

FOOD AND AGRICULTURE

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.

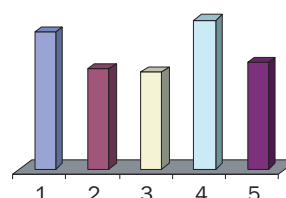
OVERVIEW

Planned and implemented jointly with FAO, the Agency's food and agriculture programme helped Member States to strengthen significantly their capacities to integrate nuclear techniques into national and global efforts for overcoming some of the key constraints to sustainable food security. Efforts were also made in building awareness among political and technical decision-makers of the potential offered by nuclear technology in tackling these constraints. Examples of the many interactions and partnerships fostered during the past year included the decision of African Heads of State to move forward in using the sterile insect technique (SIT) against tsetse flies, the General Conference of the OIE adopting an accreditation procedure for animal disease diagnostic laboratories, and the Secretariat of the Global Rinderpest Eradication Programme (GREP) including the Agency on the technical body that will certify the global eradication of rinderpest.

The transfer by the Agency, through technical co-operation, of techniques and strategies developed or validated through previous research resulted in a number of achievements in dealing with problems of food security. These included the advances made by many Member States in: controlling fruit flies and improving trade through the use of SIT; eradicating rinderpest and increasing animal production and income generation with the help of immunoassay techniques; introducing better crop varieties developed through radiation and more efficient nitrogen-fixing tree species for improving soil fertility and crop production which were identified using isotopes; and adopting food irradiation to improve food safety and securing plant health. Finally, the Agency made progress in identifying and exploring, through co-ordinated research, new opportunities for harnessing nuclear techniques. In addition, important knowledge gaps and new applications were assessed critically before being recommended for wider transfer. The use of radiation to treat sewage sludge is one example; others include the development of molecular techniques for assisting plant breeders to select agronomically useful traits in crops; a technique for diagnosing trypanosomosis in livestock; and better procedures for mass rearing tsetse flies for use in SIT projects.

Regular budget expenditure: \$11 770 179
(of which FAO's contribution is \$ 2 216 108)

Extrabudgetary programme expenditure
(not included in chart): \$2 929 469



1. Soil and Water Management and Crop Nutrition: \$2 219 737
2. Plant Breeding and Genetics: \$1 621 053
3. Animal Production and Health: \$1 570 585
4. Insect and Pest Control: \$2 413 213
5. Food and Environmental Protection: \$1 729 483

SOIL AND WATER MANAGEMENT AND CROP NUTRITION

Isotopes are playing a dynamic and growing role in monitoring and improving the nutrient and water status of soils, and thereby the sustainability of natural resource use for crop production. This was one of the main conclusions of an FAO/IAEA symposium on nuclear techniques in integrated plant nutrient, water and soil management, which was held in Vienna in October 2000. In addition to increasing the awareness among the interna-

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tional scientific and development communities of recent advances in methodologies and approaches, the symposium drew special attention to the substantial opportunities now available for improving the sensitivity and precision of stable and radioactive isotope determination through better instrumentation. New multiple labelling approaches with stable isotopes were identified that can follow the cycling of two or more nutrients simultaneously and which illustrate clearly the interdependence between nutrient and carbon fluxes.

Urban societies are faced with the ever-increasing problem of managing waste materials. Modern sewage treatment plants produce large quantities of sludge that constitute a public health hazard owing to the presence of pathogenic organisms. A CRP and technical co-operation activities supported national and international efforts to identify approaches for dealing with this problem and to demonstrate the usefulness of sludges for improving soil fertility and crop production. The CRP concluded that gamma irradiated sludge was not only free of pathogenic organisms but was a valuable source of plant nutrients, increasing crop yields several fold and providing up to

50% of their nitrogen and phosphorus requirements. Moreover, by increasing water retention and decreasing soil compaction, this sludge was a valuable soil conditioning agent. Interestingly and contrary to common belief, sludges from urban areas generally had low concentrations of heavy metals. Nevertheless, the CRP recommended that the concentrations of these metals be monitored in soils and plants, and adherence to disposal guidelines and prescribed loading limits is necessary if sludge is repeatedly applied to agricultural land.

Phosphorus deficiency is a major constraint to crop production in many countries with acid soils. The use of a rapid and simple soil test to diagnose phosphorus deficiency in agricultural fields is therefore an essential first step in tackling the problem. The Agency’s Laboratories at Seibersdorf validated an iron oxide impregnated filter paper (Pi-strip) method for estimating plant-available soil phosphorus. The results showed a close correlation between the Pi-strip method and the standard reference method based on isotopic exchange kinetics and hence with plant phosphorus uptake. The availability of this cheap and easy to use method improves the opportunities available to countries both to diagnose phosphorus deficiency and ameliorate its effects by applying locally produced phosphate rock fertilizers.

