

# Food and Agriculture

## Objective

To enhance capabilities within Member States for alleviating constraints to sustainable food security by the application of nuclear techniques.

## Reducing Soil Erosion

In many parts of the world soil erosion is a major form of land degradation that can have severe effects on people, local economies and the environment. The Agency has assisted Member States in establishing the extent of soil erosion using radionuclides still in the soil as a result of nuclear weapons testing in the past or from cosmic radiation and atmospheric deposition of nuclides. Soil conservation measures, such as no-tillage and grass strips, were introduced when the rates of erosion were determined. These simple measures led to reductions in soil erosion rates of 20–90% in Chile, China, Morocco, Romania and Vietnam, resulting in an increase in the productivity of the land.

## Improving Water Use Efficiency

Improving water use efficiency in agriculture is a major focus of the Agency's programme in food and agriculture. Research in Bangladesh, China, India, Nepal and Pakistan using nitrogen-15 isotopic techniques and neutron probes established that the novel cultivation of rice in raised beds without continuous flooding can lead to significant savings in the use of irrigation water compared with the traditional practice of growing rice in paddy fields.

Research supported by the Agency involving Algeria, Australia, China, India, Morocco, Pakistan and Yemen demonstrated that a carbon isotope discrimination technique can be used for the selection of wheat varieties, resulting in greater grain yield and increased water use efficiency through a greater tolerance to drought. The technique is based on differences between carbon-12 and carbon-13 isotopes in plant tissues. Building on these results, the technique will be used to develop crop cultivars matching specific environments prevailing in the participating countries.

In plant mutation breeding, the number of officially released mutant varieties reached 2541. One

Member State that benefited directly in 2006 from the release of these varieties was Peru. Barley is an important part of the diet for the three million people living on subsistence agriculture in the Peruvian Andes. The harsh and extreme climatic conditions make this environment inhospitable to many crops, and barley is often the only source of nutrients available to the population. High yielding mutant varieties of barley and 'kiwicha' (a type of grain) were released in Peru during the year, adding to the varieties that were introduced in earlier breeding programmes. These varieties now cover 90% of the barley producing area in Peru, which is above 3000 m and extends up to 5000 m above sea level (Fig. 1). The availability of these improved mutant seeds has contributed to increased food security for the local population and to increased income from the sale of the production surplus.

A mutant wheat variety was released in Yemen, which in yield trials was shown to mature earlier than the original variety, thereby avoiding losses imposed by disease. In addition, Botswana and Kazakhstan have, for the first time, introduced mutation induction as part of their crop improvement programmes, while Sierra Leone has re-established its capacity to conduct mutation breeding. The importance of mutation breeding in the Islamic Republic of Iran and Kenya was emphasized by the introduction of this topic in graduate university courses in these States.

Several new techniques to enhance the efficiency of mutation induction in plant breeding and crop



FIG. 1. The barley mutant variety UNA La Molina 95 growing at an altitude of 5000 m in Peru.

improvement were developed by the Agency in 2006, along with pilot testing schemes for further use. In the area of molecular screening, targeting induced local lesions in genomes (TILLING), which allows the rapid identification of plants carrying mutations in genes of interest, has established itself as a powerful functional genomics discovery technique, opening up new perspectives for breeding. It has recently been verified as a proof of concept for crop improvement in bread wheat, and its further development for mutation induction was developed at the Agency's Laboratories, Seibersdorf.

Advances were made in techniques for producing more stable and useful mutant variants of vegetatively propagated crops such as banana and plantain at the Agency's Laboratories, Seibersdorf. Research established protocols for the efficient in vitro irradiation of explants from exotic fruit trees, including litchi, guava, carambola, cherimoya, pitanga and jaboticaba. These mutant trees are undergoing testing for confirmation of the mutation for earliness, seedlessness and resistance to disease, while maintaining their agronomical performances.

The Agency participated in China's Cosmic Ray Treatment programme. The Shijian-8 satellite, specially designed for seed breeding in space, carried over 2000 varieties of plant seeds belonging to 133 species, including rice samples from the Joint FAO/IAEA Programme on Nuclear Techniques in Food and Agriculture, which will be used for both breeding and basic research. The exposure of plant materials to strong cosmic radiation for long periods of time, combined with microgravity and a weak geomagnetic field, has the potential to cause mutagenic effects on plants and induce a range of genetic variations, including higher yield and improved quality. Some useful mutations from space induced mutations are rarely found in crop germplasm and may open up a new road to increase crop yield.

## **The Sterile Insect Technique (SIT) for the Sustainable Control of Insect Pests**

A new sterile insect production facility was established in Bahia, Brazil, where a mass rearing facility started operations dedicated initially to the production of about 100 million sterile Mediterranean fruit flies (medflies) per week. The facility, developed with assistance from the Agency's technical cooperation programme, will service the

rapidly expanding commercial fruit production areas in the various irrigation districts around Rio San Francisco in the arid northeast of Brazil. The initial objective is to reduce insecticide applications by suppressing fruit flies in an environmentally friendly manner, with the ultimate goal of eliminating the costly post-harvest treatments by establishing officially recognized low prevalence and fruit fly free areas.

