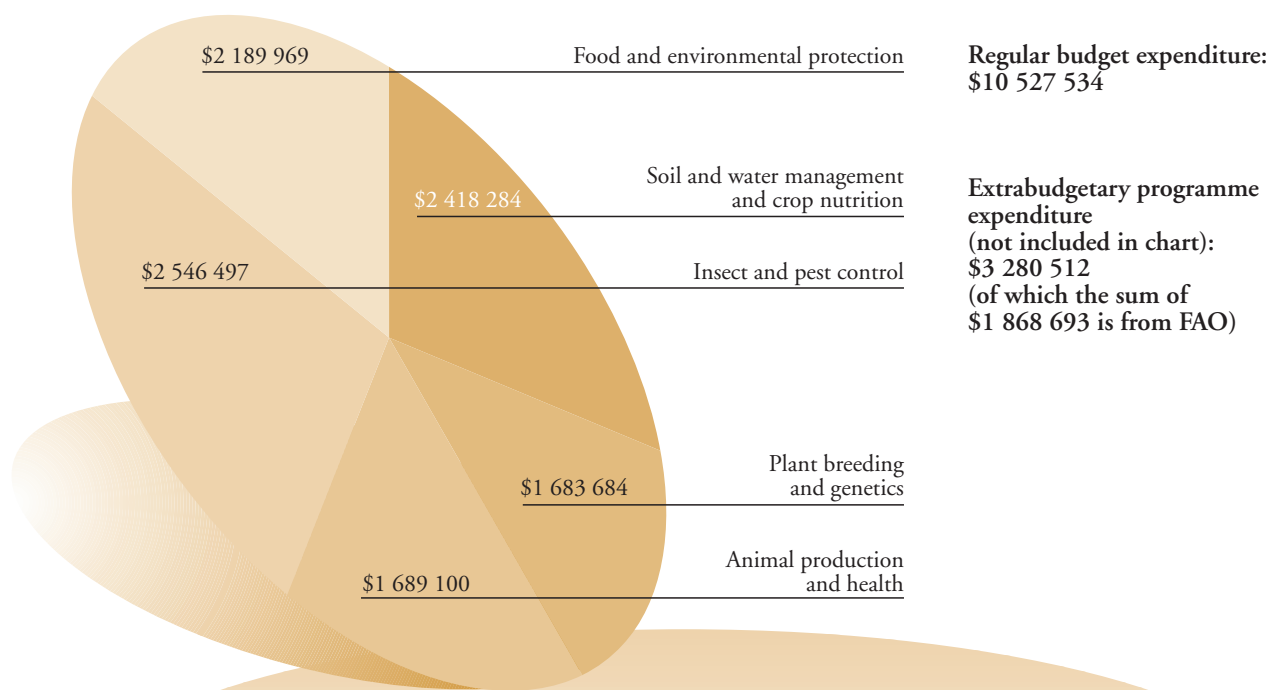


# FOOD AND AGRICULTURE



To improve food production and quality through developing and transferring environmentally sound practices using nuclear and related biotechnology methods.

**Programme objective**

Significant progress was made in the introduction of technologies to intensify crop and livestock production, protect natural resources and improve the quality and safety of food. Examples included: the development and adoption of management practices which led to increased crop yields with less water and fertilizer; and better crop varieties and improved strategies for the identification of cost effective conversion of feeds into meat and milk by livestock. Similarly, the development and use of better methods for diagnosing important livestock diseases, coupled with the major progress achieved in extending the concept of the area wide management of insect pests through the sterile insect technique (SIT), have enhanced considerably the capacities of Member States to address important livestock

and crop protection issues. The increasing acceptance of food irradiation and greater support given to the issue of food quality and safety through the newly established FAO/IAEA Training and Reference Centre at Seibersdorf, near Vienna, have contributed to enhanced trade and better food control systems.

