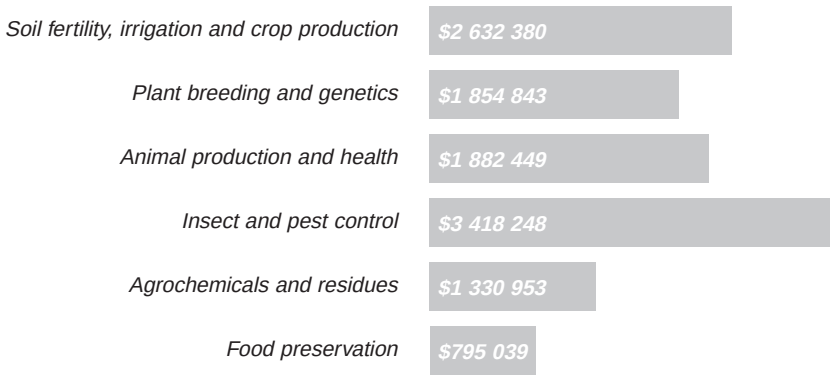
FOOD AND AGRICULTURE

Regular Budget expenditure: $11 913 912

Expenditure by subprogramme



Extrabudgetary programme resources utilized (not included in chart): $2 917 102
(of which the sum of $1 498 599 is from FAO)

A feature of 1996 was the increasing extent to which techniques and technologies developed through the Agency's research contract programmes and at the FAO/IAEA Agriculture and Biotechnology Laboratory at Seibersdorf were applied through technical co-operation projects and other activities to improve food security and assist Member States in meeting international agricultural standards and undertakings. An example is the use of mutation breeding and biotechnology to support crop improvement and biodiversity under the Leipzig Declaration on Plant Genetic Resources. Other examples include the increasing use of FAO/IAEA developed diagnostic tests, the sterile insect technique (SIT) and food irradiation in assisting Member States to meet obligations with respect to sanitary and phytosanitary standards and technical barriers to trade under Uruguay Round agreements. Also noteworthy is the work on agrochemicals to assist in the implementation of the International Code of Conduct on the Distribution and Use of Pesticides.

Soil Fertility, Irrigation and Crop Production

A series of CRPs has been conducted over the years on enhancing the use of atmospheric nitrogen by plants through biological nitrogen fixation by the Rhizobium–legume symbiosis using the nitrogen-15 isotope dilution technique, and through the efforts of the FAO/IAEA Laboratory. In the latest CRP, a gene marker method for studying Rhizobium ecology was developed and tested. The new method was used for the identification and classification of Rhizobium strains and for studying strain competition for establishing symbiosis with the legume. Apart from being an important tool for research in Rhizobium ecology, this method, when combined with the dilution technique, will greatly enhance the selection of elite strains in nodulating legumes for use in biofertilizer production. The method has been transferred to microbiological laboratories in developing countries.

In Bangladesh, smallholder farmers have begun to realize higher crop yields and savings on chemical nitrogenous fertilizers from the use of legume biofertilizers developed from Rhizobium strains selected for their superiority in nitrogen fixation. Results from about 1500 demonstration trials conducted in farmers' fields showed that substantial increases in nitrogen fixation and yield can be obtained through the use of biofertilizer. The yield increases recorded in 1996 were over 95% for lentil, 70% for soybean and chickpea, 40% for groundnut and 25% for cowpea.

Progress was made in a CRP on optimizing fertilizer nitrogen application and irrigation water supply on wheat with reference to a CERES–wheat simulation model. This model will assist in refining nitrogen fertilizer management strategies. Using data generated through the nitrogen-15 isotope dilution technique and neutron moisture probes, it was found that the model is able to provide a realistic estimate of nutrient uptake, water use and crop growth. After validation, the model will be a quick and simple tool to evaluate specific management practices that would otherwise require several years of costly field research.

The first phase of a CRP on irradiated sewage sludge, which includes studies to quantify the availability of nitrogen to crops and to assess increases in crop yields from the applied sewage sludge, was completed. The results from 14 countries indicated the positive effect of irradiated sludge on yield and crop quality and a decrease in soil contamination by pathogenic organisms compared with the use of non-irradiated sludge.

