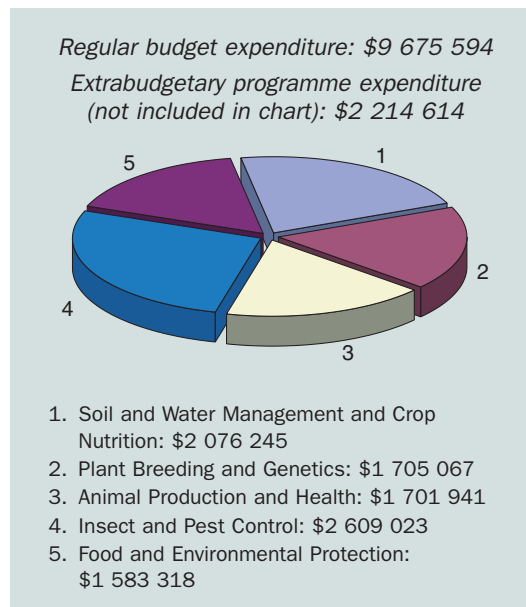


# FOOD AND AGRICULTURE

## PROGRAMME OBJECTIVE

To enhance capacities at national and international levels for identifying and alleviating constraints to sustainable food security by facilitating the development and adoption of nuclear and related biotechnologies.



## KEY ISSUES AND HIGHLIGHTS

- The 1964 Arrangements between the Directors General of FAO and the Agency for the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (which plans and implements the food and agriculture programme at the Agency) were revised to enhance their effectiveness. The main features of the new Arrangements include redefinition of the responsibilities of the Joint Division and establishment of a steering committee composed of representatives from the two organizations to oversee the programme's direction and implementation, and review staff and strategic issues.
- Significant achievements were made in applying radiation and isotopic techniques in research, leading to the optimization of water and nutrient use by plants, and ultimately ensuring sustainable crop and livestock productivity and environmental preservation.
- To support human capacity building and technology transfer, standard operating and good laboratory procedures, manuals and guidelines were developed for use by Member State scientists and technicians. Self-reliance at the national and regional levels was also promoted.

## SOIL AND WATER MANAGEMENT AND CROP NUTRITION

Soil organic matter, which is a key component of soil fertility, is concentrated in the surface soil and is rapidly lost under tropical conditions through accelerated oxidation due to conventional cultivation practices under hot, moist conditions, as well as through water erosion processes. This rapid loss can be arrested through appropriate soil conservation measures that include retention of crop residues. A CRP completed during the year supported national efforts in 11 Member States to identify management options for crop residues for sustainable agricultural production and environmental preservation in a wide range of soils and cropping systems. Various options for the recycling of crop residues that are sustainable and economically attractive to farmers were examined using isotopic techniques. The value of simple practices using wheat and rice residues to produce compost as an alternative to stubble burning was demonstrated. Such practices can have important implications apart from the desired maintenance of soil organic matter and improving plant growth. For example, millions of tonnes of rice and wheat straw are burnt annually worldwide, causing atmospheric pollution and producing large quantities of carbon dioxide, a greenhouse gas. In addition, various gaseous forms of nitrogen are emitted during burning, representing a loss of fertilizer equivalents and significant pollution of the environment by nitrous oxide.

Soil erosion and associated sediment deposition are natural landscape forming processes that can be accelerated by such human interventions as deforestation, overgrazing, excessive tillage and other non-sustainable farming practices. Recognizing erosion as a serious threat to sustainable agricultural production and hence global food security, the Agency formed two international research networks — through CRPs — involving 25 Member States, to develop standardized methodologies for measuring soil redistribution at the catchment level. The studies resulted in a validated and cost effective technique, based on the fallout radionuclide caesium-137, that provides spatially distributed and time integrated estimates of soil erosion and sedimentation rates in a wide range of envi-

ronments and scales worldwide. In addition, institutional capacity in the various Member States for conducting applied research on soil erosion has been greatly enhanced. Standardized protocols and methodologies for the use of the caesium-137 technique have paved the way for field testing of strategies to control soil erosion, and to obtain a better understanding of the relationships between rates of soil loss and soil and water quality, soil carbon and nutrient redistribution, and the fate of agrochemicals and related contaminants in the landscape.

