

FOOD AND AGRICULTURE

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PROGRAMME OBJECTIVE

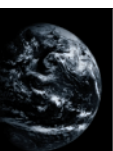
To promote sustainable food security by fostering the development and transfer of nuclear and related biotechnological methods which provide significant opportunities for intensifying crop and livestock production, enhancing biodiversity and improving food quality and safety.

OVERVIEW

Progress was made in this programme in developing technologies and formulating environmentally sound practices for enhancing food security. Isotope and radiation techniques provided new scientific information on nitrogen fertilizer and water use by wheat, leading to practices which improved or maintained yields while saving on nitrogen fertilizer applications and reducing nitrate pollution of groundwater. Mutation techniques combined with modern biotechnology led to the generation of economically useful traits in crop plants. The use of radioimmunoassay (RIA) and related methods provided Member States with recommendations for improving artificial insemination, increasing milk production and controlling important livestock diseases. The sterile insect technique (SIT) continued to play a major role in the control and eradication of pests of both crops and livestock, while the role of irradiation as a sanitary and phytosanitary treatment of food and agricultural commodities continued to gain recognition. Finally, the FAO/IAEA Training and Reference Centre for Food and Pesticide Control at the Agency's Laboratories in Seibersdorf strengthened its assistance to Member States in the area of food quality and safety.

SOIL AND WATER MANAGEMENT AND CROP NUTRITION

A CRP on the use of nuclear techniques for increasing nitrogen fertilizer efficiency for irrigated wheat, and involving Afghanistan, Chile, China, Egypt,



India, Mexico, Nepal, Pakistan and the Syrian Arab Republic, was completed. Despite the shortage of water and the increasing cost of fertilizer, farmers tend to use excessive amounts of both resources in an attempt to maximize crop production. This results in depletion of water reserves and nitrate pollution of groundwater. Nitrogen-15 labelled fertilizers were used to estimate fertilizer recovery by crops and nitrogen losses, while a soil moisture neutron probe was used to assess the soil water balance and crop evapotranspiration. The timing of fertilizer application was critical in determining effectiveness. Application of nitrogen fertilizer at the locally recommended rate in two splits (one third at tillering and two thirds at the elongation stage of wheat), resulted in significant losses, especially during the first split, with a recovery of only 35%. The recovery during the second split was 62%. By reducing fertilizer application to 20% in the first split and increasing the second split to 80% of the annual rate, nitrate leaching was reduced and fertilizer use efficiency increased. A realistic increase of 5% of the overall nitrogen fertilizer recovery corresponds to annual savings of approximately \$100 million for developing countries producing wheat. Irrigation was well managed in all but two of the countries mentioned earlier, where nitrate leaching was observed during the cropping season and better management could save 30% of current usage. A decision support system, incorporating the CERES-wheat model, was able to explain differences in wheat yield between countries, and to predict the effect of fertilizer timing on crop uptake and irrigation water usage on nitrate leaching.

An interregional technical co-operation project on external quality assurance in total nitrogen and nitrogen-15 isotope ratio analysis by optical emission spectroscopy was completed by the Agency's Laboratories at Seibersdorf. The objective of the project was to identify a network of regional laboratories capable of carrying out precise and accurate analyses. Institutes in Argentina, Chile, Côte d'Ivoire, Guatemala, Malaysia, Mexico, Syrian Arab Republic, Thailand and Uruguay fully complied with requirements and can be recommended to act as regional network labo-

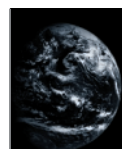
ratories. The identification of proficient laboratories underpins attempts to increase nitrogen fertilizer use efficiency in developing countries, which used more than 50 million tonnes in 1996 worth \$15 billion.

PLANT BREEDING AND GENETICS

Through a CRP on the improvement of new and traditional industrial crops by induced mutations and related biotechnology, major achievements were recorded on modifying agronomic traits, improving yield and modifying the oil quality in crops providing oilseeds and fibre. For example, advanced breeding lines of soybean with increased yield potential and improved quality of seed for oil and meal used in the food and feed industries were developed, while linseed and *Cuphea* mutants with new oil composition were created with potential use as renewable energy sources ('biodiesel'). Also, sunflower lines were selected with very high oleic content (suitable for use as frying oil), new lines of cotton were produced with shorter growing cycles and improved fibre yields, and new sources for pest and disease resistance were identified in rapeseed, mustard, sunflower and cotton. The development of molecular markers for soybean, sunflower, *Cuphea* and cotton and the isolation and transfer of genes related to specific oil qualities, pest resistance and drought tolerance were also achieved through this CRP. In addition, the exchange of germplasm, isolated genes and DNA sequences among participating countries was carried out.

Ninety-three new accessions were registered in the FAO/IAEA database for officially released mutant varieties. The total number has grown to 1961 mutant varieties of more than 163 species released in 62 countries.