Overexploitation of natural vegetation and soil resources in many countries has resulted in widespread land degradation, lower crop productivity and reduced food security. A regional technical co-operation project that ended in 2000 involved nine countries in the East Asia and Pacific region in redressing this problem through agroforestry (i.e. the use of nitrogen fixing trees). Participants identified locally adapted species with high nitrogen fixing potentials using isotope methods. For example, when *Gliricidia sepium* was introduced as a shade tree in the coffee plantations of Sri Lanka and the prunings used as mulch on the soil surface, berry yields increased more than five-fold. Typically, the introduction of trees into cropping systems resulted in fast tree growth, better tolerance to drought and soil acidity, and less soil erosion on sloping

land. On-farm demonstrations of the benefits of agroforestry — better conservation of natural resources and more sustainable production of cash crops and valuable timbers — provided tangible incentives for farmers to integrate leguminous trees into their cropping systems.

PLANT BREEDING AND GENETICS

Molecular markers are playing an increasingly major role in the genetic characterization, breeding, and improvement of many crops. They have also greatly expanded the ability to assess biodiversity and understand the structure, evolution and interaction of plants with the environment. Through a CRP completed in 2000, more than 12 000 hybridization probes (both radioactive and non-radioactive), 2800 microsatellite primer pairs, and 2000 fingerprinting primers were distributed free of cost to facilitate the transfer of molecular marker technology to developing countries. In addition, information was provided on protocols describing the best methods of application and on software technology resources, troubleshooting and access to reference materials. The CRP participants made considerable progress in the development and application of amplification based DNA markers, and on introducing the robust methods of experimental design now widely used by the electronic and automotive industries to optimize experimental DNA marker protocols and conserve resources for the analysis of plants and their pathogens. They also used these materials and techniques to develop molecular maps for pearl millet, rice, barley, wheat, sorghum, and maize and for detecting fungal diseases in banana, plantain, yams and chickpeas.

Date palm plays an important role in food security and in maintaining the ecosystems of North African countries. However, date production and income generation from these trees is seriously threatened by ‘Bayoud’ disease, which in Morocco and Algeria has already killed over 15 million trees. A technical co-operation project on identifying new approaches for the control of this disease used low dose gamma radiation to increase the

formation of somatic embryos, thereby enabling date palm trees to be rapidly multiplied. Further breakthroughs included the isolation of the toxin produced by the fungus and the identification of seven molecular marker primers that are associated with resistance or tolerance to the disease. These now make it easier to select disease resistant trees for subsequent testing in the field.

The continued use of radiation induced mutations was reflected in the inputs provided by Member States to the FAO/IAEA database on mutant varieties. During 2000, the number of mutant varieties that were officially released reached 2252 — an increase of 291 over the

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previous year and covering 163 species spread over 62 countries. To better quantify the impact of some of these varieties, the Agency embarked on a number of fact-finding missions to selected countries. The mutant variety ‘TNDB100’, which was developed from a traditional variety after radiation treatment and officially released in Viet Nam in 1997, now covers more than 200 000 hectares (ha) in the Mekong Delta. Its fast acceptance by farmers arises from its high yield (6–8 t/ha) and grain quality despite acidic soils and low input conditions, while its early maturing nature means that two or three crops can be grown per year. India provides another example. Here, the mutant variety TAU-1 of black gram is grown on over 500 000 ha, covering 95% of the area in Maharashtra State. The increased area planted and the yield achieved has contributed the equivalent of \$64.7 million annually to the economy of the region.

Lowering the cost of technology for crop improvement is vital for developing countries. Studies carried out in 2000 in the Agency’s Laboratories at Seibersdorf demonstrated that natural daylight captured through

tubular skylights could replace artificial light and substantially reduce the costs of in vitro culture methods used for large scale propagation of crop plants. A prototype system to capture natural light and eliminate the need for electricity was developed which will be of major benefit in reducing the cost of micro-propagation in developing countries. Using random amplified polymorphic DNAs, the Agency's Laboratories also identified four primers that are associated with specific DNA fragments of salt-tolerant rice varieties but not with those from salt-susceptible varieties. These primers are now available to assist the many Member States affected by soil salinity to select mutants for tolerance to saline conditions.

