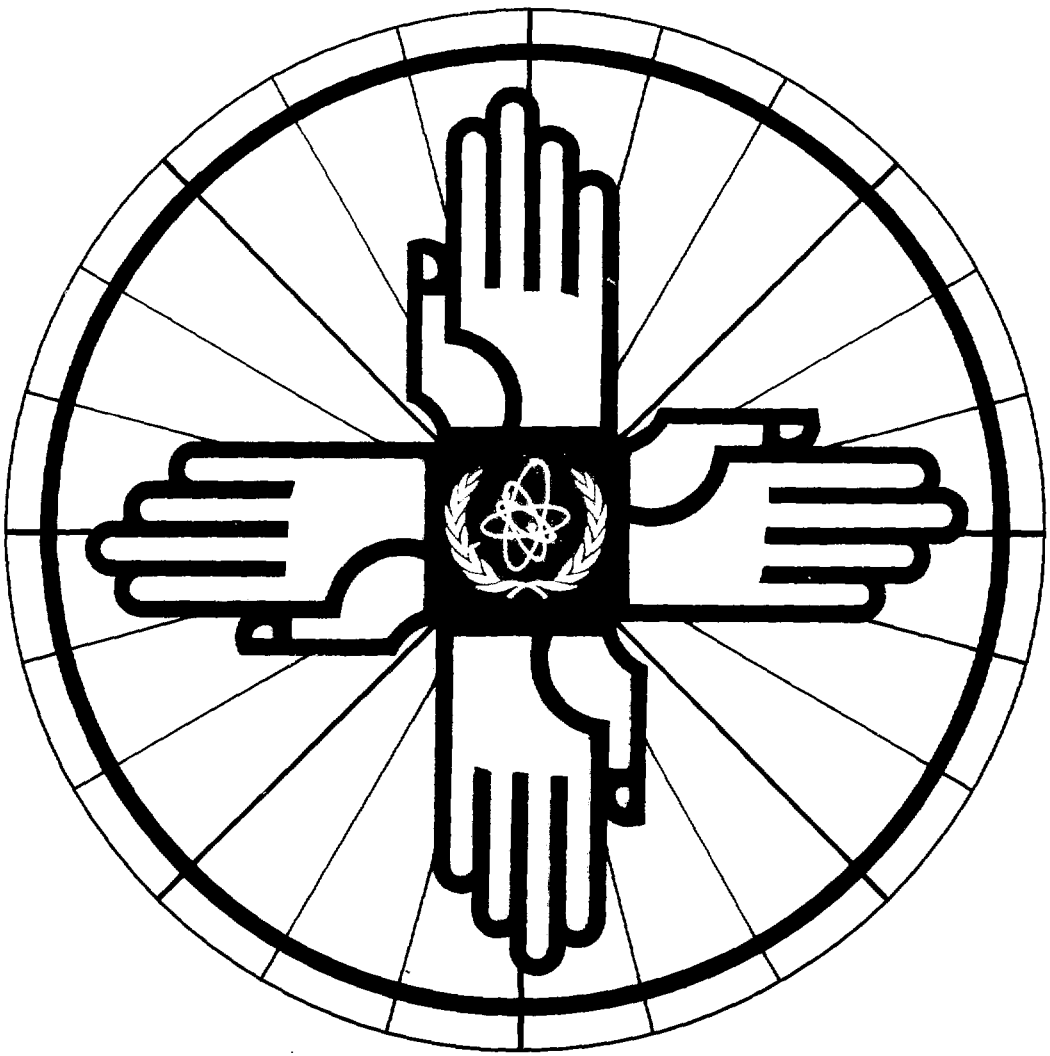
# Technology transfer for development



INTERNATIONAL ATOMIC ENERGY AGENCY

# Technology transfer for development

IAEA
Division of Public Information

1/2

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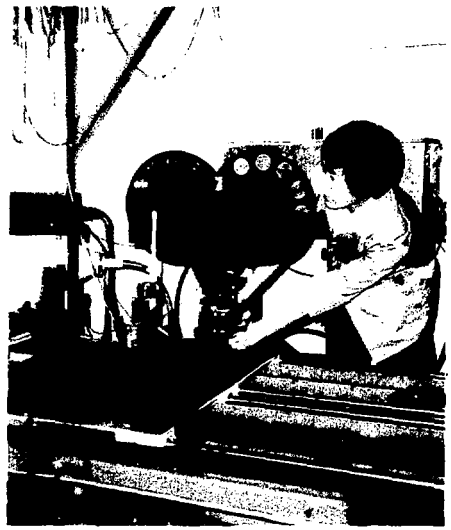
# Peaceful Uses of Nuclear Energy and the Technology Transfer Process

When the IAEA was established in 1957 relatively few countries possessed the know-how to apply nuclear technology for peaceful purposes. Many countries joining the IAEA recognised early on that they could strengthen their development efforts through technical co-operation to permit nuclear technology transfer for modern development.

Many nuclear technology applications have moved from research laboratories to routine use in hospitals, farms, industrial enterprises and universities with such clear results as: new and more productive species of important crops, new industrial manufacturing processes giving higher quality and safer components, properly sterilized medical products available throughout the world and improvements in the quality of health care as a result of new diagnostic procedures and treatment. Within the nuclear technology field, isotopes and radiation techniques have considerable potential

▲ Rice plant resistance to disease is one of the main objectives of mutation breeding.

Liver scintigraphy of a patient at Larkana Institute of Nuclear Medicine and Radiotherapy. ▶



Technician working with X-ray dosimetry in Korea.

Animal health in developing countries can be improved by the use of nuclear techniques.

to foster economic growth and improvements in daily life. They are being used, for example, to study environmental pollution, determine groundwater resources, analyse hormones, track animal and plant diseases and examine materials used in construction. Isotopes and radiation applications have come to play an important role in the technologies that engaged in providing us with basics such as food, water and a satisfactory standard of health because these methods have meant faster solutions to a number of practical problems, allowed a more direct approach to others and in some cases offered the only way to solve them.

## The approach adopted

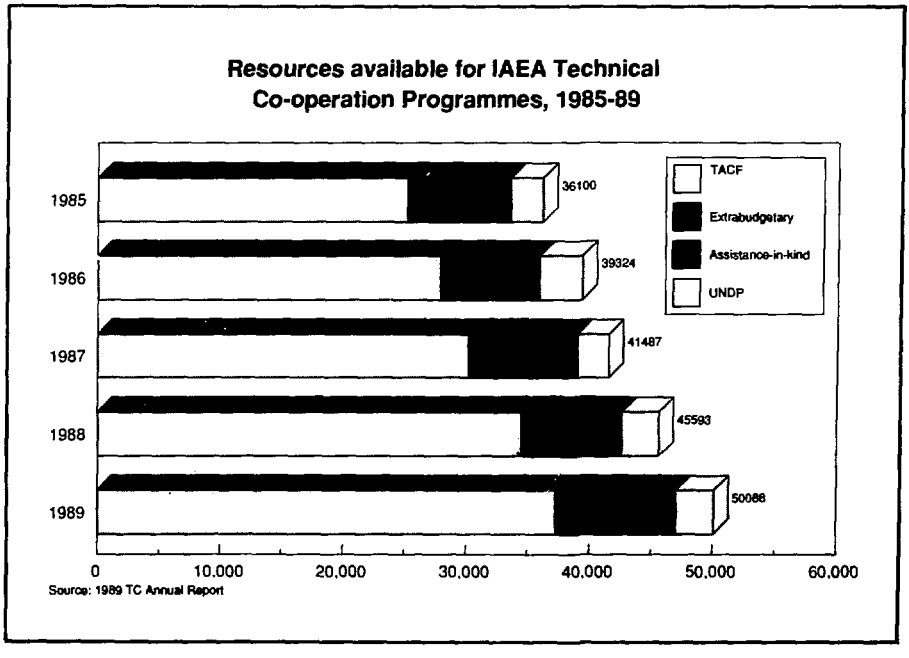
The IAEA has developed a multifaceted approach to ensure that assistance to Member States results in assured technology transfer. First, through advice and planning, the IAEA helps to assess the costs and benefits of a given technology, determine the basic requirements for its efficient use in conditions specific to the country, and prepare a plan for its introduction. In parallel, appropriate training is provided in the form of interregional, regional or national training courses, fellowships at leading scientific institutions, scientific visits or management seminars. The IAEA utilizes technical

