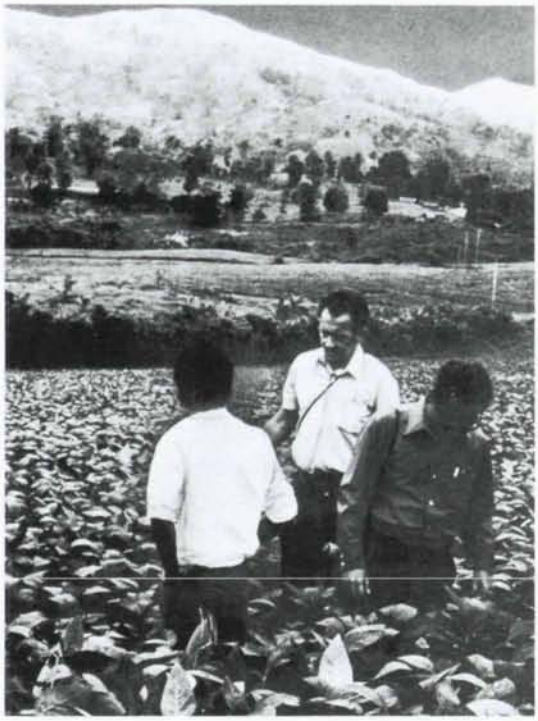

Regional co-operation for technical progress

Reports on IAEA programmes in Latin America and in Asia and the Pacific

by Mohammad Ridwan and Peter L. Airey

Successful applications of nuclear science and technology in the developed world are now being pursued by many countries in Asia, Africa, and Latin America. It is a natural, and indeed inevitable, development that began more than half a century ago.

Yet creating conditions in which nuclear science and technology can contribute to a country's development is not an easy task. The necessary precursors include: adequate manpower and facilities to generate it; a basic research programme to act as a springboard for technological development; and an adequate infrastructure and resources to carry forward the programme.* In most developing countries, these preconditions are not found. External support must therefore be provided for the consolidation of the progress that has been possible, and for the realization of the true potential of nuclear science and technology to improve the well-being of the people.

Therefore, one mandate of the IAEA is "to accelerate the contribution of atomic energy to peace, health and prosperity throughout the world". One of its most important activities is the provision of technical assistance to Member States where nuclear science and technology can contribute to solutions of scientific, agricultural, medical, industrial, and energy problems.

Activities in which the IAEA provides technical assistance can be divided into the following four major areas:

- Basic human needs, including water resources management, agriculture, livestock, and health care
- Industrial applications, covering industrial control using radioisotopes, radiation processing such as surface coating, radiation sterilization, hydrology, radioisotopes and radiopharmaceutical production, and food preservation
- Electricity generation, including exploration and exploitation of nuclear raw materials, fuel element fabrication technology, metallurgy and materials testing, research and power reactor design, and energy planning
- Support for nuclear safety — including areas related to regulation, safety standards, radiation protection and dosimetry, waste management, maintenance of nuclear instruments, physics, and chemistry.

Regional co-operation and planning

There are a number of approaches to the provision of technical assistance. Most commonly, the IAEA deals directly with Member States, seeking a comprehensive identification of national priority projects to which nuclear science and technology can contribute.

However, in recent years, the IAEA has become increasingly involved in regional activities. Regional planning is seen as a way of accelerating moves towards self-sufficiency in scientific disciplines and appropriate

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* Iyengar, P.K., "Role of research in nuclear science and technology", IAEA-SM-291/2.

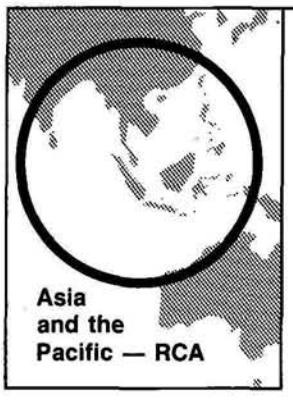
Photo above: Using radiation to induce mutations in plant breeding has been an ongoing emphasis of IAEA's regional programmes. Shown here are participants at a 1975 IAEA Seminar in Sri Lanka that focused on grain legume production.

technologies by co-ordinating intellectual and physical resources of Member States. Specifically, regional projects can facilitate:

- Technical co-operation among developing countries (known as TCDC)
- A greater sharing of resources, including facilities, equipment, and manpower
- A greater pooling of knowledge and close communication and collaboration between the scientist in the region.

