the Agency — in partnership with FAO — continued to assist Member States in 2013 on cutting edge food and agricultural issues, as well as in the areas of insect pest control, plant breeding and genetics, soil and water management, and environmental protection.

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Sustainable Management of Major Insect Pests

The Neretva valley in Croatia is a major producer of citrus, but regular insecticide applications are required to control the Mediterranean fruit fly. With support from the Agency and the USA through the Peaceful Uses Initiative (PUI), the sterile insect technique (SIT) is being applied on an area-wide basis over an expanding range, effectively suppressing the pest. Compared with 2010, before SIT application, fruit infestation levels in 2013 were down by 97% and infested fruit in export shipments of mandarins was down by 93% to only 0.2%. In addition, insecticide use in the valley was reduced by 20 000 L per year, thereby protecting farmers, their families and wildlife in important wetland areas. The rejection of shipments by importing countries has declined drastically, with increased potential for selling fruit at a premium to organic markets. The project is also being used as a training location for 12 neighbouring countries.

A detailed understanding of the swarming, sexual behaviour and physiology of adult male mosquitoes

is required to establish the biological and behavioural determinants of sterile male sexual competitiveness — defined as their ability to copulate with and inseminate wild females — relative to that of wild males. Implementation of methods for mosquito control, such as SIT or other genetic control approaches, requires not only colonization, mass rearing, shipping and release of male mosquitoes, but also assessment of their effective performance after release, which will affect the success of control. A CRP on the Biology of Male Mosquitoes in Relation to Genetic Control Programmes was completed, filling a critical knowledge gap in this area. The CRP created a network of researchers working on the biology and behaviour of male mosquitoes of the main mosquito vectors of malaria, dengue and chikungunya, and led to the acquisition of detailed knowledge of male pre-mating requirements, mating behaviour and mating success. A summary of the results of the CRP was published in a special issue of the journal *Acta Tropica*.

An FAO/IAEA Spreadsheet for Designing and Operation of Insect Mass Rearing Facilities was published, combining a procedures manual and an interactive spreadsheet to assist managers in designing, costing, constructing, equipping and operating insect mass rearing factories of different sizes using different scenarios. While the spreadsheet was designed using the vast experience gained from Mediterranean fruit fly mass rearing, its settings can be changed to suit any other fruit fly or insect pest.

The Joint Division developed a new DVD based tutorial in 2013 on using open source geographical information system (GIS) techniques in insect pest control programmes, which includes free GIS software. Area-wide insect pest control programmes require GIS for efficient design, implementation and analysis of entomological monitoring and pest control activities. However, many programmes can face difficulties in funding costly licences for commercial GIS software. Free open source software has made great strides in producing high quality software applications, and insect pest control programmes can now take advantage of this development.

Crop Improvement through Mutation Breeding

Member State demand for plant mutation breeding increased in 2013. The Agency was requested to irradiate a record number of plant materials for mutation induction, and this service has now been provided to over 75% of Member States. In addition, the Agency, through the Joint Division, supported the initiation of national plant mutation breeding programmes in Lesotho, Oman, Palestine, Qatar and Saudi Arabia through technical cooperation projects, irradiation services, training programmes and expert advice.



FIG. 1. Mutant wheat line resistant to Ug99 (left); wheat line susceptible to Ug99 (right).

In 2013, 18 new mutant cultivars of seven crops were officially released or pre-released to farmers in seven Member States. These include two mutant varieties of wheat in Kenya resistant to wheat black stem rust (race Ug99). The Kenyan success is part of a multinational effort coordinated through an interregional technical cooperation project on responding to the transboundary threat of wheat black stem rust (Ug99) involving 18 Member States. It is difficult to find varieties that are resistant to this devastating disease, which can cause complete crop failure if fungicides are not sprayed in time. The disease is a major concern for countries that depend on wheat for sustenance. During this project, the Agency, through the Joint Division, carried out seed irradiation to induce the desired resistance, provided individual and group training, and sought funding for additional group training on future objectives in selecting resistant mutant lines (Fig. 1).

Soil and Water Management and Crop Nutrition

A new, cost effective technique for determining the stability and age of soil organic matter (SOM) pools is being evaluated at the Agency's laboratories in Seibersdorf. This evaluation is vital for assessing the impact of soil management and environmental factors on SOM dynamics, an important part of the global carbon cycle, and is key to improving climate-smart agriculture. The technique, based on measurements of the natural abundance of carbon-13, the nitrogen-15 stable isotope signature and the carbon to nitrogen ratio of the SOM fractions in agricultural soils, is less costly than the carbon-14 technique for assessing the age of SOM and its

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stability in different climatic and land use conditions. Soil samples with low and high SOM from long term field trials (over 15 years) from Austria, Belgium and Kenya are being analysed as part of this evaluation. The results show that the combined use of carbon-13 and nitrogen-15 is a promising approach to support decision making to enhance soil carbon sequestration in agricultural soils.

The increased focus on efficient use of water resources has led to a shift in the use of isotopic and nuclear techniques from a field approach to an area-wide approach. The Agency, through the Joint Division, and in collaboration with the Technical University of Vienna and the Austrian Federal Agency for Water Management, is evaluating the use of a cosmic ray soil moisture system for measuring area-wide soil water content to improve agricultural water management (Fig. 2). This new technology allows non-invasive, intermediate scale monitoring of soil water in an area of up to 40 hectares (ha). The evaluation is being carried out near Petzenkirchen, 80 km west of Vienna, where nearly 40 conventional soil water sensors covering an area of 60 ha of agricultural land were installed in 2013.



FIG. 2. Cosmic ray soil moisture system in Petzenkirchen, Austria.