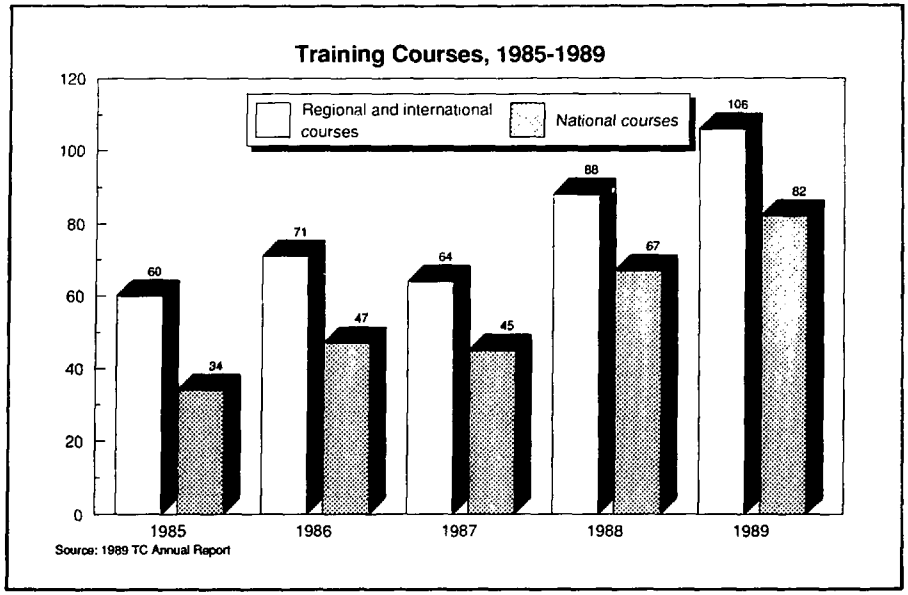
co-operation projects to bring together all the essential elements including training, expert advice and specialized equipment, to ensure effective technology transfer. Technology transfer usually proceeds from a source, normally in a developed country, to a recipient institute in a developing country, and then to end users.

A good example is the benefits of nuclear technology transfer to buffalo farmers in Asia. In an IAEA supported technical co-operation project initiated in Sri Lanka, radioactive tracer techniques were used to determine the life cycle of parasites, which led to the implementation of a simple remedy and significant improvements in buffalo calf health. The techniques were extended to other countries in the region.

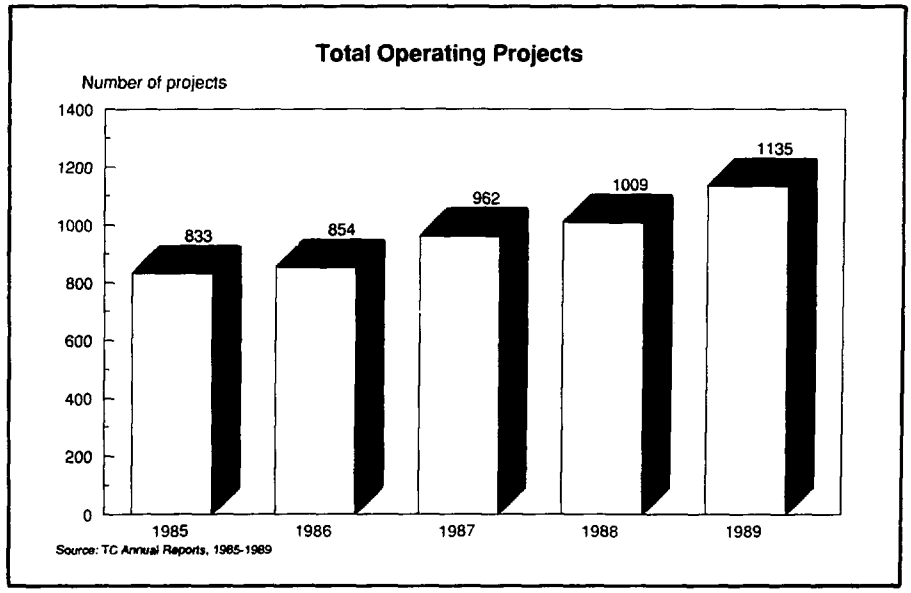
## Growth 1985–1989

The Project programmes are carefully designed with agreed target dates, to pool external assistance and a country's own resources into an organized effort, thus bringing a specific nuclear application into actual use. A measure of the success of this approach is that in the five years from 1985 to 1989 direct resources available to the IAEA for technology transfer support grew rapidly — about 18 percent per year (see below). Part of this is made



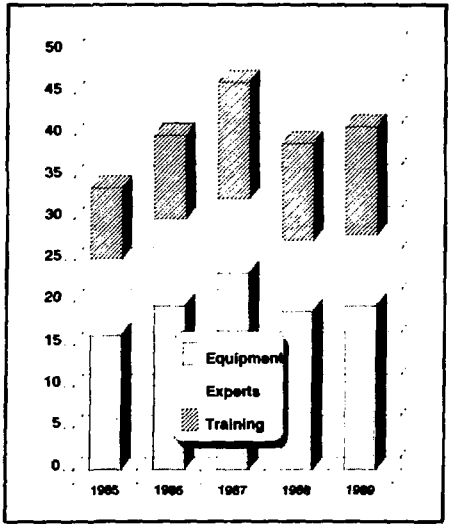



up by the voluntary contributions by Member States to the IAEA's Technical Assistance and Co-operation Fund (TACF) which rose from US $26 million in 1985 to $42 million in 1989. In this period, utilized IAEA funds provided $55 million for training, $41 million for expert services and $88 million for equipment and supplies. The growth in volume of projects, expert missions, and training is shown in the graphs.



In 1989 alone, more than 2000 professionals benefited from IAEA training courses and fellowship programmes. There were almost 2000 expert assignments undertaken. For training and expert assignments that year, IAEA funding provided US $16 million worth of equipment. Furthermore, as a result of the IAEA's human resource programme, a number of developing Member States have already established appropriate infrastructures and have acquired the capability to carry out, on their own, substantial parts of their nuclear programmes. Many of them have organized national training courses and have played leading roles in regional and interregional ones. They have also developed the capability at their institutions to provide training for IAEA fellows.

