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.

Animal Production and Health

Development of early and rapid diagnostic technologies for 'on the spot diagnosis' of animal diseases plays a crucial role in limiting the spread of disease and in applying timely disease control measures. With this in mind, the Agency developed a prototype of a mobile laboratory device that brings the laboratory to the field. The device, aimed at the early and rapid diagnosis of various infectious diseases such as peste des petits ruminants (PPR), Newcastle disease, avian influenza H5N1, and foot-and-mouth disease (FMD), was successfully evaluated in Cameroon. This new technology is being disseminated to Member States through regional training courses. The device supports scientifically advanced diagnostic chemistries packed in simplified reagent kits and using equipment capable of being connected to car batteries (Fig. 1).

FIG. 1. The Agency's mobile laboratory device for rapid disease diagnosis in the field, shown in Cameroon.

Animal diseases, including those with zoonotic impact, are still a major threat to animal and human health in developing countries. The Agency enhanced support to numerous Member States in the diagnosis and control of animal diseases such as FMD (Argentina, Bolivia, Botswana, China, Democratic Republic of the Congo, Mongolia and Nigeria); PPR (Angola, Botswana, Democratic Republic of the Congo, Mozambique, Namibia, United Republic of Tanzania and Zambia); Rift Valley fever (Botswana, Kenya, Islamic Republic of Mauritania, South Africa and Zimbabwe); trypanosomosis (Ethiopia, Kenya, United Republic of Tanzania and Zambia); African swine fever (Angola, Democratic Republic of the Congo and Zambia); and brucellosis (Algeria, Bosnia and Herzegovina, and Zimbabwe).

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Artificial insemination of domesticated animals is a well known technique that improves the productive performance of farm animals by using the semen of carefully selected, certified males. In 2012, artificial insemination centres for cattle and small ruminants were established in Angola, Cambodia, Central African Republic, Chad, Iraq, Jordan, Nepal, Oman, Sierra Leone, Syrian Arab Republic and Yemen, enabling wider use of genetically superior animals which can improve livestock productivity (Fig. 2).

FIG. 2. Cross-bred cattle are more resistant to diseases.

Emergency Preparedness and Response

An interactive database used to monitor the radiological contamination of foodstuffs for human consumption after the accident at the Fukushima Daiichi nuclear power plant has been developed by the Agency through the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture. This database, which is awaiting release, includes information provided since March 2011 by the Japanese Ministry of Health, Labour and Welfare through the FAO/WHO International Food Safety Authorities Network (INFOSAN) and facilitates standardized data entry and evaluation by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) of exposure and assessment of dose to the public and the environment. Additionally, the database allows interactive communication with independent external databases, enabling comprehensive, multi-layer analysis of accidents.

Approximately 126 000 records on radionuclide concentrations in over 500 types of foodstuff collected from 1076 locations in all 47 prefectures of Japan, have been compiled in the database. The database was made available to the Expert Groups for the UNSCEAR Fukushima study during September 2012 and is now being used for the assessment of radiation doses to the public and the environment. This assessment is on the agenda of UNSCEAR's 60th session, in May 2013, at which it is expected to finalize its evaluation for the United Nations General Assembly.

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Food Safety and Food Control

To facilitate the training of developing country scientists, five train the trainers workshops on food quality and safety were held in 2012, the first year of a three year project funded by the Peaceful Uses Initiative. Approximately 90 developing country scientists were trained in the use and deployment of liquid and gas chromatography coupled to mass spectrometry, advanced analytical methodologies, laboratory quality systems, food safety monitoring and contaminant control programmes, sampling, radiotracer techniques for food contaminant control, and integrated analytical approaches for food traceability. The workshops were held in Austria, Belize, Panama and Uruguay. Special emphasis was given to the central role played by analytical laboratories in the 'farm-to-fork' food safety chain.

Irradiation prevents insects from reproducing without leaving residues or altering product temperature, and avoids detrimental effects on food quality by eliminating harmful pre-shipment chemical treatments. Consequently, the use of irradiation as a treatment against harmful insect pests is expanding with Agency assistance in countries such as Australia, India, Mexico, New Zealand, Pakistan, Thailand, the USA and Vietnam, which trade irradiated fruit to meet quarantine requirements for international trade.

Through the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture, the Agency has supported research into phytosanitary irradiation treatments since 2007, resulting in 13 treatments against specific insects and one generic fruit fly treatment being adopted as the International Plant Protection Convention (IPPC) standard. Important gaps remain, however, and generic treatments need to be developed against broad pest categories to provide countries with safe new options for protecting their produce and strengthening international trade (Fig. 3).

FIG. 3. Irradiation prevents loss of fresh produce.

Sustainable Management of Major Insect Pests

The combination of pre-harvest pest suppression measures and post-harvest quarantine treatments can help countries to export their produce by eliminating the risk of introducing new pests into importing countries and by improving food quality. The FAO/IAEA Insect Pest Control Laboratory in Seibersdorf is currently rearing 14 species of invasive tephritid fruit flies, with some 30 different strains. This offers the opportunity, not possible in any other facility in the world, to develop, in collaboration with the United States Department of Agriculture, phytosanitary treatments for several important pest species. A cold treatment for *Bactrocera zonata* on oranges was completed, which has led to the development of a new internationally recognized treatment schedule for this pest species on citrus. Studies on the relative cold tolerance of other species are continuing. Validation of hot water treatment for three fruit fly species (*B. invadens*, *B. zonata* and *Ceratitis capitata*) in mango is in progress. Also, work on *Anastrepha grandis* is continuing with the successful development of infestation techniques for this tephritid in zucchini and pumpkin.