Progress was made in a technical co-operation project on international quality assurance for nitrogen-15 analysis using emission spectrometers by laboratories in Member States co-ordinated by the FAO/IAEA Laboratory. The aim of the project is to determine whether results generated from Agency supported laboratories are accurate and reliable, and to recommend or take corrective measures where problems exist. About three quarters of the laboratories were found to produce reliable data, while the remaining produced data outside the acceptable limits of accuracy. Measures have been taken to assist the latter in correcting the situation.

Plant Breeding and Genetics

Promising results for the improvement of cassava, yam, sweet potato, plantain, sorghum and African rice were obtained through a recently completed CRP on improving basic food crops in Africa through plant breeding including the use of induced mutations. Mutants of sorghum with long panicle length, improved grain quality and drought tolerance were obtained in Mali with the potential to yield 10–30% more grain than the parental variety. Presently, these mutants are being evaluated in multi-location field trials in Mali in co-operation with the International Crops Research Institute for the Semi-Arid Tropics. In the United Republic of Tanzania, mutants of upland rice (*Oryza sativa*) with increased yield, early flowering and short height were developed and are in advanced field trials.

A CRP on the application of DNA based marker mutations for the improvement of cereals and other sexually reproduced crop species concluded in 1996, laying the foundation for a better understanding of induced mutations at the molecular level. A comparison of the use of radioactive and non-radioactive markers showed that there is a place for both methods in the analysis of seed propagated species. Radioactive probes were used for the analysis of agronomically important traits in a number of species, including aluminium and drought tolerance in maize and resistance to barley yellow dwarf virus in wheat. Polymorphisms and selectable molecular differences were identified for blast resistance and salt tolerance in rice, and marker assisted selection has begun. The results achieved were facilitated by linking molecular biologists and plant breeders in developing and developed countries.

The use of linked DNA markers makes possible, for the first time, the large scale application of indirect selection for important agronomic traits. In order to implement these molecular technologies on a large scale in laboratories throughout the world, it is necessary to distribute DNA resources, including probes and primers. A CRP on radioactively labelled DNA probes for crop improvement helped to make available the necessary resources so that Member States can keep pace with developments in the fast changing world of marker assisted breeding. Major programmes in several developed countries are producing DNA resources for rice, wheat, barley, maize, sorghum, pearl millet, mungbean, cowpea and soybean. This CRP facilitates the distribution of DNA resources to laboratories in Member States. More than 210 requests for probes and primers have been fulfilled in 25 countries, with 40% of the requests coming from developing countries.

Techniques were developed at the FAO/IAEA Laboratory to regenerate ensete (*Ensete ventricosa*) through somatic embryogenesis and adventitious buds. This crop, which

is grown in Ethiopia and is an important starchy staple food crop, supports the diet of a quarter of the population. Owing to difficulty in germinating seed and the long vegetative period, the breeding of ensete is extremely difficult. No phenotypic variation was observed among the regenerants. Also, polyploids were induced in diploid banana and verified by flow cytometry. The polyploids were propagated for field testing in banana breeding programmes.

Animal Production and Health

To determine ways of increasing livestock productivity, radioimmunoassay laboratories for animal steroid hormone determinations have been established in over 60 countries. Using these resources, and through a CRP on the development of feed supplementation strategies for milk producing animals in tropical and subtropical environments using nuclear and related techniques, studies in Mexico showed the critical importance of supplementation feeding linked to innovative management. This finding led to an extension programme to improve dual purpose farming practices among 900 co-operating farmers in the region. The result was an increase in average milk production from 4.5 to 7.2 litres per cow per day (i.e. an increase of 63%), representing a rise in milk production of ten million litres per year.

Following similar studies supported under this programme in the Pucallpa region of Peru, a sustainable milk producing farming industry was created. The offspring produced 6–10 litres of milk per day without concentrates, generating a substantial increase of 60–80% in the daily income of farmers. The introduction of an artificial insemination scheme and an improved pasture production scheme amongst 80 farmers owning 2 to 15 cows each were key factors in this success.

In Sri Lanka, studies showed the advantage of grazing cattle on the natural herbage growing in coconut plantations. In grazed areas, coconut yields increased by 20%, with considerable improvements in soil fertility and water retention, while milk yields increased from four to ten times.