Distribution of funds in $million for equipment, experts and training. ▶




Laboratory expert lecturing at an interregional training course on the introduction and use of mutations in plant breeding. ▼

These financial resources understate the amounts actually gathered together by the IAEA and its Member States in support of expanding nuclear applications. The nuclear technology field in which the IAEA is able to provide assistance is broad, and this trend has not changed. Recently, there has been growing interest on the part of all Member States in nuclear safety and environmental protection.

The IAEA's four regional programmes — Asia and the Pacific, Latin America, Africa, and Europe and the Middle East — have proven to be effective means of putting together additional support through intensive regional co-operation. This allows developing countries to assist each other as well as involving regional industries directly in the technology transfer effort. In Asia and Latin America this kind of co-operation is already well under way and is a prologue to a much wider and more dynamic movement expected in the 1990s. While countries in Africa and the Middle East have been slower to go ahead in this direction, recent significant steps, it is hoped, will lead to major advances in these regions as well.

# Technical Co-operation Programme

The technical co-operation programme is the IAEA's primary vehicle for promoting the peaceful uses of nuclear energy. The Department of Technical Co-operation provides general administrative support for the programme, while both the Departments of Research and Isotopes and Nuclear Energy and Safety lend technical support. In 1989, for example, more than 172 technical officers supported the 1145 projects that were operational during the year. Guidance and support are given in areas that offer immediate benefit to Member States. These include fields related to basic human needs, industrial applications, electricity generation, radiation protection. This advances the contribution of atomic energy to world peace, health and prosperity.

## Assistance to Member States

The IAEA responds to Member States' needs for assistance in national projects which are supported by the government and counterpart institutions in the country. The IAEA serves as a participant, partner, and contributor to projects in which it, and Member States, share a vital interest. A key factor in this process is human resources development and institutional backing. Thus, with the provision of expert services, equipment and training through the Technical Co-operation Programme, Member States are guided on implementation of future atomic energy needs.

As regional and national infrastructures improve, regional co-operation becomes more important. This has already been demonstrated in programmes for the Asian-Pacific and Latin American regions. New programmes for regional co-operation are being proposed in Africa and Middle East under the United Nations Development Programme (UNDP). Co-operation among developing countries leads to mutual assistance, exchange of experience and personnel and facility sharing, all of which encourage an increase in the use of experts from developing countries themselves.

## Asia and the Pacific

The IAEA's Regional Co-operation Agreement (RCA), established in 1972 in Asia and the Pacific, contributes to the development of Member States through the application of nuclear technology.

The first project phase of RCA was formally incorporated into the UNDP Fourth Programming Cycle of 1982–1986. The UNDP has continued support for RCA projects through phase II of the Industrial Project (1987–1991) and two new food and agricultural projects. During the period 1986–1989 project budgets increased from US $1.8 million to $3.2 million.

## Achievements

In the period 1985–1989 there were many successful projects which enabled a transfer of technology to the benefit of the end users. They can be grouped into three major areas: industry and energy, food and agriculture, and medicine.

Industrial projects made the largest contributions to development in the region. Following a technology development programme on the radiation vulcanization of natural rubber latex, significant private investment in the technology is flowing into the Asian region. One commercial product in Japan, namely protective gloves, is already being produced using radiation vulcanization, and Indonesia is producing condoms and surgical gloves on a trial basis using this technology.

Technology transfer in nucleonic control systems (NCS), which measure key parameters in a manufacturing or production related process, is moving ahead steadily. In 1988, there were new NCS installations in paper mills in Indonesia and Thailand, and new NCS installations in mineral processing plants in India and Malaysia. The project brought further developments in NCS technology in four other countries in the region in 1989. Overall project sponsored application of nucleonic control systems to the paper, steel, mineral and coal preparation industries is expanding.

Parallel to this, radiation curing technology in the wood and allied industries is being introduced with an ultraviolet curing facility installed in 1988 in Jakarta, Indonesia — in addition to an electron beam facility created in 1984.

In the field of non-destructive testing (NDT), harmonization of NDT personnel certification is gradually being realized. Since NDT is used to test

Executive management seminar on industrial radiation curing technology, Jakarta.

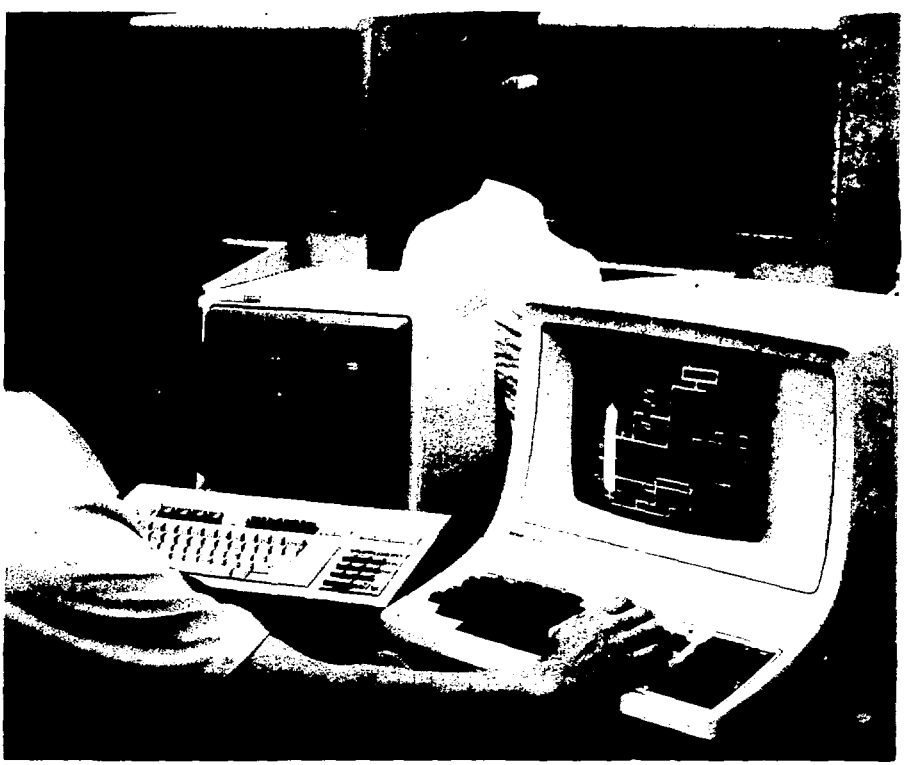
structures without their being affected, it can be applied to a wide range of industrial sectors. This increases the need for self-sufficiency in NDT techniques. In 1987, there were 5 courses and 30 trainees in the NDT self-sufficiency programme. By 1989, there were 25 courses and 220 persons trained.

A project to develop radiation cross-linking applications for the wire and cable industry, established in 1987, is assisting the spread of technology throughout the region, as is the introduction of tracer techniques in base industries which is supporting regional development.

In energy planning, workshops and training courses are being held to enable electricity power plant managers and the relevant electricity system authorities to plan expansion of the electric systems.

RCA is not only contributing, therefore, to technical co-operation in developing Asian countries, but is also reducing the technology gap between the developing and industrialized countries. This presents a major challenge to sustaining the rate of growth and development in the region in the future.

Simulators are used in energy planning and training activities in Asia and the Pacific region.



An example of a Chinese mutant of cotton which was grown within an area of 200 million hectares in China.

Blood sample being taken for progesterone measurement using radioimmunoassay in Thailand.

## Food and agriculture

There has been much progress in the agriculture sector with plant breeding. In the Punjab, for instance, 25% of the cotton growing area is now planted with a superior radiation induced mutant variety. Also, the RCA plant mutation breeding project has brought about the development of about 70 new varieties of grain legumes.