In order to improve the probability of selecting disease resistant banana and plantain mutant plants, which is currently hampered by chimerism, the in vitro mutagenesis of multicellular meristems was simulated in the Agency's Laboratories at Seibersdorf by inducing mixoploidy and using flow cytometry



for detection. This approach made it possible to monitor and understand chimerism dissociation using different propagation methods. Multi-apexing proved the most efficient method, reducing chimerism from 100 to 7% after three subcultures.

Doubled haploid techniques, such as anther culture, were also used to accelerate the identification of recessive mutants and to purify selected mutants in rice. In the variety 'Taipei 309', pollen embryogenesis was much higher in

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cultivated anthers derived from the second crop of donor plants after harvest of the main crop, than in anthers derived from the first crop.

An FAO/IAEA seminar, organized in October in Manila, focused on the current status and future direction of mutation techniques and related molecular genetic approaches for plant research and crop improvement. The presentations by participants clearly demonstrated the significant progress and impact of mutation techniques in the development and utilization of improved varieties of various economically important crops in the region. It was agreed that mutation techniques should be used not only for the improvement of major crops, but also for the domestication of crops with economic potential. The integration of related molecular genetic techniques in the characterization of mutant derived lines and varieties illustrates the potential of these techniques in complementing and accelerating breeding programmes through marker aided selection, diversity analysis and fingerprinting for plant variety protection. In order to transfer recent molecular and mutation techniques more widely and efficiently to crop improvement programmes in the region, the

Agency was requested to provide training and information on these subjects.

ANIMAL PRODUCTION AND HEALTH

A CRP on the use of RIA and related techniques to identify ways of improving artificial insemination (AI) programmes for cattle reared under tropical and subtropical conditions resulted in a unique international database on the current status of AI in 14 Member States in Asia and Latin America. Conducted on nearly 2000 farms and covering some 11 000 artificial inseminations on over 7000 cows, the study showed that conception rates following AI were often far lower than generally presumed by many organizations which provide these services. On average, 17% of cows (up to 40% in some locations) were mated at an inappropriate time in relation to oestrus. Even in those mated correctly, 25–50% of animals either did not conceive or suffered death of the embryo within two months. This is a waste of available resources and results in economic losses to farmers. The problems which need to be addressed by providers of AI services as well as farmers were identified, improvement strategies were tested and the responses monitored. In Sri Lanka, for example, the introduction of improved reproductive management by farmers combined with more efficient AI services increased the proportion of cows in lactation at a given time by 20%, annual milk production by 30% and the net profit to farmers by 40%. This CRP also resulted in the development and standardization of methodologies — including a software program 'AIDA' (Artificial Insemination Database Application) — which are now being applied on a wider scale in these as well as other Member States through regional and national technical co-operation projects in Asia, Africa and Latin America.

Contributing to the wider application of progesterone RIA for field level problem solving and provision of diagnostic services of direct benefit to farmers, the Agency's Laboratories at Seibersdorf developed a novel 'self-coating' RIA system based on a monoclonal antibody to progesterone. This dramatically reduces the



cost of assaying milk samples and facilitates development of the capability to produce the essential reagents in selected national laboratories of Member States. Training and infrastructure development to achieve self-sufficiency in RIA requirements within each geographical region and promote the sustainability of applications to improve livestock production was conducted through technical co-operation projects.

Foot and mouth disease remains one of the most serious threats facing livestock production and trade. A CRP designed to improve diagnosis of this disease in Asia and to monitor control and eradication efforts was completed. Involving national veterinary laboratories in the region, this CRP led to the development, validation and standardization of specific and sensitive diagnostic tests. The proficiency of the laboratories involved was verified through the operation of an external quality assurance exercise. Major outcomes of the development of this diagnostic capability across the region were the initiation of a multi-donor control and eradication programme for foot and mouth disease in Asia and the completion of a regional high security reference laboratory in Thailand for this disease.

INSECT AND PEST CONTROL

As a result of an SIT technical co-operation Model Project in Argentina on fruit fly eradication, major economic benefits were achieved in the Provinces of Rio Negro, Neuquen and Mendoza. Not only did insecticide applications decrease greatly in commercial fruit orchards, but the quantity and quality of temperate fruit production increased significantly since the start of the project, and several fruit producing valleys were declared fruit fly free. Most importantly, this work resulted in the neighbouring country of Chile, already recognized internationally as fruit fly free from a previous SIT project, allowing the fruit industries in Mendoza and Patagonia Provinces to use Chilean ports for their fruit exports. Fruit exports from Argentina already amount to approximately \$0.5 billion annually, and this access to the export markets of Pacific Rim

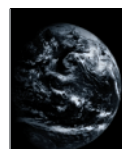
countries through Chile should bring further major economic benefits to Argentina's fruit industry.

Progress was made in an SIT technical co-operation project in the Middle East, where sterile Mediterranean fruit fly males were released over the Arava region of both Jordan and Israel with the objective of developing internationally recognized fly free areas to allow fruit and vegetable exports. The sensitive logistical issues involved in the long

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distance shipment of sterile males to the region and aerial releases over both countries were satisfactorily resolved and significant economic benefits have been derived from the establishment of fly free areas. The impact can be measured by the fact that six agricultural areas have now been designated as fly free and a fifty fold increase in the economic value of vegetable exports was achieved. The success of this pilot project and the environmental benefits of reduced insecticide use led to preparations to expand area-wide medfly control using SIT northward into Gaza and to agricultural areas of Israel and Jordan.