The existence of a regional programme also provides strong evidence of the clear interest of developing Member States in collaborating for their common good; thus, the potential is far higher for the effective use of the assistance provided.

Currently, IAEA has two regional co-operative agreements, one in Asia and the Pacific and the other in Latin America and the Caribbean. In addition, some regional projects are also being implemented, not only in these two regions, but also in Africa, the Middle East, and Europe.



Since 12 June 1972, when it entered into force, the IAEA's Regional Co-operative Agreement for Research, Development, and Training Related to Nuclear Science and Technology (RCA) for Asia and the Pacific has been extended twice for periods of 5 years. Its specific aim is "to promote and co-ordinate co-operative research, development, and training projects in nuclear science and technology through appropriate national institutions".

The following 14 countries are now party to the agreement: Australia, Bangladesh, People's Republic of China, India, Indonesia, Japan, Republic of Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, and Viet Nam.

There are currently 14 projects under the RCA umbrella. Originally, they were all involved with medical and agricultural applications of nuclear techniques, and the basic science using research reactors. However, at IAEA's 1976 General Conference, RCA Member States urged the Agency to take steps toward initiating a large-scale regional industrial project funded by the United Nations Development Programme (UNDP). This led to the successful UNDP Industrial Project that is about to enter its second phase. *(See the accompanying table for RCA project activities.)*

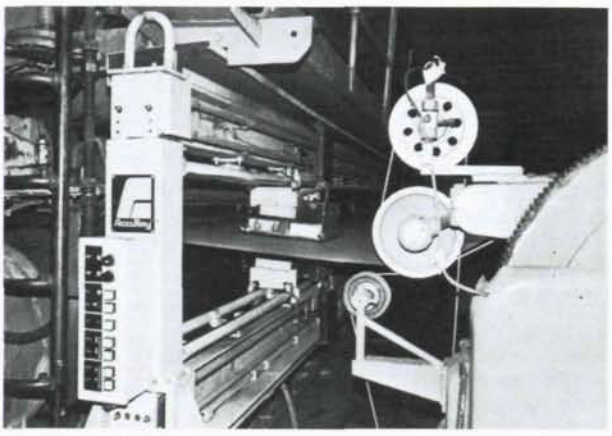
Project activities in Asia & the Pacific under RCA

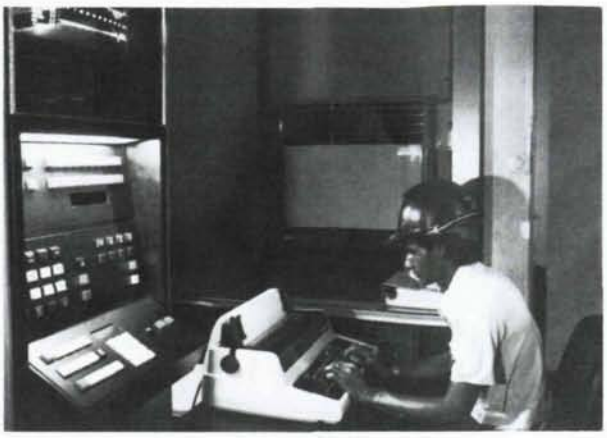
Project	Funding
Medicine	
• Improvement of cancer therapy	Japan, CRP, TC
• Imaging procedures for the diagnosis of liver diseases	Japan
• Data processing in radioimmunoassay (training course)	TC
• Nuclear medicine (training course on radioimmunoassay)	India
• Nuclear techniques for tropical parasitic diseases	CRP
• Development of technetium-99m generator system	CRP
• Sterilization of biological tissue grafts	CRP
Agriculture	
• Nuclear techniques to improve domestic buffalo production	CRP
• Regional project on food irradiation (Phase II)	Australia
• Semi-dwarf mutants for rice improvement	CRP
• Mutation plant breeding (training course)	TC
• Induced mutations for improvement of grain legume production	CRP
• Isotope applications of hydrology and sedimentology	Australia/CRP
• Nuclear techniques for toxic elements in foodstuffs	CRP
• Environmental research monitoring (training course)	TC
Industry	
• Regional UNDP (RCA) project on industrial applications of isotopes and radiation technology	UNDP, TC Japan, Australia
Sub-projects	
• Tracer technology in industry	
• Non-destructive testing	
• Radiation processing	
— radiation vulcanization	
— surface coating of wood products	
— radiation-induced modification of wire and cable insulation	
— radiation sterilization of medical products	
• Nucleonic control systems	
— Paper industry	
— Steel industry	
— Minerals	
• Nuclear instrumentation maintenance	
General	
• Basic science using research reactors	India
• Maintenance of nuclear instruments	CRP