In the buffalo project, isotope techniques played a crucial role in determining the life cycle of a type of roundworm (*Toxocara utolorium*), which at one time was responsible for the death of 30 to 40% of calves in Sri Lanka. This led to the development of a cheap and effective control strategy.

To reduce food wastage and foodborne diseases, radiation can be used to inactivate food spoilage organisms, including bacteria, moulds and yeasts. The food irradiation project in the region to promote co-operation in the use of nuclear technology to reduce food losses and facilitate food trade is now entering its third phase. The first phase was mainly concerned with scientific aspects, the second with technology transfer to the food industry and the third with food irradiation control and acceptance.

## Medicine

Projects in the medical field have been particularly successful. The culmination of the IAEA's liver-imaging project has been the publication of a liver images atlas widely appreciated by physicians in developing countries in Asia and elsewhere. Another imaging project to produce a lung image atlas is well under way.

The RCA project on radioimunoassay (RIA) on thyroid related hormones has documented the possibility of reducing the cost per patient investigation by up to a factor of 10 using methods to allow for the use of bulk supplies of antibodies. Within the scope of this project there is a quality assessment scheme which provides for external quality control of the reagents. Also, sources within the region for reagent production and distribution are being organized. Given that over 100 million people in South-east Asia are affected with iodine deficiency disorders this is a significant step forward.

# Latin America

The regional programme for Latin America, known by its acronym ARCAL, formalized in 1984, now has 15 participating Member States with 12 projects under way in 1989. These projects represent priority areas such as agriculture, environment and radiation protection. They have, either directly or indirectly, a high social value content, having been carefully reviewed for technical soundness and viability.

## Infrastructure development

The IAEA's support for a network of institutions and qualified personnel made it possible to implement the infrastructure to establish radioimmunoassay (RIA) techniques for studies in animal reproduction. RIA techniques, used in a livestock research project at the small farm level, complemented traditional reproductive performance measures for milk, meat and fibre producing livestock. This project also generated information on livestock reproductive efficiency and on local livestock crosses with temperate zone breeds to increase productivity.

The first international ARCAL publication, entitled 'Livestock Reproduction in Latin America', with 32 research papers by 135 research workers, reflects the co-operation fostered by the ARCAL programme since its inception.

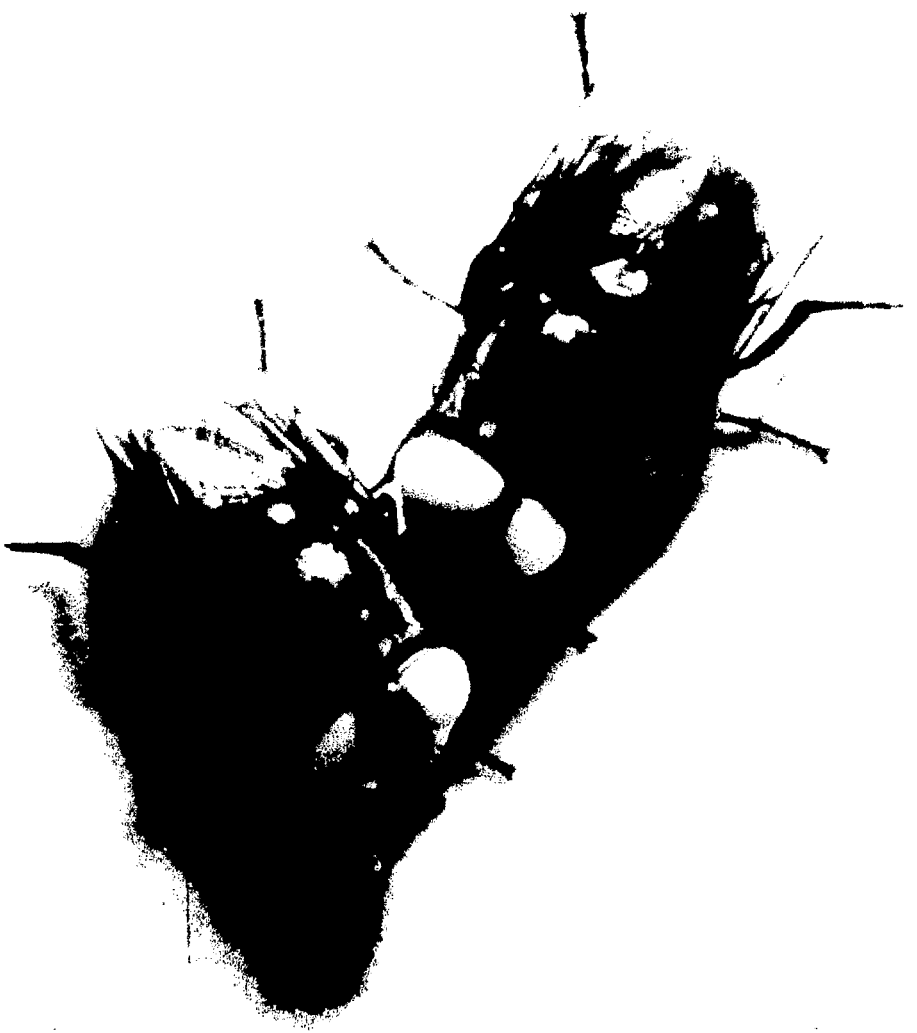
Another area of infrastructure development for social benefit is the research work carried out in ecology and hydrology. The large scale project on the Amazon Basin ecology, operational from 1979 to 1984, laid the foundation for further developments in the environment field. Co-operation between UNDP, the Centre for Nuclear Energy and Agriculture (CENA) at Piracicaba, Brazil, and the IAEA, established an important research infrastructure. This enabled CENA to develop from a small provincial laboratory to a major national centre in agricultural research and ecological studies. It currently collaborates with 52 other research institutes and universities, and about 150 government institutions and research centres.

## Agriculture and water resources

In plant genetics and mutation breeding, projects have led to development of improved varieties of sorghum crops in Venezuela and, for example, wheat and barley in Peru. These improved cereals are more resistant to the

Peruvian highland environment, so it has become possible to increase production and lower imports. At the same time, Guatemala, Mexico and Peru are applying the sterile insect technique (SIT) to control or eradicate insects that cause crop damage or harm animal health.

Tsetse fly.



Plant mutation breeding facilities at CENA, Piracicaba, Brazil.

Water resource investigation being carried out in 12 ARCAL Member States utilizes environmental isotopes to determine hydrological system characteristics, such as precipitation, water vapour, and surface water conditions. The results will be valuable in assessing the effects on the environment of changing the land usage. Using isotopes to explore geothermal energy sites is a key activity since many countries in the region have considerable geothermal resources; Mexico is the world's third largest geothermal electricity producer, while in El Salvador, geothermically generated electricity is the major source of power. Moreover, identifying aquifers for irrigation and sanitary needs utilizes isotopic hydrology. In Lima, for instance, scientists in an IAEA supported project are using isotope techniques to locate suitable aquifers to supply water for the sanitary demands, which at the moment are insufficient for a population in excess of 7 million.

## Developments

The programmes in Latin America in nuclear research, dosimetry, medicine, food irradiation and nuclear chemistry reinforce the need for radiation protection standards. Activities under way to bring about harmonization and standardization of radiation protection procedures include expert missions, dosimeter intercomparisons, equipment provisions, legislation workshops and radiation protection training and research work.