In addition to the studies mentioned above, and to provide the required regulatory framework, an international standard on 'Systems approach for pest risk management of fruit flies (Tephritidae)', developed by the Agency in support of the IPPC, was ratified by the Commission of Phytosanitary Measures in 2012. Its application allows a level of quarantine security that guarantees that the fruit fly pest cannot establish itself in the importing country, thereby overcoming phytosanitary trade barriers and supporting the exports of fruit and vegetable crops by Member States.

A CRP on 'Improving SIT for Tsetse Flies through Research on Their Symbionts and Pathogens' was completed in 2012, resulting in a better understanding of the dynamics and interaction between bacterial symbionts and viral and other pathogens, as well as the development of strategies based on symbionts or entomopathogenic fungi to control tsetse flies. In conjunction with this CRP, the Agency developed effective tsetse virus management protocols that have significantly reduced the virus load in fly colonies, thereby removing some of the constraints to mass rearing systems in Africa and the implementation of the sterile insect technique (SIT) for tsetse.

Crop Improvement through Mutation Breeding

The introduction of mutant varieties contributes not only to food security, but also to adaptation to climate change. The High Level Panel of Experts on Food Security and Nutrition that supports the United Nations Committee on World Food Security emphasized the importance of developing strategies for climate resilient agriculture and food security.

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In 2012, six new mutant varieties were officially released by Member States, and another three pre-released, to farmers. These varieties were produced with the support of the Agency through its technical cooperation programme and CRPs. They include two tomato varieties from Sudan that are resistant to tomato yellow leaf curl virus (TYLCV) (Fig. 4). Both had higher fruit yields, earlier harvesting, better fruit quality in terms of size and firmness, and higher tolerance to TYLCV and powdery mildew in comparison not only to their parent variety, but also to the most commonly grown commercial tomato cultivars.

Agency support in building capacity in the area of mutation breeding in the former Yugoslav Republic of Macedonia resulted in the first national yield trials of

FIG. 4. Mutant tomato lines in Sudan.

mutant wheat varieties. These are expected to be the first mutant varieties officially released in this country.

Further applications of mutant varieties contribute to both food security and to adaptation to climate change. In this context, an Agency CRP included a Chinese research contract on a cropping technique that allows the production of two crops from one planting. The crop involved should have a well developed root system, earlier maturity, and a perennial nature. The technique involves cutting the crop in such a way as to allow a shoot to sprout from the root of the cropped plant (rationing), reducing the need to prepare and clear the land for agriculture. The technique's main economic benefit is to rapidly expand the area of cultivation, thereby contributing to food security.

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Sorghum, a crop introduced in Indonesia, has a narrow genetic base which has been improved through mutation breeding. In 2012, mutant sorghum varieties with high yield and drought tolerance increased crop productivity in Indonesian drylands. This promoted food diversification and sustainable agricultural development, while providing employment and improving the welfare of farmers through a range of healthful food products high in protein and calcium. In Peru, a high altitude mutant amaranth variety adapted to harsh climatic conditions was certified as an organic produce. This variety is in demand for export due to its high quality grain, and because it is cultivated under good agronomic practices with little or no chemically maintained weed, pest or disease management interventions. Its export has generated additional income for farmers.

Soil and Water Management and Crop Nutrition

The Agency organized an FAO/IAEA international symposium on 'Managing Soils for Food Security and Climate Change Adaptation and Mitigation' in July 2012, which covered a wide range of topics, including soil management for crop production, climate change adaptation and mitigation, ecosystem services, preservation and protection of soil resources, water conservation for agricultural production and pollution control. Recent advances in nuclear techniques and applications in soil and water management for agricultural production were also discussed. In addition, the FAO Global Soil Partnership was highlighted, and various soil and water sampling and measurement devices were displayed.

Maize is a staple food crop in Zambia and is grown by 70% of smallholder farmers. Yield is low (1.2 tonnes/hectare (t/ha)), compared with the global average of 4 t/ha). One of the major challenges limiting high maize yield is poor soil fertility and inadequate nutrients due to the high cost of fertilizer. With a price of around $41 per 50 kg bag of urea, many farmers cannot afford to pay for the fertilizer to maximize yield. There is thus an urgent need to improve maize yield while keeping the input costs to a minimum. Under a technical cooperation project on 'Developing Maize Genotypes for Drought and Low Soil Fertility Tolerance', scientists in Zambia used nitrogen-15 isotopes to evaluate and apply the most effective fertilizer, resulting in the yield increasing from 1.2 to 5 t/ha with a urea application of 100 kg N/ha. The project results showed that the controlled or slow release of urea coated with nitrification and urease inhibitors decreases the rate at which urea is converted to ammonia and nitrate. This decreases the amount of urea required for maize crops by 50% while maintaining yield. The potential impact in terms of saving fertilizer and increasing production over 500 000 ha is significant. The results of this study are likely to shape the policy on the type of fertilizer to be used and fertilizer imports in Zambia (Fig. 5).

FIG. 5. Farmers applying urea fertilizer to a maize crop.