RCA = the acronym for the IAEA's Regional Co-operative Agreement for Research, Development, and Training Related to Nuclear Science and Technology for Asia and the Pacific.
UNDP = United Nations Development Programme.
CRP = Co-ordinated Research Programme, IAEA Department of Research and Isotopes.
TC = IAEA Department of Technical Co-operation.

RCA projects: Medicine and biology

The widespread use of isotope techniques in health care and radiotherapy is reflected in a number of RCA activities. Projects in the field of cancer therapy, the diagnosis of liver diseases, the production of technetium-99m generators, and radioimmunoassay (RIA) are being supported.





This nucleonic control system at the Siam Kraft Paper Co. in Bangkok is among those that have been established under the RCA project in Asia and the Pacific.

Cervical cancer. Carcinoma of the cervix is a disease that attacks relatively young women, often at a time when they are still supporting their children in the home. In developing countries, the incidence of this cancer is thus an important sociological factor, in addition to the high level of personal suffering involved. In response to this problem, the Government of Japan donated remote after-loading equipment for intercavitary therapy to the Government of Malaysia through the IAEA. Patients are now being treated, and the installation is the focus of an IAEA training course. Japan is also supporting a research project concerned with the improvement of cancer therapy by combining treatment using conventional, radiation, and chemical or physical means.

Liver diseases and radioisotope production. The need to develop nuclear medical capabilities within the region is illustrated by the increasing use made of technetium-99m radiopharmaceuticals in the location of tumours and the diagnosis of liver and kidney disease. A project designed to evaluate practical technetium generators for low-power reactors is therefore being implemented. Complementing this activity is a Japanese funded project to evaluate the performance of radioisotope imaging instruments available in different countries. The technique involves the analysis of images produced by transmission liver phantoms designed by the IAEA and the World Health Organization (WHO).

Radioimmunoassay (RIA). A fourth major field of activity aims to achieve regional self-sufficiency in RIA, a highly valuable diagnostic technique. An important regional training course in RIA funded by a contribution from the Government of India has recently been conducted at the Bhabha Atomic Research Centre (BARC) in Bombay.

A significant factor inhibiting the wider use of RIA techniques in developing countries is the cost of commercially imported kits. A new regional Asian project has the ultimate aim of reducing costs by introducing the local production of reagents and, at the same time, improving the analytical capabilities of laboratories responsible for quality control.

RCA projects: Food and agriculture

Nuclear techniques can have significant influence on the efficiency of many steps in food production chains.

Buffalo production. One of the most active programmes involves the use of nuclear techniques to improve domestic buffalo production. Most of these 140 million animals are located in the Asian region. They are an important source of milk, meat, and draught power, particularly for small farmers. The aim of the project is to study the interrelationship between nutrition, reproduction, disease, and animal management.

Crop yields. Of importance in countries with agriculturally based economies are projects leading to increases in the yields of staple commodities. Studies of radiation-induced mutation aimed at developing improved varieties of rice and grain legumes are being implemented under the Agency's co-ordinated research programme. Some outstanding successes can be reported: In Pakistan, for instance, a chickpea variety CM-72 has been evolved which is resistant to blight disease and has a high yield potential. This variety now accounts for nearly 30% of the total chickpea crop in the country. In Indonesia, new high yield varieties, namely Atomita-I and Atomita-II, have been released to farmers by the Government. These varieties could withstand brown and/or green insect biotype #1, as well as leaf bacteria, stripe leaf, and blast diseases.