Human resources development is an important service provided by the Agency to Member States through its CRPs and the technical cooperation programme. The Agency's Laboratories at Seibersdorf provided training in total nitrogen and nitrogen-15 isotope analyses of soil and plant materials and associated quality assurance procedures. Fellowship training was provided to scientists on radiation and isotope methods to monitor flows and the balance of nutrients and water in cropping systems. To support human resources development activities, a new training manual, *Use of Isotope and Radiation Methods in Soil and Water Management and Crop Nutrition*, was published.

## PLANT BREEDING AND GENETICS

Global banana production, which totals around 95 million tonnes per year and ranks fourth after cereals, is threatened by many pests and diseases such as Black Sigatoka, *Fusarium* wilt, nematodes and viruses. Among the achievements of a recently concluded CRP on cellular biology and biotechnology, including mutation techniques, for the creation of new useful banana genotypes were the generation and screening in Cuba, Malaysia, Philippines and Sri Lanka of a series of mutants for desirable traits such as early flowering, reduced height, large fruit size and tolerance to *Fusarium*. 'Novaria' — a banana mutant variety derived from mutation induction of 'Grande Naine' with improved traits such as early flowering, short stature, high yield potential and good flavour — was released in Malaysia. Further breakthroughs included: identification of methods for the analysis of karyological stability using a

DNA flow cytometer; early screening of *Fusarium* wilt disease; a selection system against Black Sigatoka disease; and a screening technique for nematode resistance. Significant advances were also made in the application of molecular marker and cytogenetic techniques for the detection of different genomes of *Musa*, and in the genetic stability of micropropagated banana plants. Finally, the CRP helped several young researchers in receiving advanced degrees in Belgium, the Czech Republic and Israel.

A technical co-operation project in Viet Nam led to the development of a new and improved saline tolerant rice mutant, CM6, with an attractive long grain and a higher yield of 3–4.5 tonnes per hectare. The market price for this long grain variety is about one and a half times higher than the price of the currently available salinity tolerant rice mutant variety CM1. In addition, a number of mutant varieties, produced through other technical co-operation projects were officially released (see Table I).

Molecular markers are rapidly being adopted by plant breeders as effective and appropriate tools for accelerating the breeding process. In order to introduce new and promising marker tech-

niques to Member States, a new training programme was developed. The first interregional course in this programme, on mutant germplasm characterization using molecular markers, was held at the Agency's Laboratories at Seibersdorf.

Free access to crop mutants is essential for their widespread use in locations other than their origin of development. Moreover, mutants have become valuable tools in functional genomics and proteomics. An FAO/IAEA Mutant Germplasm Repository was set up at the Agency's Laboratories at Seibersdorf with the aim of collecting and freely distributing mutant germplasm to researchers. An Internet accessible database was also developed to promote the exchange of germplasm from donors to recipients in Member States (<http://www.iaea.org/programmes/nafa/navig/index.html>).

## ANIMAL PRODUCTION AND HEALTH

Efficient and robust disease diagnostic tools are essential for any disease control or eradication programme. In 2001, the production and development of animal disease diagnostic kits

TABLE I. MUTANT VARIETIES OF PLANTS RELEASED BY THE AGENCY IN 2001

Country	Crop/ornamental plant	Name of mutant variety	Changed character
Mali	Sorghum	Fambe, Tiedjan, Gnome	Increased yield, lodging resistance, improved grain quality, disease (striga) resistance
Egypt	Sesame	Taka 1, Taka 2, Taka 3, Tushki, Shandawill 3	Disease and insect resistance
Malaysia	Orchid ( <i>Dendrobium</i> )	Sonia Keena Ahmad Sobri	Diamond shaped petals
	Oysterplant ( <i>Tradescantia spathacea</i> )	Sobrii	Creamy leaf stripes
Thailand	Moss Rose ( <i>Portulaca grandiflora</i> )	KU1, KU2, KU3	Flower colour
	Canna ( <i>Canna x generalis</i> )	Pink Peeranuch, Yellow Arunee, Cream Prapanpongse, Orange Siranut	Flower colour

based on nuclear technologies was consolidated in Africa. For the first time animal health authorities in Africa have regional access to kits for the diagnosis of African Swine Fever, Rift Valley Fever, brucellosis and rinderpest. Through state of the art technology utilizing a baculo-virus expression system that can inexpensively generate highly specific diagnostic reagents, the national veterinary laboratory in Dakar, Senegal, has distributed rinderpest diagnostic kits to some 34 African countries. Similarly, kits for African Swine Fever are now being distributed by the same laboratory. Although requiring further validation, the technology itself is proving appropriate and applicable to the developing country situation. Linked to the use of another biotechnology, the polymerase chain reaction (PCR), African scientists now have a regional capacity to both rapidly diagnose and accurately characterize the major diseases of their livestock. Produced locally, but based on training and technology provided through the Joint FAO/IAEA programme in food and agriculture and Agency technical co-operation activities, this capacity will considerably assist national governments in more effectively combating livestock diseases in the region.