Weekly sterile screwworm fly releases were initiated over Jamaica. This was the culmination of intensive preparatory work involving the establishment of a ‘National Screwworm Eradication Project’, economic and environmental assessments, staff training, baseline data collection and infrastructure development. With eradication activities now in progress, the prospects for eradication of this major livestock pest from Jamaica appear promising. Preparatory activities were initiated for a similar eradication project in Cuba, which together with the Dominican Republic,



is the last area in the northern half of the Western Hemisphere where this pest is currently present.

A new medfly genetic sexing strain was produced at the Agency's Laboratories at Seibersdorf. This strain contains genetic material from many different medfly populations and utilizes a translocation that both increases stability during mass rearing and alleviates some of the quality control problems

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associated with previous genetic sexing strains. The strain was shipped to medfly SIT programmes in South Africa and Australia for further testing, and it will be provided to facilities in Argentina, Chile, Guatemala, Portugal and the USA.

A prototype tsetse rearing unit designed to reduce the cost of tsetse mass rearing was shipped to three facilities in Africa for evaluation under local conditions using different species of tsetse. This unit is a refinement of an earlier unit developed at the Agency's Laboratories at Seibersdorf. Essential to the operation of the unit is a simple protocol for the introduction of the correct number and sex of flies into production cages. This protocol was fully evaluated and introduced into routine colony maintenance at Seibersdorf, with major savings in time and labour.

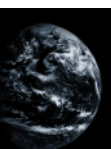
FOOD AND ENVIRONMENTAL PROTECTION

An international conference on ensuring the safety and quality of food through radiation processing was held in Antalya, Turkey, in

October to assess the current status and future prospects for food irradiation. It was convened at a time when there is increasing acceptance and application of irradiation as a sanitary and phytosanitary treatment of food and agricultural commodities and also at a time when the widespread and increasing incidence of foodborne illnesses, caused by pathogenic bacteria and parasites, has brought the issue of food safety to the forefront of public health concerns. The conference reaffirmed that the safety and nutritional adequacy of irradiated food produced under conditions of good manufacturing practices, are no longer in question regardless of the absorbed dose. It was also agreed that irradiation as a cold pasteurization/decontamination treatment of food, both of animal and plant origin, is an essential step in the Hazard Analysis Critical Control Point based approach being widely applied or even mandated in many countries to ensure its safety.

New developments in food and environmental protection included co-operation between countries in Asia and the Pacific through RCA, resulting in the adoption of a harmonized protocol on irradiation as a quarantine treatment of fresh horticultural commodities and the development of guidelines on irradiation as a phytosanitary treatment. The protocol and guidelines will be submitted to the Secretariat of the International Plant Protection Convention for elaboration into an international standard. Another development was the progress made by a number of Asian countries in using this technology on a commercial scale. And new or additional commercial irradiation facilities are under construction in Bangladesh, China, India, the Republic of Korea and Thailand.

The mandate of the International Consultative Group on Food Irradiation (ICGFI) was extended until 2002 to strengthen involvement of the food industry in its work and to facilitate the dissemination of information to the public on the safety and benefits of food irradiation. At the request of ICGFI, the FAO/WHO Codex Alimentarius Commission initiated steps to amend the current Codex General Standard for Irradiated Foods with



the aim of removing the upper dose limit of 10 kGy.

A CRP assessed the effects of repeated and long term applications of pesticides on the properties of soils, including their effects on microbial populations and biochemical processes, binding and release of pesticide residues, and the mineralization of pesticides. The radiotracer technique involved the use of carbon-14 labelled compounds. The results indicated that some pesticides temporarily inhibited microbial growth and various biochemical processes in the soil, whereas others were stimulatory. All applications caused an increase in the amount of soil bound residues with the passage of time. Also, mineralization of radiolabelled pesticides was reduced in soils receiving repeated applications of pesticides. The information obtained will be used to assist Member States develop better pest management strategies.

The capabilities of national food control authorities in developing Member States for analysing food contaminants continued to be

strengthened through the FAO/IAEA Training and Reference Centre for Food and Pesticide Control at the Agency's Laboratories at Seibersdorf. Examples of the support provided by the centre included: the organization of an RCA workshop in the Philippines and an inter-regional FAO/IAEA training course at Seibersdorf on quality assurance procedures for mycotoxin and pesticide residue analyses; the establishment of an International Food Contaminant and Residue Information System to provide up to date information through the Internet (<http://www.INFOCRIS.iaea.org>) on sampling and analytical methods for food contaminants affecting trade in food and agricultural commodities; and the development of simpler multi-residue analytical methods. In addition, a workshop on the principles and practices of method validation was held in Hungary to develop guidelines for single laboratory validation of methods for the analysis of trace organic compounds. These guidelines will be considered at the upcoming sessions of the Codex Committees on Pesticide Residues and on Veterinary Drug Residues for development into Codex standards.