## Soil and water management and crop nutrition

A CRP on the use of nuclear techniques in the management of nitrogen fixing trees to enhance the

fertility of fragile tropical soils was completed. New information was obtained on the potential of leguminous trees to fix atmospheric nitrogen, on the ability of some species to thrive under adverse conditions and on the value of tree prunings as an organic fertilizer source. Studies conducted in Sri Lanka showed that *Gliricidia* was able to obtain more than 50% of its nitrogen requirement through biological nitrogen fixation. In Pakistan, *Acacia ampliceps* was found to thrive in hypersaline soils where other crops failed. In Chile, the biomass production of *Chamaecytisus* species was about ten times higher than the commonly grown *Acacia caven* on degraded soils under drought conditions. Results from field experiments conducted in a wide range of agro-ecological zones showed that substantial increases in crop yields can be obtained by the proper management of tree prunings. In the Democratic Republic of the Congo, the grain yield of corn increased by more than 60% owing to the application of a mixture of leaf prunings from *Albizia lebbek* and *Acacia auriculiformis*.

A regional technical co-operation project for West Asia involving the Islamic Republic of Iran, Jordan, Lebanon, Saudi Arabia, the Syrian Arab Republic, Turkey and the United Arab Emirates on water balance and fertigation (i.e. fertilizer nitrogen applied in combination with irrigation water) for crop improvement was completed. The application of nuclear based techniques (nitrogen-15 labelled fertilizer, soil moisture neutron probe) in the field demonstrated that fertigation was a highly effective method for conserving water and increasing nitrogen fertilizer use efficiency. The yield of cottonseed in the Syrian Arab Republic was increased by more than 20% by fertigation compared with traditional fertilizer and water management practices. Moreover, water use efficiency, based on dry matter yield, increased by more than 90%, which resulted in savings of more than 30% of irrigation water.

A CRP on the use of nuclear and related techniques for evaluating the agronomic effectiveness of phosphate fertilizers, in particular phosphate rock (PR), was completed. The effectiveness of RP depends on its solubility (reactivity), which is related to the degree of carbonate substitution for phosphate in the apatite structure. Rock phosphates with low reactivity are unsuitable for direct application to annual crops. However, research carried out in Brazil, China, Cuba, Thailand and Venezuela demonstrated that effectiveness can be increased by partial acidulation or by mixing with organic materials or a water soluble

phosphorus source. Effectiveness can also be enhanced through a biological approach involving inoculation with mycorrhizal fungi. The efficiency of PR also depends on crop species, being particularly powerful on crops such as canola and lupin which exude organic acids from their roots. The utilization of PR by crops is higher in soils with low pH, low available phosphorus, low exchangeable calcium, high cation exchange capacity and high organic matter content. A database is in preparation for validating a model to provide recommendations for PR application.

An indirect (nitrogen-15 dilution) technique to estimate the availability of nitrogen from a range of organic sources was developed and validated at the Agency's Laboratories at Seibersdorf. The technique involves comparison of the isotopic composition of plants grown in nitrogen-15 labelled soil with and without unlabelled residue addition. It will have wider application than the direct method (use of nitrogen-15 labelled residues) owing to the difficulty of labelling some organic materials (e.g. manures and sewage sludges).

## Plant breeding and genetics

In a CRP on induced mutations for sesame improvement, the main plant characters responsible for the genetic improvement of sesame and the recommended mutagen treatments and selection criteria for major agronomic traits were determined. Mutation induction proved to be a valuable breeding technique in sesame, with several mutants with desirable characters such as indehiscence, determinate growth, increased seed yield, disease resistance and water logging resistance being obtained. It was recognized that the exchange of useful germplasm among participants in the CRP was important, and in order to facilitate future exchange a database of confirmed mutant lines was set up containing some 140 different lines with agronomically important characteristics. Some advanced mutant lines were evaluated in regional or national yield trials, and recently the mutant derived variety 'Pungankkae' was officially released in the Republic of Korea. This was obtained by crossing a local variety with the determinate mutant 'dt-45' from Israel. It was concluded that by focusing efforts on one neglected crop such as sesame and exchanging breeding techniques and mutant germplasm, the productivity of such crops can be improved within five years.

Twenty-one new accessions were registered in the FAO/IAEA database for officially released mutant varieties. The total number has grown to 1868 mutant varieties of more than 163 species released in 59 countries.