Animal Production and Health

Animal diseases can pose significant public health threats, affecting people's lives and livelihoods. A new strain of avian influenza emerged in several provinces of China at the beginning of 2013, infecting 394 people, 123 of whom died. The outbreak was caused by a novel H7N9 strain that could not be detected using conventional influenza A tests. The Agency responded by developing, evaluating and validating diagnostic tests for the H7N9 strain, and providing technical support for their distribution to Member States. It also held two training courses in affected and at-risk areas of Asia and Europe.

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Another zoonotic disease, trypanosomiasis, which is transmitted by tsetse flies, is one of the most devastating diseases in Africa. The Joint Division is working on a gamma irradiated vaccine. Experimental results have shown that these gamma ray attenuated trypanosomiasis organisms induce protection against both homologous

challenge and the development of parasitaemia. Trials for heterologous protection and the use of low virulent mutants of trypanosoma are in progress. As part of a pilot vaccine development project in Mongolia, an exceptionally strong X ray irradiator was installed in Ulaanbaatar. The instrument, capable of delivering doses of up to 7 kGy/h, will be used to develop procedures for the attenuation or inactivation of pathogens, which can be used as a vaccine to immunize animals.

Peste des petits ruminants (PPR), a virus similar to the recently eradicated rinderpest that is spreading rapidly worldwide, has been earmarked as the next virus to be eradicated. As part of this effort, the Joint Division performed molecular epidemiological studies to improve both diagnostic capabilities and the understanding of the geographical spread and disease dynamics of PPR.

Livestock biodiversity is essential for sustainable animal production in diverse agro-ecological environments and for enhancement of food security. The Agency supported Member States in implementing FAO's Global Plan of Action for Animal Genetic Resources by improving capacities in Burkina Faso, Iraq, Jordan, Myanmar, Oman, Pakistan, Yemen and Zambia through individual and group training in DNA marker based genetic characterization of indigenous livestock breeds. For example, 300 animals were evaluated in Myanmar (Fig. 3) and Zambia to characterize six indigenous cattle breeds. In addition, 194 DNA markers were developed at the Agency's laboratories to investigate parasite resistance in sheep. The parasite resistance markers are currently being tested using more than 3000 samples from animals in Argentina, Brazil, Burkina Faso, Ethiopia, Indonesia and the Islamic Republic of Iran.

Food and Environmental Protection

Technical expertise in measuring trace chemicals in food was refined and used in a new way to develop novel, cost effective food authenticity testing techniques to meet the needs of Member States. For example, isotopic measurements and metabolomics (the scientific study of the set of metabolites present within an organism, cell or tissue) can be used to combat fraud involving various food commodities important in terms of international trade, such as honey, fruit juices and dairy products. In this regard, reference materials were developed at the Agency's laboratories, in collaboration with other laboratories, and distributed to Member States.

Regional training courses on nuclear and related technologies, with an emphasis on integrated control of contaminants such as pesticides and veterinary drug residues, were held in Botswana, Colombia, Nigeria and Tunisia, and at the Agency's laboratories. The courses involved participants from Africa, Asia, Europe, and North and South America. Also in 2013, the Latin American and Caribbean Analytical Network (RALACA), a network of food control institutions, was established in the Latin America and the Caribbean region with support from the Agency. The network will be used as a model



FIG. 3. Native cattle breed sampled for DNA testing in Myanmar.

for other regions. These initiatives were both boosted by extrabudgetary funding obtained under the PUI. Activities in response to requests for direct support included a workshop on chemical residue monitoring in Faisalabad, Pakistan, as part of a national project on strengthening capabilities to monitor and control veterinary drug residues in food.

The growing use of irradiation as a phytosanitary treatment has helped producers reach markets that had been closed to them because of quarantine restrictions. The guidelines developed by the Joint Division in collaboration with Member States in the Asia and the Pacific region served as a basis for the new Regional Standard for Phytosanitary Measures (RSPM) *Approval of Irradiation Facilities*, approved by the Asia and Pacific Plant Protection Commission (APPPC) in September 2013. The same guidelines were later expanded into a manual on good food irradiation practices to be used by regulators, traders and irradiator operators in the participating countries.

Emergency Preparedness and Response

The Agency continued its efforts during the year to harmonize and optimize responses to a nuclear or radiological emergency by the food and agriculture sector. A new project focuses on the development of innovative information technology tools to link data collection, data management and geovisualization for improved decision making during nuclear or radiological

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emergencies to ensure food safety and the sector’s rapid economic recovery. Twenty-two participants from eight countries and international organizations met at the first regional coordination meeting at the Agency’s Headquarters to discuss the technology, needs and challenges, and to develop project and individual work plans.

In October 2013, the Follow-up IAEA International Mission on Remediation of Large Contaminated Areas Off-Site the Fukushima Daiichi Nuclear Power Plant, involving the Joint Division, reviewed the implementation of remediation activities and provided advice on addressing associated challenges. The team met with representatives of Japan’s Ministry of the Environment and Ministry of Agriculture, Forestry and Fisheries, among others, and visited the remediation sites in Fukushima Prefecture. Good progress has been made in the remediation of affected farmland, and comprehensive implementation of food safety measures has protected

consumers and improved consumer confidence in farm produce. A comprehensive programme to monitor fresh water sources such as rivers, lakes and ponds is ongoing, including extensive monitoring of both wild and cultivated freshwater fish.

Following the events in Japan, there is renewed interest in the revision of international guideline levels for radionuclides in foods and commodities. Work undertaken in cooperation with international organizations included

the dissemination and interpretation of international food safety standards, and the collation and analysis of monitoring data from Japan. Input was also provided to the Agency's ongoing review of the accident at the Fukushima Daiichi nuclear power plant, the assessment of the public and the environment by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), and activities related to the IAEA Action Plan on Nuclear Safety.