Atoms for peace: Extending the benefits of nuclear technologies

Through IAEA-supported projects, beneficial nuclear technologies are contributing to national development goals

by Jihui Qian and Aleksander Rogov

Over the past 40 years, a disease known as rinderpest, or "cattle plague", has been devastating for farmers in Africa, claiming the lives of millions of cattle and severely hurting farm production and income. Especially in the 1980s, serious outbreaks of rinderpest in livestock were reported throughout Africa.

Today, that picture has changed. Out of 18 African countries where cattle once were infested with rinderpest, only two show signs of the disease today. Instrumental to this remarkable turnabout has been a Pan-African campaign that incorporated the application of a new nuclear-based testing technique developed jointly by the IAEA, Food and Agriculture Organization (FAO) of the United Nations, and a laboratory in the United Kingdom in 1987. The application has radically increased the effectiveness of vaccination campaigns against cattle plague, enabling African countries to declare themselves free of the disease. Veterinarians in these countries received support from the IAEA's technical co-operation programme and an FAO/IAEA co-ordinated research programme. They were supplied with necessary testing kits, equipment, training, and technical support to ensure the correct use of the technique in national veterinary laboratories. Participating laboratories throughout Africa now have acquired the expertise and skills they need to carry out effective testing.

The project's success is leading to similar work in other regions of the world. A global rinderpest campaign has been launched with the aim of eradicating the disease over the next 20 years. Under a 4-year IAEA technical co-operation project, the techniques developed through the FAO/IAEA's work in Africa will be part of efforts for rinderpest surveillance and control in West Asia. Countries there currently are suffering millions of dollars in losses from animal deaths. The IAEA regional project aims to help these countries eradicate rinderpest by the turn of the century.

The case of rinderpest is just one example of how international and national scientists are working together to bring practical benefits to people through technology-transfer projects supported by the IAEA. In other fields as well — including medicine, environmental protection, and food preservation, for example — nearly 1300 IAEA-supported projects are making key contributions around the world. This article looks at the kinds of projects co-operatively undertaken through IAEA mechanisms to extend the reach of beneficial nuclear technologies in response in increasing demands for technical support and assistance from its Member States.

Evolution of international nuclear co-operation

In the early 1950s, the international community was first becoming aware of the great opportunities that peaceful applications of atomic energy could offer for economic and social development. It was also becoming apparent that, for most countries, these opportunities could be materialized in a most effective manner through extensive and concerted international efforts.

In this environment, on 4 December 1954, the United Nations General Assembly unanimously passed an "Atoms for Peace" resolution expressing the hope that an international atomic energy agency would be established without delay to facilitate the use by the entire world of atomic energy for peaceful purposes, and to encourage international co-operation in the further development and practical use of atomic energy for the benefit of humanity.

At the time when the IAEA was established in 1957, only a limited number of countries had

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People in many countries around the world are seeing benefits of nuclear technologies in their lives, through IAEA-supported projects in fields of health care, water management, agriculture, and industry, for example.
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knowledge and experience in nuclear research, and especially its practical application. At the first International Conference on the Peaceful Uses of Atomic Energy, held in Geneva in August 1955 and attended by scientists and engineers from 73 countries, less than half of participating States were able to present reports on nuclear science or technology and only 12 of these States were from developing areas of the world.

In framing the IAEA's Statute, governments sought to create an international institution through which countries could receive multilateral technical assistance on peaceful nuclear research and applications. The Statute stipulates a range of conditions for countries to receive such assistance. These include, *inter alia,* the usefulness of the project, including its scientific and technical feasibility; the adequacy of plans, funds, and technical personnel to assure the effective execution of the project; and the adequacy of proposed health and safety standards for handling and storing materials and for operating facilities.

Back in 1957, however, the basis for technical assistance activities was fairly weak. The sphere of co-operation was relatively limited covering mainly nuclear power and aspects of its fuel cycle, and to a certain extent some aspects of radiation applications. Very few peaceful nuclear technologies had reached the level of maturity which enabled them to be effectively used for practical applications. At that time as well, most developing countries were not yet at the stage where they could effectively apply nuclear science and technology. It should also be noted that, in the early years, none of the three partners involved in the technical assistance process — i.e. donor countries, recipient countries, and the IAEA — had neither the required experience nor administrative arrangements for multilateral intergovernmental co-operation.

Today, the situation is different. Most IAEA Member States from the developing world have gained knowledge and experience in many fields of nuclear research and applications, mainly those related to basic human needs. Mechanisms for technology transfer have been put into place, and their effectiveness is continually reviewed. IAEA activities cover practically all areas of peaceful applications of nuclear energy, and interest in receiving technical assistance is growing.

Priorities and needs

What kinds of technical assistance are countries receiving? In terms of total annual disbursements through the IAEA's technical co-operation programme, the largest share is for projects related to nuclear applications in food and agriculture, which accounted for about 22% of disbursements in 1994. Nuclear-related methods are widely used in developing countries in such areas as plant breeding, soil fertility studies, insect and pest control, animal production and health, and studies of the fertilizer efficiency and the fate of agrochemicals and residues. The technology of food irradiation additionally is finding increasing acceptance as an effective means of protecting agriculture products from spoilage, and as a method for controlling pathogens associated with serious food-borne diseases and for meeting the strict quarantine requirements of international food trade.