A major constraint to increasing livestock productivity in developing countries is the scarcity and fluctuating quantity and quality of the year round supply of conventional feeds. Trees and shrubs form the most abundant source of protein in nature. However, the amounts of tannins that they contain vary widely, are largely unpredictable and have adverse effects on animals ranging from decreased nutrient utilization to toxicity and death. With a better understanding of tannin properties and proper management, leaves from trees and shrubs could become an invaluable source of protein for strategic supplementation. As the demand for food rises, tanniferous plants must play an increasingly important part in the diet of animals, in particular for ruminants in smallholder subsistence farming in developing countries. In studies conducted under a CRP, it was found that seven tannin assays are required to predict the nutritional value of tannin containing forages. The use of these assays, including the radiolabelled bovine serum albumin method for predicting the biological effects of feeding tannin containing leaves,

together with the new method for hydrolysable tannins developed in this CRP, provide the necessary momentum to the efforts being made by a number of international organizations to develop strategies to effectively utilize the vast resource of protein in the form of trees and browses as livestock feed.

## INSECT AND PEST CONTROL

As the interest of the private sector in the application of the sterile insect technique (SIT) increases, there is a need for guarantees that sterile insects will continue to be safely and legally shipped. In response, a 'scenario analysis' technique was used to quantify the potential risks involved in the transboundary shipment of sterile insects for pest control programmes. This analysis was the basis for the development of a draft international standard that was submitted for consideration to the Interim Commission on Phytosanitary Measures (ICPM), the governing body for the International Plant Protection Convention (IPPC). Harmonized guidance on regulating the shipment of sterile insects will facilitate trade, while addressing any concerns about shipment of what could be quarantine pest species.

Fruit flies cause very significant fruit losses, but they are also of major quarantine significance internationally, interfering with the transboundary trade in fresh fruits and vegetables. There are no international guidelines on fruit fly monitoring, with importing countries establishing different and changing monitoring requirements to determine low fly prevalence or fly free status. At the request of Member States, guidelines on fruit fly monitoring were developed. These guidelines are now being used to facilitate the international trade in fruit commodities among Member States.

An International Database on Insect Disinfestation and Sterilization (IDIDAS) was developed to compile information on a species basis for both disinfestation (trade and quarantine) and sterilization (SIT). IDIDAS, which fills a gap in the current knowledge base, adds value to existing information by performing a quality assurance check on existing data and by making the information more accessible.

Considerable progress was made in developing SIT for the date moth, a serious pest in North Africa. Following a ban on the use of insecticides, the Government of Tunisia embarked on a programme to reduce infestation rates in dates using biological control methods including SIT. The introduction of an artificial larval diet and oviposition system through a CRP and a technical co-operation project increased the production level in the rearing unit to one million adult moths per week. In addition, a chilled moth dispersal device was developed and tested. The pheromone lure used to monitor adult male moths was synthesized, and tests on the efficiency and stability of different formulations were carried out in the field.

In response to an outbreak of tsetse transmitted animal trypanosomosis a few years ago, and to reduce the fear of a resurgence of sleeping sickness in tourist areas of the Okavango Delta, the Government of Botswana initiated a series of sequential aerosol spraying operations in the northern part of the delta, to be followed eventually by the use of SIT as a permanent solution. A regional technical co-operation project was set up to support Botswana's integrated, area wide programme for tsetse and trypanosomosis control and eradication. The key component of this support is the establishment of mass reared colonies of *Glossina morsitans centralis* at insectaries of collaborating institutions for the supply of sufficient sterile males for aerial releases.

With the objective of reducing insecticide use in citrus production for export markets, a mass rearing facility for the Mediterranean fruit fly (medfly) capable of producing 12 million sterile males per week was constructed in Sidi Thabet, Tunisia, in the framework of a technical co-operation project. This followed the agreement of the Tunisian Ministry of Agriculture and the fruit industry to participate in the project and undertake field activities. The national Atomic Energy Authority is responsible for sterile fly production. A trapping network has been set up in the Cap Bon Peninsula, the main commercial citrus production area, for the collection of field data.