In order to reduce the cost of tissue culture techniques for mutated generations, natural light was examined as an alternative light source for the *in vitro* culture of banana at the FAO/IAEA Agriculture and Biotechnology Laboratory of the Agency's Laboratories. Traditionally, *in vitro* plants are grown in a growth chamber under artificial light and conditions of controlled temperature and length of day. The costs of illuminating a growth chamber are around \$3 per m<sup>2</sup> per week. Experiments showed that more *in vitro* shoots were produced when grown under non-controlled conditions, such as in a greenhouse or in a sunlit room with temperatures between 23° and 30°C and a photoperiod of 12–16 hours, than under artificial light in a growth chamber providing controlled conditions of light, temperature and photoperiod. The concept of using sunlight for micropropagation systems is proposed as a way of reducing tissue culture costs.

## Animal production and health

Studies conducted under a CRP on the development of feed supplementation strategies for improving the productivity of dairy cattle on smallholder farms in Africa showed the value of combining field observations and measurement of progesterone by radioimmunoassay to monitor reproductive performance and in evaluating the responses of livestock to different supplementation strategies. The outcome was the development of specific feed supplements at each study location, including tree legumes, cottonseed cake, brewers' grains, urea–molasses–multinutrient blocks (UMMB) and fish silage. Using these at strategic periods, such as in the dry season or during pregnancy and lactation, resulted in significant improvements in milk production and/or reproductive performance. These concepts are now being introduced through a regional technical co-operation project for improving milk production in Africa. Similar advances have been made through technical co-operation projects in Asia and Latin America, where feed supplementation strategies developed in previous CRPs and based on UMMB are now being adopted by large

numbers of dairy farmers in peri-urban and rural areas in countries such as Indonesia, Sri Lanka, Venezuela and Viet Nam.

Brucellosis is considered one of the most important diseases affecting animals and, through the consumption of milk and dairy products, is one of the most dangerous and widespread diseases affecting people. A five year study was completed in five Latin American countries on the development and validation of a diagnostic assay to separate animals vaccinated with brucellosis from those naturally infected. This represents the largest ever serological study undertaken with regard to this disease, and through the support provided by the Agency an essential tool now exists to assist Member States in the future control and eradication of brucellosis. Similar studies through this CRP concerned with foot and mouth disease, the most important livestock disease constraining trade, have resulted in the international validation of a fully standardized assay for diagnosing this disease, an essential prerequisite to its control and eradication. Over one billion dollars have been pledged to eradicate the disease from Latin America and this assay will be an essential component of this effort.

Quality assurance is central to the effective use of diagnostic assays. A comprehensive FAO/IAEA external quality assurance programme was developed involving national veterinary laboratories in over 70 Member States. Based in part on this programme, a generic veterinary laboratory accreditation scheme was developed that is being considered as the basis for a worldwide programme. The need to ensure the quality of information on livestock disease occurrence is fundamental to the international livestock trade and the work of the WTO, and the scheme developed by the Agency and FAO is considered a major step forward in this process.

## Insect and pest control

An FAO/IAEA conference entitled 'Area Wide Control of Insect Pests: Integrating the Sterile Insect and Related Nuclear and other Techniques' was held in Penang, Malaysia, at the same time as the 'Fifth International Symposium on Fruit Flies of Economic Importance'. The conference was the first international event to focus on the concept of integrated pest management, addressing the economics, trade issues,

commercial perspectives and implementation of pest control programmes. It also reviewed progress in refining SIT and other developments in biotechnology, genetics and molecular biology related to insect pests.

A CRP on the development of female Mediterranean fruit fly (medfly) attractant systems for trapping and sterility assessment resulted in the development of a female attractant which allows detection of medfly females under situations of sterile male releases. The lure, which was validated in 14 countries, is now available commercially and is being used in medfly SIT programmes. Also, a filter rearing system to increase the stability of genetic sexing strains under industrial level mass rearing conditions was developed and validated for maintaining production colonies. As a result, mass rearing facilities in Argentina, Guatemala and Portugal have now demonstrated such stability during the mass production of hundreds of millions of sterile males per week for SIT programmes.