The expansion and successful development of these and other projects call for a greater share of technical assistance. The achievements surely point to further development and interest in nuclear applications for social and economic progress in that region.

# Africa

Among the 25 IAEA Member States in Africa there are vast differences in development and use of nuclear technology. In the light of this, and given that the first important step for a developing country is preparation of a sound development programme, more emphasis is being placed in the region on project programming, pre-project assistance, and radiation protection.

## Need for planning and co-ordination

More planning work in the region is essential to ensure effective human resource development and science infrastructure. Co-ordination meetings and group training, therefore, have come to play a vital role. For example, at a regional meeting in Tunisia, participants set down plans for future co-ordinated activities on regional nitrogen fixation using isotopic techniques. Eight countries are co-operating in this project and the primary objective is to reduce the need for nitrogen fertilizers and decrease the damage to water resources as a consequence. Another regional activity in 1989 was the coming together of participants from 6 countries to learn more about the use and safe handling of isotopes. Further to this, the technical assistance programme caters for projects with a common interest to a specific group of countries. This permits resource pooling to help solve subregional problems; for example the North Africa fruit fly infestation study in Algeria, Tunisia and Morocco, and hydrology studies in the Sahelian region (Mali, Niger and Senegal).

Rag soaked with insecticide. This technique is used to control the tsetse fly population in Nigeria.

A major project to control or eradicate a species of tsetse fly, using the sterile insect technique (in which radiation is used to sterilize insects), and insect traps, covering a project area of 1500 square kilometres in Nigeria, resulted in a marked decrease in trypanosomiasis in cattle. In Burkina Faso another project eradicated this pest from a pastoral zone of 3500 square kilometres. At the end of 1988, 14 Member States entered into a regional livestock project to do work in hormone assay disease diagnosis, and nutrition. The IAEA's Seibersdorf Laboratory in Austria is furnishing kits for various types of assays.

A standardized ELISA kit (enzyme-linked immuno sorbent assay) comprising reagents and equipment required to measure antibody levels in animal disease diagnosis.

## Radiation protection important

African governments consider radiation protection a priority. The IAEA has expanded the assistance it provides to African countries by drafting proper regulations, and creating adequate systems to supervise and ensure their efficient application. Seventeen African countries have been receiving IAEA assistance under national projects in radiation protection in the past 5 years. One example is the meetings held in Tanzania, where chief radiation protection officers from 9 countries discussed the establishment of a regional radiation protection project. IAEA assistance covers such activities as formulation of laws, regulations and codes, provision of radiation monitoring equipment, calibration and dosimeter processing, and environmental sampling services. Member States are also benefiting from an interregional project which provides missions by the IAEA's Radiation Protection Advisory Teams (RAPATs). So far, 15 African countries have received RAPAT missions. These are instrumental in initially assessing the state of radiation protection and rendering advice on the total requirements of a sound radiation protection programme.

Co-operation and organization of regional courses have increased. In 1989, Algeria, Zambia, Senegal and Sudan hosted regional courses in nuclear medicine, preventative maintenance and quality control of nuclear equipment, nuclear instrumentation maintenance, hydrology and soil and plant nutrition.

Workshop on radiation protection.

## New regional agreement

Owing to the increase in technical co-operation in nuclear applications in Africa the IAEA endorsed a proposal put forward by African Member States to create a regional agreement known as the Africa Regional Co-operative Agreement (AFRA). Approved by the IAEA Board of Governors in February 1990, this agreement will broaden the scope for technical co-operation, in which there are many common problems, such as difficult climatic conditions, power supply problems, and the lack of proper maintenance facilities for nuclear equipment. The benefits derived from a more formal regional co-operation framework have led African Member States to take concrete steps to ensure further technology transfer and benefit to society.

# Technical Co-operation for Nuclear Techniques in Food, Agriculture and Environmental Protection

The use of nuclear techniques in food, agriculture and environmental protection is part of the IAEA's activities to enhance international developments in nuclear technology that are beneficial to society and environmentally sound. There has been growth particularly in the application of nuclear energy to solve environmental problems through the IAEA's technical co-operation programme and IAEA support in general.

Looking at project activities, the application of isotopes and radiation in agriculture gained top priority again in 1989, accounting for 20% of all disbursements in the technical co-operation programme. While the joint FAO/IAEA programme, initiated over 25 years ago, has established a sound basis for isotope and radiation applications in food and agricultural development, the number, scope and diversity of projects are increasing all the time.

For projects in food and agriculture, technology transfer through technical co-operation and exchange has taken place in the fields of: optimizing fertilizer and water use, animal health, pest control, enhancing biological nitrogen fixation, mutation breeding, increasing livestock production, food preservation, and pesticide residue studies. Along with this diversity, there are marked increases in the IAEA's nuclear energy programmes from the point of view of: environmental monitoring, environmental impact and conservation — especially to build a reliable database on different types of health and environmental impacts imposed by the total energy system cycle.

## Activities and developments

### Food irradiation

Food irradiation, which uses the radiation energy of gamma rays, X-rays, or electron beams to preserve foods, is used to counteract high food losses from infestation, contamination, air-borne diseases and spoilage. A range of national and regional research and training programmes are supported through the joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. The Asian and Pacific countries, for example, are participating in an FAO/IAEA regional food irradiation project directed at the transfer of the technology to local industries. Food irradiation technology has now been transferred to several countries in the region. Establishment of food irradiation technology is being carried out in Latin America, Europe, the Middle East, and Africa through IAEA backed co-ordinated research programmes. The IAEA, in co-operation with WHO and the FAO, plays a major role in the development of standards for irradiated food processing. This assists Member States in the control of international trade of irradiated food.

### Soil fertility

Nitrogen fertilizers, widely used to increase agricultural production, can harm the environment. Nuclear techniques are used to trace fertilizers to determine their best form, timing and placement to avoid wastage and reduce movement into the environment. Tracers and radiation are also used to detect, measure and track fertilizer-supplied nutrients in soil and plants, determine the availability of soil moisture and thereby promote crop production. Research on atmospheric nitrogen fixation extended to trees, demonstrated how this technique aids soil fertility and helps prevent erosion. Also,

work on soil and its water supply is being done. Tests with neutron moisture gauges show that traditional irrigation methods can be improved to cut total water use by 40%.

Soil microbiology analysis at the IAEA laboratories, Seibersdorf.