ANIMAL PRODUCTION AND HEALTH

Working closely with the OAU's Inter-African Bureau of Animal Resources (IBAR), FAO, the European Union, the Swedish International Development Agency and other donors, the Agency has continued to be active in its role as a catalyst and in harmonizing international

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and national efforts to develop immunoassay tests for monitoring the eradication of rinderpest from livestock in Africa. The results of a CRP revealed the enormous progress that has been made in eliminating this lethal virus infection from the region and underlined the critical role of FAO/IAEA technologies, strategies and capacity building for their use in securing this rollback. When the Agency first became involved, 14 African countries were infected and over a million heads of cattle were dying each year. Today only small areas in Somalia and southern Sudan remain infected and all countries in the region now use internationally standardized and vali-

dated sero-monitoring and surveillance tests backed up by quality assurance programmes and defined surveillance performance indicators monitored from the Agency's Laboratories at Seibersdorf.

Equally deadly to cattle production and food security in Africa is trypanosomiasis. In 2000 a CRP ended, funded by the Netherlands, that resulted in the successful development, international standardization and validation of an immunoassay test to reliably detect the disease-causing parasite in cattle populations. Already used in Zanzibar Island, United Republic of Tanzania, to confirm the eradication of the tsetse fly and in Ethiopia to provide baseline data to gauge the outcome of the Southern Rift Valley tsetse fly eradication campaign, this assay coupled with the national capacities established to use it reliably will become increasingly important as the momentum to eliminate the disease and its vectors from the region intensifies.

Using the knowledge and experience gained in developing and transferring immunoassay technology to national laboratories for animal disease diagnosis and surveillance, the Agency assisted the OIE (Organisation Internationale des Epizooties) to develop a generic veterinary laboratory accreditation scheme to facilitate international trade in livestock and livestock products. Based on an interpretation of the international standard ISO 17025, this scheme was adopted by the 154 Member States of the OIE at its annual General Conference in May 2000. Linked to the external quality assurance programme operated from the Agency's Laboratories at Seibersdorf, this provides a path for national veterinary laboratories to achieve international accreditation and conform to World Trade Organization standards for trade related laboratory testing.

Another major constraint to animal production in most developing countries is inadequate feed supplies. Building on the success of previous CRPs that identified feed supplementation strategies as being able to overcome this problem, two regional technical cooperation projects in Asia and Africa addressed the issue on a wider scale. Reviews

of both projects confirmed that the feed resources and strategies for their use identified through the CRPs led to better utilization of low quality feed for ruminant feeding in all participating Member States, and that one of the supplements developed — the urea-molasses multinutrient block (UMMB), proved particularly valuable both to smallholder as well as semi-commercial farmers. In Asia, for example, over 1.6 million kg of UMMBs were fed to over 25 000 cattle, buffalo, yaks and goats by the 6200 farmers associated with the project in 2000. In addition to stimulating livestock production, the project generated employment and income, particularly for village women. Critical to this success were the efforts made by Member States and the Agency alike to strengthen and extend the modalities and linkages between collaborating institutes, national livestock agencies, farmer organizations and non-governmental organizations for extension of the technology. Over 145 national training activities were conducted for field extension personnel and farmers, amounting to over 5000 person-days of training. Exhibitions, demonstrations, publication of leaflets in local languages and educational programmes through the mass media were also conducted. Some Member States established microfinancing schemes through revolving funds for farmer groups, while in other States commercial companies took on the production of UMMBs.

INSECT AND PEST CONTROL

Following the successful eradication of the tsetse fly from Zanzibar Island in the United Republic of Tanzania, the sterile insect technique (SIT) has continued to gain more recognition among Member States in the past year. In response to the increasing problem of African trypanosomosis, a livestock disease caused by tsetse fly, 12 affected countries formed the “Pan-African SIT Forum” under the auspices of the OAU for the development and application of SIT in area-wide programmes for tsetse fly eradication. Subsequently, the Heads of African States and Governments adopted a “Decision on Proposal for Eradication of Tsetse Flies on the African

Continent” at their 36th Summit Meeting in Togo. As a result arrangements are under way to initiate a Pan-African Tsetse and Trypanosomosis Eradication Campaign.

Other developments in tsetse eradication included the development at the Agency’s Laboratories at Seibersdorf of a new feeding and holding system which allows large numbers of tsetse flies to be provided with a

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blood meal as required and from which pupae can be efficiently collected. A field cage protocol for assessing the quality of sterile male tsetse was also developed and evaluated which will make a major contribution to the effectiveness of tsetse SIT field programmes in Africa. Furthermore, a robust and accurate protocol for the production of all male tsetse pupae was developed which eliminates two extremely time consuming processes that had to be followed during the eradication programme in Zanzibar. Taken together, these breakthroughs will reduce considerably the cost and increase the quality of mass produced tsetse flies.