Brucellosis is a disease that affects both humans and cattle worldwide. In some countries, eradication has been possible through the slaughter of infected cattle, but this approach is difficult in many areas where vaccination is practised since it has not been possible to differentiate between infected and vaccinated animals. Under a CRP, a new test that can show whether an animal is free from the disease, vaccinated or infected was developed, standardized and internationally validated. Based on a competitive enzyme linked immunosorbent assay (ELISA) and using a monoclonal antibody developed at the Animal Disease Research Institute in Nepean, Ontario, Canada, studies in five Latin American countries have clearly demonstrated the advantages of this new assay, which will now have a large role to play in future brucellosis control and eradication campaigns.

Under a regional technical co-operation model project in West Asia, support was provided for sero-monitoring and surveillance of rinderpest. As part of the intensive drive to eradicate this disease from the region, nine countries undertook national surveys in 1996 using FAO/IAEA ELISA kits. The surveys demonstrated a reasonable level of vaccination in most countries, but also highlighted problem areas where levels of immunity were too low to prevent disease. For example, in the Kurdish communities in northern Iraq it was shown that less than 30% of the cattle were vaccinated; an emergency vaccination campaign was consequently undertaken. The FAO/IAEA Laboratory provided over one million assay units to Member States in 1996.

Insect and Pest Control

In a model project applying SIT for the eradication of the tsetse fly from the island of Zanzibar, United Republic of Tanzania, persistent suppression of the target fly population below detectable levels was observed. The last wild fly was captured in September 1996 and there have been no detections of flies since that time. Also, trypanosomosis in cattle declined rapidly, reaching the lowest levels ever recorded since routine blood sampling was established. The third insectary at the Tanga mass rearing facility in the United Republic of Tanzania was inaugurated. The total number of flies in the colony reached almost a million females, allowing aerial releases of 100 000 sterile males per week over the whole island. Furthermore, in view of the self-sufficiency achieved by the Tanga facility, the backup mass rearing efforts at the FAO/IAEA Laboratory were discontinued.

In Argentina, advances were made in the streamlining and upgrading of Mediterranean fruit fly (medfly) SIT eradication activities over half a million hectares of deciduous fruit producing land in Mendoza and Patagonia provinces. These advances included improvements in quarantine legislation, infrastructure and operations to

protect the territories under fruit fly eradication from reinfestation. Also, the creation of the Mendoza Plant Protection Institute to provide this joint FAO/IAEA model project with more efficient and independent programme management resulted in important economic savings and the active participation of fruit growers and exporters in programme funding and management. For the first time a medfly genetic sexing strain (in which mostly sterile males are released and where the detection of the remaining wild female flies among the sterile and wild male population is the main objective) developed at the FAO/IAEA Laboratory was being mass reared and released on a large scale in an operational SIT eradication programme. As a result of these advances, and production of over 200 million sterile pupae per week, the medfly has now been eradicated from most of Mendoza Province.

In Madeira, Portugal, the medfly SIT project, financed jointly by the Agency, the European Union and the Government of Portugal, also made rapid progress. A modern medfly mass rearing facility with a capacity of 50 million sterile male flies per week was completed. Installation of mass rearing equipment is being completed and mass rearing of a genetic sexing strain provided by the FAO/IAEA Laboratory was initiated, reaching five million flies per week at the end of 1996.

A breakthrough was achieved through a CRP in the development and field testing of a very promising attractant for the female medfly. Unlike available medfly lures which attract mostly male flies, this new attractant is mainly female specific. The results of field tests of this new attractant in 12 countries confirm the effectiveness of the product, which will soon be available commercially. Its use in operational SIT projects will greatly facilitate the use of sexing strains.

Agrochemicals and Residues

A CRP aimed at finding ways to increase the stability of acaricides in livestock dips was completed. The effects of pH, sediment, microbial activity and recharging frequency on the persistence of active ingredients were studied using radiolabelled acaricides in model systems. It was found that some compounds break down more rapidly as the pH rises and that the addition of superphosphate fertilizer was a practical and inexpensive method of maintaining a low pH level. Adsorption by sediment reduced the performance of all compounds, but the addition of a surface active agent increased the suspensibility of particles and thus extended the period during which animals receive an effective dose. Photodegradation also proved to be significant, indicating that the siting of dipping baths in the shade is important. As expected, degradation by microorganisms is significant, but unfortunately this programme could not identify an effective bactericide. Information on increasing the stability of acaricides can, of course, also be applied to the problem of the disposal of spent solutions when decomposition rates should be maximized. Thus, raising the pH and dispersing the solution over a soil surface in a sunny location are recommended to minimize possible undesirable effects on the environment.