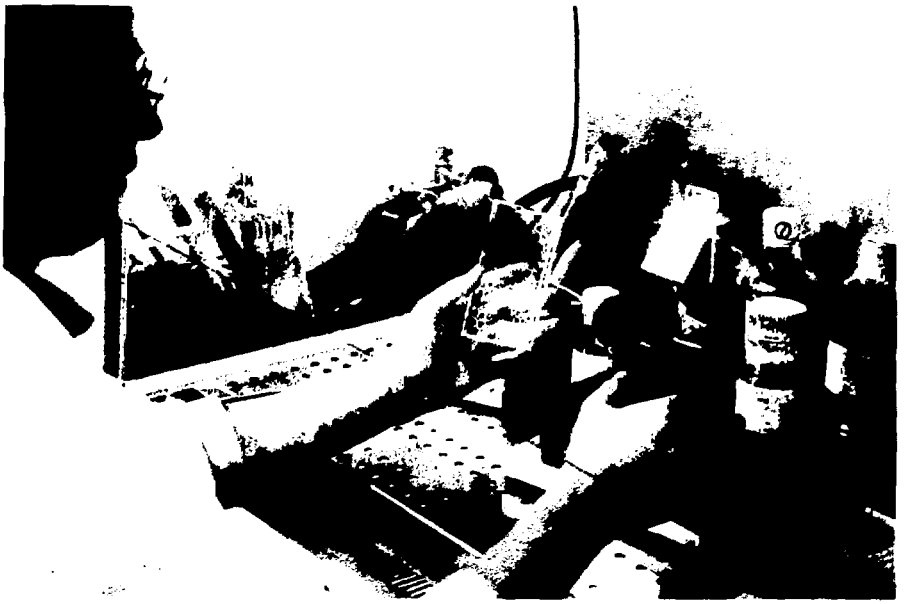
## Plant breeding and genetics

Nuclear techniques to develop new strains of important food crops have yielded over 1300 new varieties of many different crop species which better resist disease and are of higher quality and yield. During 1989, for example, 200 new cultivars were developed, and the IAEA increased support to Member States in the proper application of the necessary associated mutation breeding techniques.

## Animal production and health

Sensitive techniques using radioactive tracers are used to improve production and health of cattle, buffalo, sheep and goats. There are continuing improvements in domestic buffalo productivity in Asia, and for sheep and goats in both Africa and Asia due to the use of nuclear techniques. Similar methods are used to determine disease-causing agents in animals. To make these techniques easier to use in the field, the IAEA produces standardized kits in its Seibersdorf laboratory. Laboratory staff distributed more than 500 000 assay units to Member States for progesterone determination and a similar number for monitoring antibody levels to rinderpest.

Opening of the new Seibersdorf Med-fly laboratory. From left to right: Dr. Hans Blix, Director General of the IAEA, Amb. Mohamed EL-Taher Shash (Egypt) and Amb. Rosenzweig-Diaz (Mexico).



Scientific support at the Seibersdorf laboratories is an integral part of the Joint Division's programme.

## Insect and pest control

There is ongoing success in applications of the sterile insect technique (SIT), which can be used for the erradication of dangerous insects and pests that account for substantial losses in food supplies, animal production and even human lives. The SIT is being further developed at the Seibersdorf laboratories, in conjunction with mass insect rearing facilities, using methods developed by the FAO/IAEA Joint Division. These are to be used for new sterile insect technique projects, including planned eradication of the New World screw worm from North Africa.

## Ecology studies and projects in the Amazon basin

The Amazon basin, covering 600 million hectares, is the world's largest river catchment area, and has one third of the world's tropical rainforest and one tenth of global terrestrial primary production. Because of the sensitivity of isotopic methods, they have provided an excellent tool for measuring the effects of changing land use on ecology and climate, with data collected on vapour movements, stream flow, sedimentation, water quality, plant productivity and soil changes.

A large scale interdisciplinary project carried out in the Amazon basin during 1985–1989, developed improved techniques for optimizing plant and fertilizer utilization. Careful selection of key sites helped to maximize multidisciplinary work. For example, work on soil organic matter has relevance not only to the carbon cycle, but also to the nutrient cycle, soil fertility and crop rotation. Nuclear techniques, used for studying the nutritional and water cycles in the region, have demonstrated climate changes and the fragility of the Amazon ecology. Since 1984, finance for this large project has come from the IAEA's Reserve Fund: of over $2 million spent on this project about 40% consists of contributions from donor countries, primarily Sweden. The work carried out by CENA in conjunction with the IAEA is providing a sizeable impact on the ecological management of the region.

## New environmental studies

Using the data collected after the Chernobyl nuclear accident, the IAEA has established programmes to validate the models used for the radiological assessments. The IAEA is working together with a growing network of researchers to validate long range models for the transportation of atmospheric pollutants. It is also checking the results of models for radionuclide transfer in terrestrial, urban and aquatic environments.

Uptake of tritium in corn plants, Philippines.

In the aquatic field, marine pollution is an important concern especially with the increase in large oil spills. The International Laboratory of Marine Radioactivity (ILMR) in Monaco, established by the IAEA, is a worldwide data quality assurance centre for marine contaminants. This facility provides good possibilities to evaluate spatial or temporal trends in contaminant concentrations. Also, work is being done at the ILMR to define criteria (and in some cases legislation) for coastal water quality as well as interpret studies on the effect of pollution in biology in general.

### Hydrology

In hydrology and water resource management, the IAEA is currently carrying out three regional projects in Africa (one in the Sahel zone, one in the Nile valley and one in North Africa), in addition to more than 50 national programmes in developing Member States. Some of the activities in this area include: determination of origin, age, amount of, and mechanism for groundwater recharge; groundwater flow direction and velocity; aquifer characteristics and seepage.

# Nuclear Medicine

Through its Division of Life Sciences and Department of Technical Assistance and Co-operation, the IAEA has implemented the widespread use of radionuclides (radioactive materials) for diagnosis. Technology developed in recent years has refined diagnostic capabilities to such an extent that it is possible to measure changes in genetic material such as DNA. This is particularly beneficial to developing countries where parasitic communicable diseases are serious health problems.

Nuclear techniques for medical and biological purposes are used today in more countries and in more laboratories than for any other nuclear application. Since there is a great diversity in methodologies using radionuclides, the IAEA's programme in this field supports many small activities tailored to the needs of individual Member States.

The IAEA plays an important role in technology transfer, implements nuclear techniques and aids in the establishment of nuclear medicine units

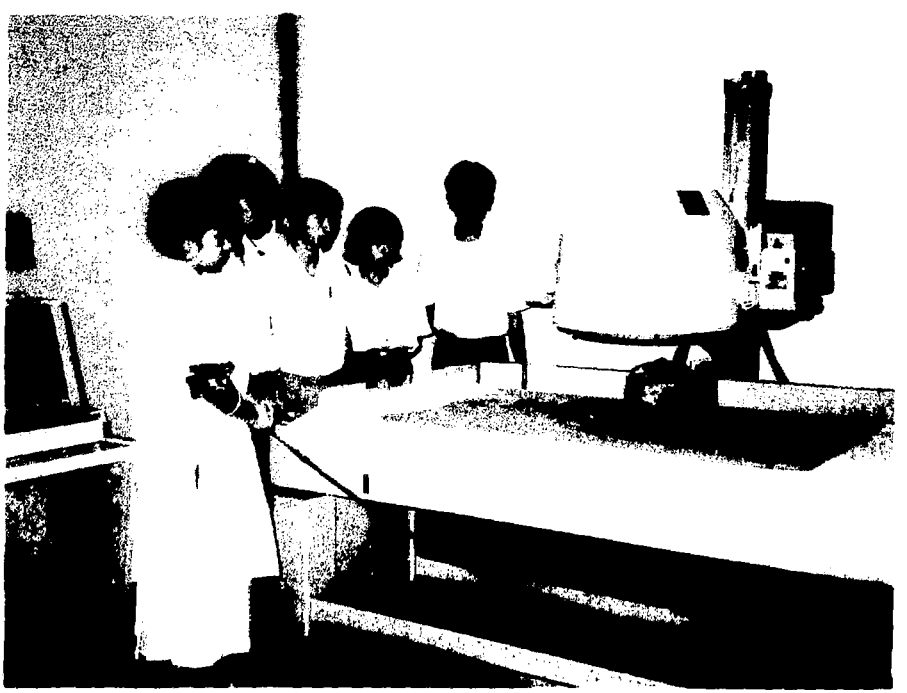
in hospitals. This is often done in collaboration with the World Health Organisation. In their collaboration, both organisations carry out programmes to strengthen the local capability for the use of radionuclides and radiation to support public health initiatives in developing countries.