An area-wide integrated pest management programme that includes an SIT component was initiated in Argentina against the codling moth, which is a major pest of apples and pears. A pilot rearing facility was inaugurated in September 2006. The Agency supported human capacity building

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and an economic feasibility study that compared the current control practices with an SIT based approach for a 100 hectare pilot area. The economic indices showed a return on investment with a benefit to cost ratio of 17:1, which if extrapolated to the entire apple and pear industry in Argentina would result in very large economic benefits.

An interregional training course on the use of the sterile insect and related techniques for the integrated area-wide management of insect pests was held at the University of Florida, in Gainesville, USA. Kenya hosted a similar FAO/IAEA regional training course in Nairobi. The Agency provided assistance in the organization of two workshops — in Burkina Faso and Uganda — to develop detailed action plans for the collection of entomological baseline data.

The Agency drafted standard operating procedures for the advanced mass rearing of tsetse flies, with particular reference to the needs of operational technical cooperation projects. In addition, two e-learning modules on SIT relevant irradiation dosimetry and on procedures to test the compatibility of tsetse strains were developed to enhance quality assurance in tsetse SIT procedures.

At the invitation of the Algerian Commission of Atomic Energy, the Agency participated in a regional

conference on 'Approaches for the Integrated Control of the Desert Locust', held in Algiers in July. The participants explored, among others issues, the possible inclusion of nuclear techniques in the arsenal of existing control tactics against the desert locust, a devastating crop pest. The conference concluded that for technical reasons, SIT was not a suitable control tactic for this pest, though other nuclear techniques such as those involving the use of stable isotopes could be considered as supplementary research tools to study certain fundamental processes of desert locust ecology, for example dispersal, distribution and nutrition.

Substantial progress was achieved in a technical cooperation project on implementation of a pilot programme using SIT against the medfly in Tunisia, where a fully equipped and staffed sterile fly packing and holding unit is now operational. The elements for area-wide SIT application are also available. At the rearing plant, located on the premises of the Centre national des sciences et technologies nucléaires, the counterpart organization is implementing quality and process control procedures. It has also provided additional areas for the storage of diet ingredients, as well as a washing room which will help reduce the risk of contamination in the facility.

## Sustainable Improvement of Livestock Production Systems

Developing countries have thousands of different breeds of livestock, which need to be properly evaluated and characterized for optimal utilization. One step in the characterization process is DNA analysis. New nuclear and related molecular technologies allow quick and rapid identification of molecular genetic markers to identify differences in genome sequences. It is possible now to 'genotype' animals through a simple DNA test, and to classify those carrying a desired trait before the selection process. Through a CRP, the Agency conducted research with the aim of assisting Member States in carrying out such DNA analysis. The activities of this project succeeded in transferring this technology and skills to eight different countries and have led to the genetic characterization of more than 90 breeds of sheep and goats.

## Improving Food Quality and Safety

Improvements in food quality and safety depend on the establishment of reliable sampling and analytical regimes for quantifying potential hazards related to food safety. Agency activities in the area of food quality and safety support analytical laboratories in Member States and include an annual interregional training workshop which helps these laboratories both in the application of methods of analysis for food contaminants and in ensuring the quality of the results produced. In 2006, scientists from 20 Member States were trained in these areas at the Agency's Laboratories, Seibersdorf (Fig. 2). Ana-

lytical methods, including radiotracer techniques, for residues of various pesticides and veterinary drugs in food were developed, their performance validated, and the protocols transferred to Member States. These activities assisted Member States in evaluating the impact of good production practices, identifying and using environmental indicators, and enhancing the potential of these States for participating in the international food commodities trade.

Collaborative efforts with international bodies in this regard include the development and adoption of Codex Guidelines on the estimation of uncertainty of results in relation to compliance monitoring of pesticide residues in food. The uncertainty of analytical results is important in evaluating the risk of violating Codex or national pesticide residue limits for food commodities before export, thereby

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FIG. 2. A laboratory training exercise at the Training and Reference Centre for Food and Pesticide Control, Agency's Laboratories, Seibersdorf.

avoiding the rejection of consignments by importing countries.

The Agency hosted a technical panel on phytosanitary treatments, where 12 specific irradiation treatments for some of the most important pests in the international trade were discussed and approved. The report of this meeting will go to the Commission on Phytosanitary Measures as part of the process of securing Member State agreement on the adoption of irradiation treatments.

Emergency planning and response to nuclear emergencies and radiological events is of growing importance in the Agency's activities, particularly

with regard to increasing the capabilities of FAO as a critical counterpart in defining and implementing agricultural countermeasures in response to such events. These collaborative activities helped to ensure the adoption of the revised *Codex Guideline Levels for Radionuclides in Foods Contaminated Following a Nuclear or Radiological Emergency for Use in International Trade* at the 29th Session of the Joint FAO/WHO Codex Alimentarius Commission, held in Geneva in July 2006. These levels provide added assurance to governments that foods are safe and help facilitate international trade in the aftermath of nuclear emergencies. ■