Food irradiation. The problem of post-harvest food losses is particularly serious in many Asian countries. It has long been recognized that the treatment of foodstuffs with ionizing radiation is an effective means of increasing storage life. The Australian Government is supporting a project aimed at transferring the extensive fund of scientific knowledge from the laboratory to local food industries. The project is timely, since governmental approval for irradiation of a range of foodstuffs has been granted in countries including Bangladesh, China, Republic of Korea, and India, and a large-scale successful public acceptance trial has been undertaken in Thailand.

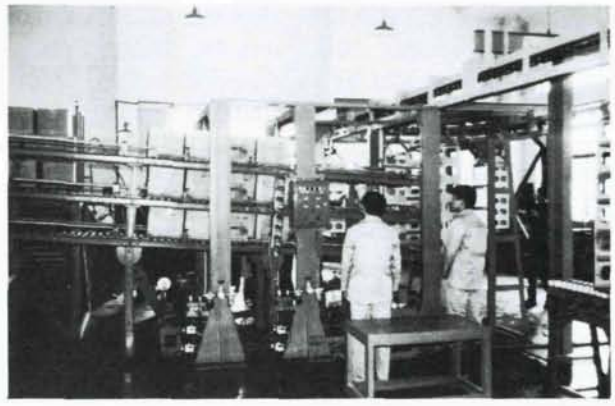
Soil and water. Fundamental to an agricultural economy is the continued availability of fresh water and fertile soil. These resources are inevitably under pressure and the development of good management practice must be based on sound scientific understanding. The Australian Government has consistently supported a regional project on the application of environmental isotope techniques to hydrology and sedimentology including erosion. Measurement laboratories have been established in five RCA countries.

RCA projects: Industry

The aim of the regional industrial project funded by the UNDP is to contribute to the economy of Asia and the Pacific region by increasing the use of modern nuclear technology in base industries. The private sector clearly plays a crucial role in these activities. Its importance is underlined by the fact that 75% of the gross domestic product of developing countries is based on private investment. A complementary aim is the development of human resources; this involves not only the enlargement and improvement of the pool of indigenous talent but also its management. *(See the accompanying table on RCA projects.)* Projects are implemented through programmes of training and demonstration at regional facilities, executive management seminars, the provision of expert assistance, and training fellowships.

Non-destructive testing (NDT). Considerable emphasis has been placed on developing capabilities for non-destructive testing. A sound, balanced NDT capability is important in building a modern industrial base. Training in NDT techniques is incorporated in most technical education programmes. The role of UN agencies is therefore to:

- Co-ordinate training at a regional level on advanced or highly specialized techniques
- Support national training courses with outside expertise



Food irradiation is drawing increasing interest in Asia. Shown here is a food irradiation plant in Shanghai, China. (Credit: Wedekind)

- Harmonize training syllabuses and support the development of internationally recognized schemes for the certification of NDT personnel.

The programme has benefitted from an extrabudgetary contribution from the Government of Japan.

Radiation technologies. Applications of radiation technology are receiving attention worldwide. An electron beam facility for the surface coating of wood products has been installed in Jakarta, Indonesia (in PAIR-BATAN). However, for a number of reasons, the spread of this technology to developing countries within the region has not been rapid. In Indonesia, a Bandung-based company recently has started to manufacture specialized fume hoods with electron-beam-coated wood panels produced at the demonstration facility. More emphasis will now be placed on ultraviolet technology, which requires lower capital investment, and on the formulation of coating materials.

Radiation sterilization of medical products is being undertaken on a commercial or cost-recovery basis in Malaysia, Thailand, Singapore, the Republic of Korea, and India. Project activities will be directed towards the development of routine services in other countries. Con-

To support an RCA radiotherapy project in Malaysia, Japan donated X-ray apparatus and other equipment.

siderable interest is also being shown in radiation cross-linking of wire and cable insulation. The process is already commercial in the Republic of Korea and China.

Radiation vulcanization of natural rubber latex is not yet commercial within the region. However, the Sri Lankan Rubber Research Institute has made a number of products of sales quality from irradiated latex produced at the project facility in Jakarta. Considerable potential is seen for applications of the process to medical products where only minimal levels of chemical residues can be tolerated. Much of this work has been made possible through funding by the Government of Japan.