All medfly SIT field programmes require that the released flies are marked with a fluorescent dye so that they can be distinguished from wild insects following their release. However, the

reliability of this procedure can be compromised, leading to misidentification of flies. In addition, the screening of many thousands of individual flies on a daily basis under a fluorescent microscope is extremely labour intensive. A genetic marker called 'Sargent' that produces an extra stripe on the fly was developed as a replacement for the fluorescent dye. Field cage tests in 2001 to assess mating competitiveness produced good results and the marker is now being mass reared.

Several components of medfly SIT implementation may be improved by the ability to introduce genes into the insect by way of transgenic technology. This technology is now available for the medfly and, following collaboration with the United States Department of Agriculture, a series of transgenic medfly lines were generated. These are marked with a fluorescent protein and are being used to monitor key aspects of strain stability and fitness in relation to the use of transgenic technology in SIT.

The extensive use of field cages in the quality assurance of mass produced fruit flies has encouraged its use in tsetse. Field cage tests were carried out to evaluate the effect of various radiation and handling procedures of the mating ability of mass reared tsetse. In addition, mating compatibility assessment of different populations of the same species of tsetse were carried out. The field cage system appears to be eminently suitable as a quality control procedure for tsetse. Standard operating protocols for this quality assurance procedure, as well as for all the other procedures involved in tsetse mass rearing, have been prepared.

## FOOD AND ENVIRONMENTAL PROTECTION

The Agency has assisted in the development of international standards and analytical capacity building to ensure the safety and quality of food in international trade. A notable advance in this respect was the progress made in the proposed 'Revised Draft Codex General Standard for Irradiated Foods' at the 24th session of the Codex Alimentarius Commission, held in July. The Commission also accepted a proposed draft 'International Code of Practice for Radiation

Processing'. Adoption of the revised Codex General Standards for Irradiated Foods, with no maximum limit on absorbed dose, by the Commission at its 2003 session will bolster consumer confidence and facilitate international trade. It would also harmonize regulations on irradiation as a food process in Member States. In addition, 'Guidelines for the Single Laboratory Validation of Analytical Methods for Trace Level Concentrations of Organic Chemicals' were endorsed by the Codex Committee for Methods of Analysis and Sampling at its 23rd session in February. The guidelines were then incorporated into the good laboratory practices document by the 33rd session of the Codex Committee on Pesticide Residues in April. It is expected that it will be adopted as a Codex Standard at the 25th session of the Codex Alimentarius Commission in 2003.

On the basis of data generated by CRPs, and recognizing the potential of irradiation for eliminating insect pests of quarantine importance in fresh horticultural commodities in international trade, the third session of the ICPM, the standard setting body of the IPPC, agreed to develop an international standard on irradiation as a phytosanitary treatment. An IPPC Working Group for this purpose was convened in November and a draft international standard was developed for further elaboration by the ICPM. A Guideline on Certification of Food Irradiated other than for Phytosanitary Purposes, drafted earlier by food control officials and plant quarantine officials in Asia and the Pacific, was endorsed for submission to the Codex Alimentarius Commission for its consideration.

Having completed its mandate of developing policy guidelines for the Agency, FAO and WHO, the International Consultative Group on Food

Irradiation (ICGFI) decided at its 18th annual meeting in Rome in October to phase out its activities by May 2004. A new organization with the strong involvement of the private sector, especially the food industry, and with emphasis on the implementation of irradiation as a method to enhance food safety, security and trade, is expected to succeed ICGFI.

To strengthen agricultural countermeasures in the event of nuclear accidents, simple and robust methods for analysing the uptake of radionuclides from specific soil types and for determining radionuclide transfer factors in model plants were developed through a CRP. In addition, a new CRP on the introduction of quality assurance/quality control principles in the analysis of pesticide products was initiated. The CRP is expected to facilitate the control of pesticide products by elaborating a multi-analyte procedure that is more cost effective and simpler to implement for Member States.

Mycotoxins are a group of naturally and biologically active substances that are toxic to humans and animals and are not widely regulated in international trade. To help national food control authorities in developing countries to strengthen their analytical capacity for mycotoxin assessment in food and feed, a regional FAO-IAEA-WHO training workshop was held in Cairo in December 2001. The emphasis of the workshop was to develop quality assurance procedures for mycotoxin analysis to enable national food control laboratories to meet safety requirements in the international food trade. The workshop provided the participants with the criteria and tools for meeting ISO 17025 requirements, which is a necessary step in seeking accreditation in mycotoxin analysis so that their results are accepted by regulatory agencies and their trading partners.