Progress in the development of tsetse mass rearing included the design and evaluation of a second prototype tsetse production unit for holding and feeding larger numbers of tsetse flies and for the more effective collection of their pupae. The system can be constructed locally and consists of a hand operated frame which holds large numbers of cages and brings them for feeding simultaneously at fixed feeding stations, and a pupal collection device which will ultimately harvest pupae to a central point. The prototype is being fine tuned and has shown promise as a system for large scale colony maintenance. New operational procedures of sex separation at emergence, previously demonstrated with *Glossina austeni*, have also been adapted to *G. pallidipes*. As a result, it is possible to automatically stock cages with the right number and sex of *G. pallidipes*, eliminating one of the most laborious steps in tsetse rearing.

## Food and environmental protection

Co-operation with the International Consultative Group on Food Irradiation (ICGFI) through an RCA regional workshop led to the adoption of a harmonized regulation on food irradiation for Asia and the Pacific based on the principle of the Codex General Standard for Irradiated Foods and the relevant recommendations of the ICGFI. Governments in this region agreed to

introduce new or amend existing regulations in accordance with the harmonized regulation by the year 2000. Similarly, countries in the Middle East and North Africa agreed at a regional workshop organized by the FAO Regional Office for the Near East to adopt the same harmonized regulation.

A CRP on standardized methods to verify absorbed dose in irradiated fresh and dried fruits and tree nuts was completed. This CRP demonstrated the reliability of a dose indicator label fixed to a reference position in commercial food packages to verify the minimum absorbed dose for insect control, as required by regulatory authorities. In addition, a simple, hand-held dosimeter reader capable of measuring absorbed dose from a label dose-indicator was developed. These advances strengthen inspection and control procedures for fresh and dried fruits, and tree nuts that are irradiated for insect control, as the minimum dose required by regulatory authorities does not always result in immediate mortality of the pest.

Another completed CRP on the use of irradiation as a public health intervention measure against foodborne diseases in Latin America, co-sponsored by PAHO, demonstrated that very low doses of radiation can effectively make *Vibrio* spp. bacteria in raw oysters inactive without killing the molluscs. Similar results were obtained for *Vibrio cholerae* on fresh vegetables; radiation doses required for this purpose do not damage the quality of fresh, refrigerated lettuce, cabbage or celery. The CRP also provided valuable information in confirming the radiation dose required to make *Taenia solium* cysticerci inactive in fresh pork meat.

The results of a completed CRP on the use of nuclear and related techniques in studies of the agroecological effects from the use of pesticides in Central America, funded by the Swedish International Development Agency (SIDA), confirmed that agricultural activities have resulted in widespread contamination of surface and groundwater in the region. In particular, pesticides have entered food chains and potable water resources. Some water samples contained concentrations of pesticides exceeding levels that are considered toxic to some aquatic organisms. The data generated were used by government authorities to improve national water quality legislation, and by pest control experts to improve the implementation of integrated pest management programmes.

A recently completed CRP, on radionuclide transfer from air, soil and fresh water to the food chain of

humans in tropical and subtropical environments, concluded that a higher or lower uptake of radionuclides by crops is not crop specific. If an agro-ecological system shows a relatively high or low uptake for one crop, all crops will exhibit the same behaviour. It has been shown that higher or lower uptake is nuclide specific. These efforts can help countries in developing countermeasures in the event of a nuclear accident. The information on environmental parameters will help improve radiological assessment models and contribute in setting limits for authorized discharges from nuclear installations. As a result, better emergency response planning, particularly in developing countries, will lead to the replacement of generic data with those more relevant to local conditions.

Extrabudgetary funds from Austria and Sweden permitted completion of the construction and equipping of the FAO/IAEA Training and Reference Centre for Food and Pesticide Control at the Agency's Laboratories, Seibersdorf. The main objective is to strengthen the analytical capacities of Member States to fulfil the requirements for implementing international standards and agreements relevant to food quality and safety, particularly those covered by the Agreement on the Application of Sanitary and Phytosanitary (SPS) Measures being enforced by the WTO.