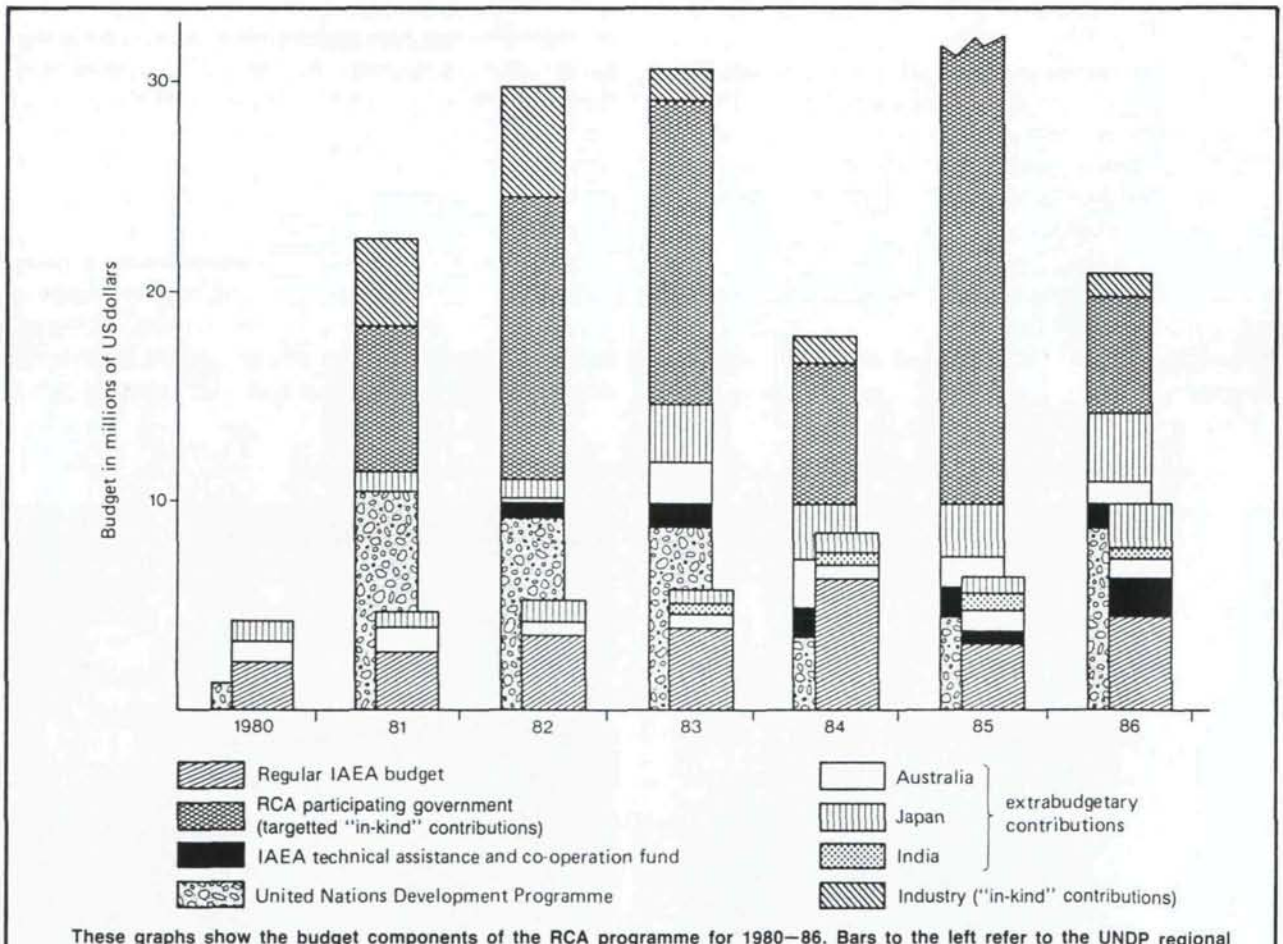
Nucleonic control systems. A sub-project on nucleonic control systems in the paper industry is an excellent example of how the RCA project has catalysed technology transfer to the region. A UNDP-funded facility was established at the Siam Kraft Paper Company, Bangkok. It quickly led to substantial acknowledged savings by the company. A payback period of about one year has been calculated. During the project period, five installations have been established in Thailand, and two elsewhere in the region.