## Advances in radiochemical techniques

A convenient way to look at the IAEA's activities is through the two major nuclear medicine fields. One of these is in vivo nuclear techniques, which involves administering radioactive molecules to the patient. The path of these molecules can then be observed through the organs using graphic images to dynamically assess blood flow and specific functions.

To raise the general standard of clinical diagnosis, the IAEA established a programme under the Regional Co-operative Agreement (RCA) in Asia and the Pacific, to evaluate nuclear imaging procedures for the diagnosis of liver and lung diseases. A liver imaging atlas, compiled in this programme, has resulted in an increase in the probability of better interpretation of images. Work is being done with normal and diseased livers to find

Medical students studying images created by nuclear imaging techniques.



the clinical conditions best suited for either nuclear or ultrasound liver imaging.

The other medical field, in vitro techniques, involves adding specific radiolabelled antigens to patient blood samples to measure minute concentrations of certain substances in body fluids, such as hormones, vitamins and drugs. These techniques have the generic name radioimmunoassay (RIA). The IAEA has served to speed up RIA development in many countries, and has often pioneered its introduction. It promotes RIA technology in developing countries by assisting laboratories to obtain low cost reagent supplies, and to monitor RIA quality in general.

The IAEA has created a programme through RCA to promote production and use of bulk reagents for RIA, and has significantly reduced the cost of the assays for thyroid related hormones. A similar programme has been introduced in Latin America. Further to this, ten regional laboratories in Asia have been carrying out clinical trials to develop a strategy for executing in vitro thyroid function testing since 1988. Additionally, the IAEA introduced a new programme to develop radioimmunoassay techniques for the diagnosis of parasitic diseases, for example, malaria, and infectious diseases, for example tuberculosis. These types of diseases are mainly found in developing countries.

## Radiation biology and radiotherapy

For the development and implementation of its radiotherapy programme, the IAEA has taken into consideration the up-to-date health care needs of developing Member States. Technical co-operation projects have had as their aim the enhancement of local skills. This is done by developing the radiotherapeutic competence of physicians and physicists, and the provision of equipment.

There are three major beneficial health applications utilizing radiation: cancer radiotherapy, radiation sterilization of disposable medical supplies and tissue grafts, and radiation disinfection of sewage sludge for safe reutilization.

The use of radiation sterilization techniques has helped an increasing number of developing countries to implement national programmes to provide sterile medical disposables and biological tissue grafts as demanded by health care services. Technology transfer in this field has enabled these countries to independently meet the needs for radiation sterilization on an economically viable basis. Availability of sterile supplies has improved safety in health services because this can decrease the incidence of cross-infectious diseases. Documents published by the IAEA have provided guidance on the technical criteria and standards to help upgrade the quality

of radiation sterilized medical supplies. Documentation has also helped in assessing sterility safety levels applicable to the validated sterilization process concerned.

### Other health related applications

Isotopes and radiation have numerous other applications in relation to health, especially in dosimetry, nutrition research and health related environmental studies. The IAEA assists Member States, particularly developing countries, by providing analytical quality control services and advice on methodology.

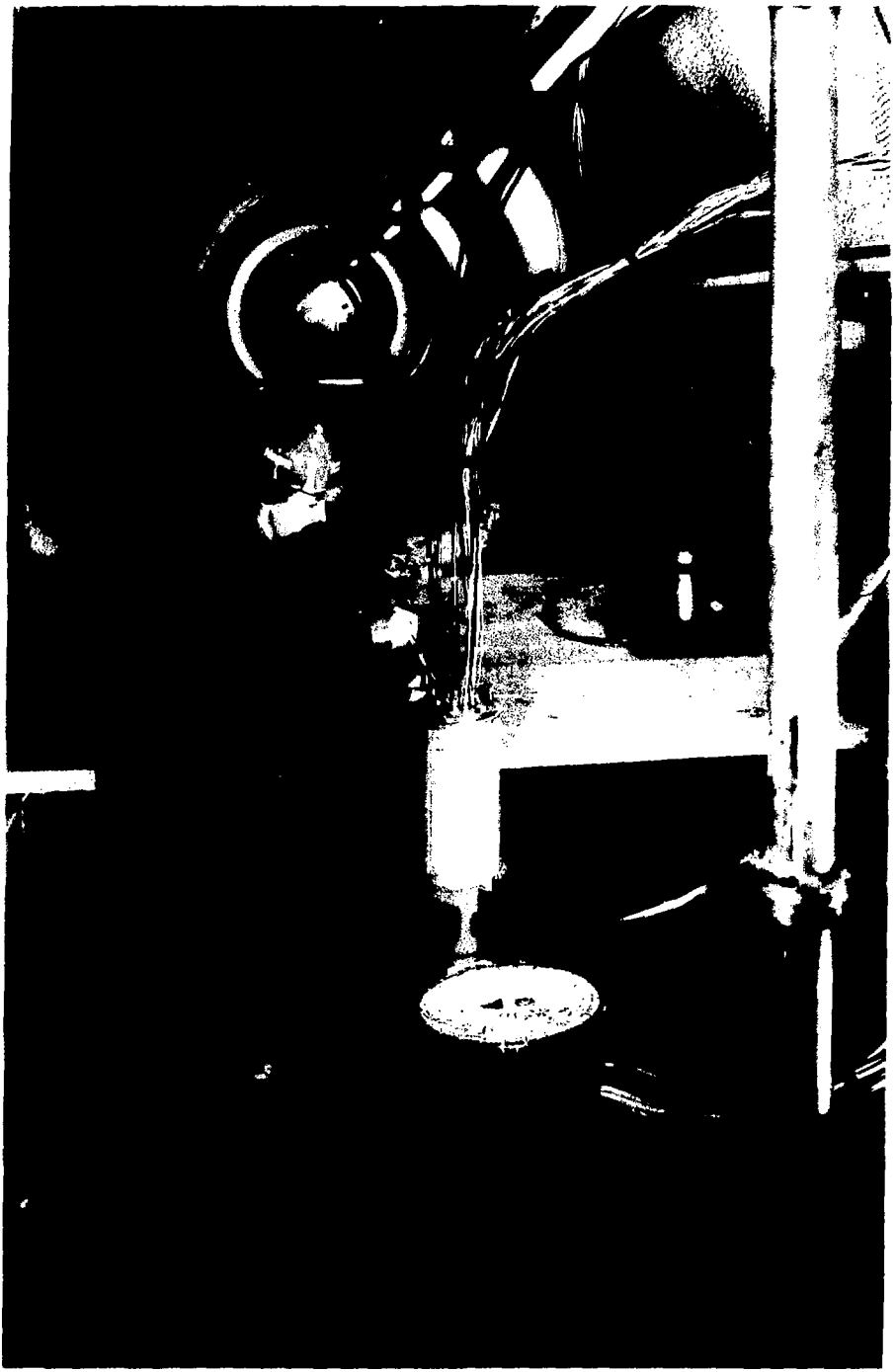
One of the most important applications of nuclear techniques in nutrition is the study of trace elements, such as iron and selenium. Nutritional deficiencies of these elements affect hundreds of millions of people throughout the world. Recent international studies supported by the IAEA, in collaboration with WHO, have provided new data on dietary intakes of trace elements, which are a basic necessity for recommended dietary allowances (RDAs) for these elements. The IAEA also supports the use of stable isotope tracers, which have important applications in the study of protein turnover and energy expenditure in humans.