The Mediterranean fruit fly (medfly) is another insect pest that causes widespread economic damage. In South Africa, an SIT pilot technical co-operation project demonstrated the cost effective use of this environment friendly technology for control rather than eradication. By replacing insecticides with aerial releases of sterile flies, medfly populations were effectively suppressed throughout 2000 in the Hex River valley, a major table grape exporting area. The direct result was an approximately 60% reduction in the rejection rate of table grapes from this valley by inspectors of importing countries, representing a substantial increase in revenue to the local fruit industry.

The transnational medfly SIT technical co-operation project between Israel, Jordan and Palestinian Authority continued to make progress, resulting in the effective suppression of the pest from the Arava region and the Lower Jordan Valley. This effort allowed exports of vegetables to medfly free countries without quarantine restrictions to the value of \$5 million. Based on the promising results in the first phase, the project was expanded with

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US Agency for International Development and ‘footnote-a’ support from the USA to cover other areas, including Gaza and Israel’s western Negev. In addition, fruit producing areas in eastern Egypt are now being included to expand the sterile fly release area.

In another medfly SIT technical co-operation control project on the Portuguese island of Madeira, the medfly mass rearing and sterilization facility built with financial contributions from the European Union began producing an FAO/IAEA developed genetic sexing strain. Sterile male releases focused on the northern part of Madeira and neighbouring Porto Santo island have reduced fruit infestation levels. This led to a feasibility study being conducted with the aim of expanding SIT technology to major citrus production areas in Valencia, Spain and other major fruit producing areas in the Mediterranean basin.

A majority of medfly mass rearing facilities in the world are being converted to adopt the most advanced male only production technology using genetic sexing strains developed by the Agency’s Laboratories at Seibersdorf. Currently, factories in Argentina, Chile, Guatemala and Portugal already produce under this system, and factories in Australia, Mexico, Peru and the USA are preparing for its introduction. The expanded El Pino facility

in Guatemala reached production levels in 2000 of over 800 million sterile male medflies per week, the largest production of a male only medfly strain in the world, and sterile males produced at this facility are being used for medfly SIT programmes in Guatemala, Israel, Jordan, Mexico, South Africa and the USA.

The Agency’s Laboratories at Seibersdorf made further technical and logistical improvements related to genetic sexing strains for medfly. The stability of the strain was improved by the introduction of chromosomal inversions and a procedure developed to allow the shipment of eggs between rearing facilities which could have a significant impact on the future commercialization of SIT.

As part of the strategy to increase awareness of the availability of the SIT for cost effective insect control, a video entitled *The Sterile Insect Technique: An Environment-Friendly Method of Insect Pest Suppression and Eradication* was produced under an interregional technical co-operation project. The video was distributed to entomology and ecology departments at universities, pest control research institutes and animal and plant protection organizations around the world.

FOOD AND ENVIRONMENTAL PROTECTION

Improving the level of awareness of industry and consumers about the facts and benefits of food irradiation is key to stimulating wider acceptance and uptake of the technology. A public information workshop arranged by the Agency and FAO for countries participating in RCA addressed public concerns about food safety and the benefits of food irradiation as a sanitary and phytosanitary measure. It resulted in the creation of a media network — *INFORM (Irradiation Network for the Media)* — to enhance public awareness.

Expanding the market opportunities for irradiated fruits, vegetables and other horticultural commodities requires that Member States meet the quarantine requirements for international trade. To facilitate this, an FAO/IAEA workshop involving senior food

control and plant quarantine officials from RCA countries certified irradiation as a sanitary and phytosanitary treatment for food and agricultural commodities. This highlighted the importance of taking a systematic approach to certification of food destined for international trade.

The draft certificate that was produced is intended to accompany irradiated foods and simplify inspection formalities in importing countries. At another workshop, guidelines were developed in the format required under the International Plant Protection Convention for using irradiation as a phytosanitary treatment of food. The aim is to have an international standard. In concert with these activities, a powerful information system was launched on the Internet called *IDIDAS*

(International Database on Insect Disinfestation and Sterilization) to keep industry, government regulators and other relevant bodies up to date on the radiation doses used in the control of insect pests and mites.

The presence of excessive pesticide residues can result in imports being blocked, and represents a barrier to international food trade. To deal with this problem, a training course on quality assurance and control procedures for analysing foodstuffs for pesticide residues was held at the Agency's Laboratories at Seibersdorf. The participants became qualified in the skills and information required to implement food surveillance programmes and analytical quality assurance to comply with Codex Maximum Residue Limits.