A significant level of technology transfer has also been realized through a system using radioisotopes for on-stream analysis installed at the Philex Mining Company in the Philippines. During the course of the project, which was substantially supported by Australia, commitments were made for at least three other installations within the region, although two of these were as a direct result of commercial marketing. This is a good example of the complex interactive role between commercial activities and a project designed to stimulate the transfer of technologies for which the private sector is the major user.

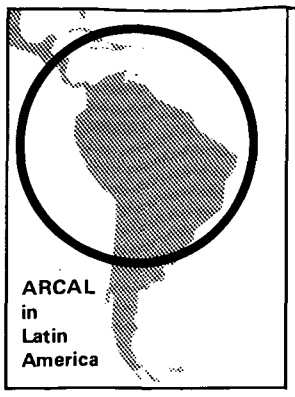
Basic science using research reactors. An important programme of activities aimed at increasing the basic capabilities within the region for applying research reactors to a range of scientific problems is being supported by the Government of India. A very successful training course on neutron diffraction was recently held there.

RCA as a co-operative undertaking

One hallmark of RCA is the spirit of co-operation that has developed between governments and UN agencies involved in project work. Such a quality is difficult to measure. Within obvious limitations, budgets can serve to show the extent to which the IAEA, UNDP, donor countries, and project participants have contributed to activities. *(See the accompanying graph, which serves to illustrate the importance of all elements in the programme implementation.)*



These graphs show the budget components of the RCA programme for 1980–86. Bars to the left refer to the UNDP regional industrial project under RCA; bars to the right refer to the regular RCA programme.



Regional co-operation in Latin America

The first definitive action towards the development of a regional programme in Latin America (which has now become known by its Spanish acronym ARCAL, for Arreglos Regionales Cooperativos para la Promoción de la Ciencia y la Tecnología Nucleares en América Latina) was provided by five countries of the Andean sub-region. In late 1981, they asked the IAEA to assist them in co-ordinating their efforts towards the adoption of nuclear techniques in a number of fields.

Following various contacts between these countries and others in Latin America and various joint planning meetings, several limited projects were identified for implementation. At the present time, 12 countries are parties to the agreement, namely Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Paraguay, Peru, Uruguay, and Venezuela.

The projects listed in an accompanying table were accepted in the order of priority indicated, and define the structure of the ARCAL programme. They have all been carefully reviewed for technical soundness and viability by the IAEA staff. The first two are basic to all.

Training — particularly at the technician level — is an important aspect of each project. It is intended that this type of training be carried out within the region at the larger, established centres, and in one of the languages of the region. Major emphasis is also being placed on the improved utilization of existing facilities and equipment.

ARCAL projects: Radiation protection

While a substantial base for appropriate radiological protection exists in most Latin American countries, there is a need to ensure the availability of a larger pool of trained manpower and radiation protection equipment to provide an adequate measurement capability for necessary inspection and evaluation procedures. Similarly, there is a need to ensure adequate protection of workers and patients involved in various medical applications of isotopes and radiation in both diagnosis and therapy. Finally, it is desirable that a standardized approach be taken to the application of radiological protection principles throughout the region and that contact between specialists in the various countries be enhanced. The basis for the programme will be provided by the recently revised *Basic safety standards for radiation protection*, which are jointly sponsored by the IAEA, International Labour Organisation (ILO), Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA), and the World Health Organization (WHO).

The objectives of the project are to improve the application of the basic safety standards, with particular reference to medical facilities; to improve co-ordination of the work of the national Secondary Standard Dosimetry Laboratories (SSDLs) of the region; and to organize a regional dose intercomparison service for radiotherapy. A regional workshop has been organized periodically and it is also anticipated to organize a regional seminar on various technical items.

ARCAL projects: Nuclear instrumentation

A great deal of nuclear instrumentation is in use in relation to a substantial number of programmes in Latin America, much of which is fairly sophisticated. There is, however, a general shortage of trained personnel able to carry out the necessary maintenance and repair of this instrumentation. Difficulties in obtaining the necessary spare parts and components frequently hamper the efficient performance of local laboratories.

Project objectives are to develop and establish an increased national and regional capability for handling, maintaining, servicing, designing, and constructing nuclear instruments and to introduce the use of microprocessors and microcomputers in nuclear experiments. A workshop training course and co-ordinated research programme are main project activities.