# Radiation Safety

Today thousands of radiation sources, including nuclear facilities, are used all over the world to support medical, industrial, energy, research, or agricultural needs. In addition, millions of consignments of radioactive materials are transported around the world every year. All this requires regulatory and technical measures for the safety and protection of both workers and the general public.

### Radiation protection compliance

Any country using radiation sources must establish basic regulatory measures and the necessary technical infrastructure to ensure radiation safety. However, many developing countries still do not have adequate radiation protection capabilities for their increasing usage of radiation sources and



Safety is a vital component in all nuclear energy activities.

facilities. These countries simply lack the necessary infrastructure for implementing a policy based on international standards. Too often, basic legislation and supporting regulations are wanting. To compound the problem, trained and knowledgeable personnel are in short supply, with no long erm strategy in place to help correct the general situation.

While radiation safety is primarily a national responsibility, the IAEA offers technical assistance to Member States requesting help in developing new, or strengthening existing, radiation protection infrastructures. Technical assistance may take the form of expert advice, education and training, co-ordinated research and information exchange.

## Developments

The IAEA, since its inception in 1957, has taken up a programme to establish safety standards for the protection of health and to minimize danger to life and property. Under this programme the IAEA issued The Basic Safety Standards for Radiation Protection. This document was last updated in 1982 by the IAEA, the International Labour Organisation, the World Health Organisation, and the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development. The safety standards are currently supplemented by a set of associated Safety Series publications, to assist in their correct implementation. These safety standards are based on the recommendations of the International Commission on Radiological Protection and are being constantly updated. The new revisions of the recommendations are expected by the end of 1990.

The IAEA's Regulations for the Safe Transport of Radioactive Materials have been widely adopted by virtually all Member States and by international organizations concerned with transport, such as the International Civil Aviation Organization and the International Maritime Organization.

To assist requesting Member States in their radiation safety programmes, the IAEA, in 1989, implemented more than 150 technical co-operation projects amounting to nearly US $10 million; this represents an increase of 13 percent over the previous year.

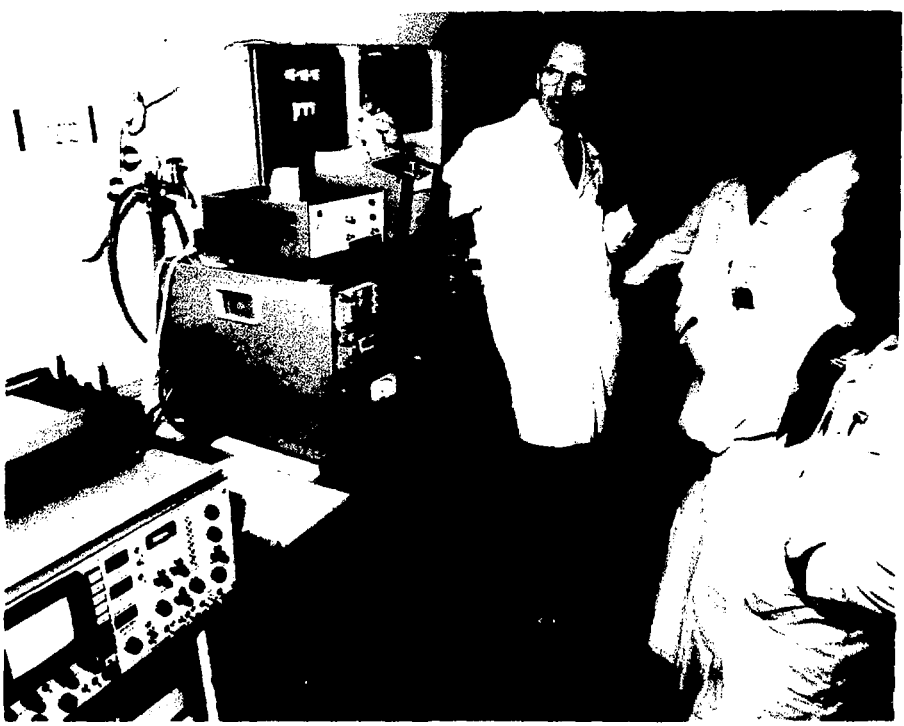
## Ensuring radiation safety

International standards and recommendations are the primary factors ensuring radiation safety. They must be applied to those working directly with ionizing radiation, by the authorities charged with overseeing the safety of these activities, and by the host of other professionals and skilled personnel whose work bears on safety performance.

The standards alone are not sufficient for overall radiation safety. Education and training are equally important for developing safety consciousness. The IAEA operates a fellowship training programme under which fellowships or scientific visits are provided to requesting Member States for training in a specialization or subject area. Also, the IAEA sponsors relatively long term general education courses, specialized training courses, and issue-oriented workshops for practitioners. One characteristic of the IAEA's policy is regional training in the official languages of the United Nations. Others are the preparation and broad dissemination of practical training materials and the concentration of the IAEA's efforts in universities, training centres and other well-established institutions in Member States. In this way the IAEA helps to build national capabilities for training local technical personnel.

Since 1981, the IAEA awarded post-graduate diplomas to over 100 radiation safety professionals from 20 different Member States through its course at the University of Buenos Aires, Argentina. A similar post-graduate course, sponsored by the IAEA, was held in Trombay, India, and such courses in French and Russian are envisioned.

Radiation safety workshop.



Specialized training on the safe handling of sealed and unsealed radioactive sources organized in 1989 and the first half of 1990, will be continued on a regular basis.

Looking ahead, the IAEA's training programme in radiation safety includes courses in several languages on such topics as the regulatory aspects of radiation protection, the safe transport of radioactive material, emergency preparedness, and the safety of radiation sources.

## Radiation safety services

The IAEA's radiation safety service employs teams of international experts to advise on the technical co-operation and assistance programmes needed to strengthen radiation safety. Member States have shown increasing interest in this service and the number of requests for assistance have grown. Since the Radiation Protection Advisory Team (RAPAT) programme began late in 1984, there have been nearly 50 missions to developing Member States to define infrastructural problems and to recommend long term strategies for assistance, tailored to each country's requirements.

With the trend towards greater use of radiation sources and practices in most developing countries, governments have become increasingly aware of the benefits of regional co-operation. Starting in the mid-1980s, the IAEA has assisted in the establishment of regional co-operation projects for Member States with cultural, political and geographical affinities. Regional projects in radiation safety are now under way for the countries of the Asia and Pacific region, for the Latin American region, for the Middle East and, most recently, for Africa.

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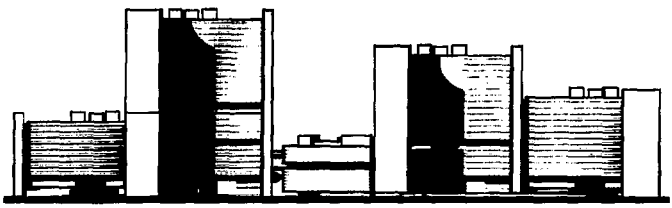

The International Atomic Energy Agency (IAEA)
shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world.
It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose.

(Excerpt from IAEA Statute)

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