A major objective of an FAO/IAEA symposium on the use of nuclear and related techniques for studying the environmental behaviour of crop protection chemicals, held in Vienna in July, was to examine the extent to which information on the environmental behaviour of pesticides can be extrapolated from one climatic zone to another. It was agreed that standard laboratory physicochemical data, together with information on pesticide metabolism and persistence obtained in temperate climates, could be used to provide a 'worst case' scenario for tropical countries. However, movement in the soil and losses by evaporation will almost always be underestimated, so additional climate specific data on these aspects is desirable. In addition, there is a need for information on the behaviour of these compounds in lateritic and volcanic soils, which are not common in temperate zones. There is also uncertainty over the validity of extra-polating toxicological data from temperate to tropical species and so appropriate studies are needed. There was strong support for the view that run-off and soil erosion play more important parts in the dissipation of pesticides in the tropics than elsewhere, so they should be taken into account in tropical environmental impact assessments. A final point of agreement was that information on impurities in pesticide formulations (products) is as important for environmental considerations as it is for human health.

The symposium also produced a number of conclusions and recommendations of interest to pesticide regulatory authorities and laboratories. The most important is that all such laboratories should now operate quality assurance and control procedures that comply with ISO Guide 25 and, where relevant, the OECD's *Principles of Good Laboratory Practice*, or equivalent standards. Only in this way will data be accepted internationally, something which is necessary if duplication is to be avoided.

Food Preservation

On the basis of results from a CRP on irradiation as a quarantine treatment of food and agricultural commodities which was concluded in 1990 and an evaluation by experts appointed by the International Consultative Group on Food Irradiation (ICGFI), the US Department of Agriculture issued a 'Notice of Policy' in May 1996. The policy recognizes the effectiveness of irradiation as a quarantine treatment of fresh fruits and vegetables against fruit fly infestation regardless of host commodities. The North American Plant Protection Organization (NAPPO), which consists of specialists on plant protection and quarantine from Canada, Mexico and the USA, issued a standard to this effect in October. Thus, the stage is set for the wider use of irradiation as a quarantine treatment of fresh fruits and vegetables against fruit flies, which should expand trade in these commodities significantly. In addition, research data generated by an ongoing CRP on irradiation as a quarantine treatment of mites, nematodes and insects other than fruit flies show that irradiation can make sterile thrips, mites and certain insects harboured in cut flowers (such as orchids, chrysanthemum, carnation and tulips), thus meeting quarantine requirements in importing countries.

A regional seminar on the use of irradiation to reduce food losses and foodborne diseases and to facilitate food trade was held in Rabat, Morocco. Co-sponsored by the Agency, FAO, the International Institute of Refrigeration, the International Trade Centre, WHO and the United Nations Economic Commission for Africa, it provided essential information on the technology and, in particular, the need to develop harmonized regulations on food irradiation in the African region. The seminar was followed by an AFRA II workshop on this subject in Ghana. This was attended by senior food control officials and food irradiation scientists who adopted a 'Model Regulation on Food Irradiation', which recognizes irradiation as a food process up to an overall average dose of 10 kGy, as recommended by the FAO/WHO Codex Alimentarius Commission.

As a follow-up to resolution GC(XXXVII)/RES/616, adopted by the General Conference in 1993, and the Action Plan described in GOV/2733, adopted by the Board of Governors in June 1994, the Agency assisted the authorities in Brazil, the Islamic Republic of Iran and the Philippines in conducting feasibility studies to establish commercial food irradiation facilities. The studies demonstrated the feasibility of establishing such irradiators in: São Paulo, Brazil; Rafsanjan, the Islamic Republic of Iran; and Manila, the Philippines. In all cases, public information seminars were organized to create an awareness of the safety and benefits of food irradiation among national authorities, the food industry and the media. In addition, a semi-commercial scale food irradiator, for which the Agency provided assistance as part of a model technical co-operation project, was commissioned in Beijing in early 1996.