Project activities in Latin America under ARCAL

Project	Funding (as of 1 March)
• Radiation protection	TC, CRP, FRG
• Nuclear instrumentation	TC, CRP
• Radioimmunoassay in animal reproduction	TC, CRP, USA
• Nuclear analytical techniques	CRP (other funding awaited)
• Research reactor utilization	CRP (other funding awaited)
• Food irradiation	TC, CRP, Netherlands (other funding awaited)
• Improvement of cereals through mutation breeding	USA, TC
• Radioimmunoassay of thyroid hormones	awaited
• Nuclear accelerator training and research	awaited
• Nuclear information	TC

ARCAL = The acronym for the IAEA's regional programme in Latin America and stands for Arreglos Regionales Cooperativos para la Promoción de la Ciencia y la Tecnología Nucleares en América Latina.
TC = IAEA Department of Technical Co-operation.
CRP= Co-ordinated Research Programme, IAEA Department of Research and Isotopes.
FRG= Federal Republic of Germany.

ARCAL projects: RIA in animal research

Latin America is a region with vast and varied animal resources. They consist not only of the more conventional domesticated species (e.g. cattle, sheep, and goats), but also of such indigenous species as the llama, alpaca, and vicuña. The production of meat, milk, wool, and/or hides from these animals is important to all countries here, providing nutrition and clothing for the human population, valuable export earnings, and, perhaps most important of all, employment and income for a high proportion of the poorer people living in the rural and highland areas.

The efficiency of livestock production in the region is invariably low, however. One principal way to increase livestock productivity is to improve reproductive efficiency. Improvement in livestock reproductivity efficiency is greatly facilitated by utilization of radioimmunoassay (RIA) and related techniques. The aim of the project is to improve the reproductive efficiency, and hence productivity, of large ruminants in Latin America through the application of reproductive hormone measurements made by radioimmunoassay.

ARCAL projects: Nuclear information

Country co-ordinators agreed by consensus that a project on nuclear information, which was recently started in the framework of the Agency's technical co-operation programme, should be included in ARCAL. The regional project originated during the second half of 1984 and became operational in early 1985. Its purpose is to assist Latin American countries in developing their nuclear information services, a need that emerged from requests for assistance from several Latin American countries starting in 1981. Since then, there has been the necessity of co-ordinating IAEA's assistance into an integral programme to benefit the entire Latin American region.

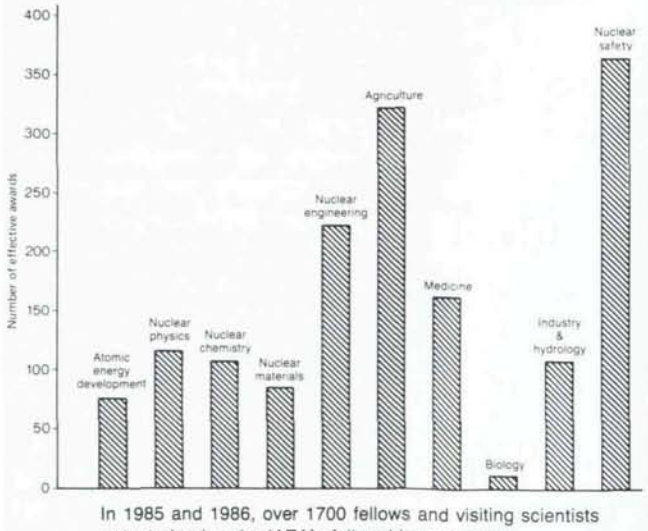
Other ARCAL projects

Six other ARCAL projects currently are awaiting full implementation pending the availability of funds. These cover:

- Nuclear analytical techniques
- Research reactor utilization
- Food irradiation
- Improvement of cereals through mutation breeding
- Radioimmunoassay of thyroid hormones
- Nuclear accelerator training and research.

Maria Da Conceição Ribeiro Vieira (foreground), from Portugal, is one of more than 11 000 scientific fellows the IAEA has trained in various fields over the past three decades. Here, she is being briefed in the IAEA's hydrology laboratory by Mr G. Hut and Ms E. Marusak. Credit: Katholitzky, IAEA)

Effective fellowship awards by field of training, 1985–86



In 1985 and 1986, over 1700 fellows and visiting scientists were trained under IAEA's fellowship programme.