Another major area of interest is the use of nuclear technologies in physical and chemical sciences, and in fields of industry and earth science. This includes the utilization of research reactors and particle accelerators for scientific studies, production of isotopes; the application, maintenance and repair of nuclear instrumentation; and the preparation and utilization of radiopharmaceuticals. Over the 1990-94 period, the share of total disbursements in this area have ranged between 18% and 25%.

Other areas showing high levels of interest are nuclear applications in industry and earth sciences — including non-destructive testing of materials and products, radiation processing, and development of water resources, for example — and nuclear-related health care and treatment. Greater support, for instance, is being requested in the use of nuclear techniques for the diagnosis of many diseases, such as leishmaniasis, Chagas disease, iodine deficiencies, and sickle cell diseases. At the same time, the use of ionizing radiation to treat cancer is drawing more and more interest. Currently the IAEA has 40 technical co-operation projects associated with radiotherapy in 29 countries. Additionally, nuclear methods and technologies are used for sterilization of biological tissues and medical supplies, and for nutritional and health-related environmental studies.

An area of shifting demand is nuclear power and safety. While nuclear power programmes in many countries have been cut back or halted, there is increasing awareness of the needs for nuclear safety and radiation protection. The share of disbursements on nuclear power has dropped from about 12% in the late 1980s to 6% in the 1990s, whereas the share for safety and radiation protection has grown. Projects being supported include those related to strengthening national infrastructures for radiation protection; occupational safety of radiation workers; safety of nuclear installations; the safe management, storage, and disposal of radioactive wastes; and nuclear emergency planning and preparedness.

On average over the past 5 years, countries have received technical assistance from the IAEA valued at about US $40 million per year through expert services, provision of equipment, and training activities. All told over the past 25 years, the cumulative resources available to the IAEA's technical co-operation programme amount to nearly US $690 million.

Realizing the benefits

As the rinderpest example illustrates, a number of techniques developed and applied with the IAEA's assistance are significantly contributing to the solution of serious problems hampering social and economic development. Some selected other cases may help to indicate the number of different ways in which the IAEA's assistance can be applied.

Water resources. The assessment and development of water resources has been a major area of IAEA activity for more than 30 years. Nuclear and isotope techniques play a valuable role in hydrological investigations. Under one current project, in Venezuela, IAEA scientists are helping local water authorities in Caracas study the potential of an aquifer to provide additional water for residential, agricultural, and industrial needs. A rapid increase in the population of Caracas has led to a deficit of nearly 20% in the water supply, and more water resources must be found. Studies will help Venezuelan authorities make decisions concerning the best use of the aquifer, and how to protect its water from pollution.

Animal health and productivity. Buffaloes and cattle in Asia are fed mainly with rice straw and native grasses. However, these materials are very indigestible and have only limited amounts

of the protein, energy, and minerals needed to provide a balanced diet. Poor nutrition seriously compromises the ability of the animals to produce meat and milk and to provide draught power. Through projects jointly supported by the IAEA and United Nations Development Programme (UNDP), assistance was provided to India and Indonesia in using isotopes for investigating the efficiency of the processes involved in feed digestion. As a result, the best combination of local materials for supplementing grass or straw was determined.

In both countries the effect of the introduction of this feed supplementation method has been very high. For example, in India the amount of milk collected by the largest milk co-operative in 1989 increased by 30%, and the price was 25% less than the price of producing milk by the other methods of feed supplementation.

Quality control in industry. Non-destructive testing (NDT) techniques are widely applied in industry and manufacturing for quality control purposes. In Latin America and the Caribbean, an IAEA-supported NDT regional project involving 18 countries was conducted from 1983-94. The overall objective was to assist them in developing an autonomous capability for applying NDT, largely by providing support in areas of training.

The evaluation review carried out by independent experts in 1994 showed that the project had been instrumental in providing the region with a significant technological tool for the advancement of the region's industrialization. This enabled the development of local industries and the displacement of NDT services previously provided from outside the region. The project marked a significant change for the region's own technological development. In previous years, the input from experts from outside of the region was the dominant mode of dissemination of NDT technology. This was often in the context of regional courses, with typically one participant from each project country. Gradually, the dominant mode changed from using external experts to using regional experts and further evolved to the use of national experts teaching courses solely in their respective countries.

Health care. Nuclear and related techniques play an especially vital role in health care and treatment. Among important diagnostic tools is a technique known as radioimmunoassay. With the IAEA's support, more than 250 radioimmunoassay laboratories have been established or upgraded in Africa, Asia, and Latin America, and supplied with reagents in bulk form. This has allowed recipient countries to provide reasonable clinical diagnostic services covering important substances such as hormones, vitamins, enzymes and even some tumor markers. The cost of each test is less than US 50 cents per patient sample, which on average is ten times less than the application of complete commercial kits. In some countries, where some of the primary reagents needed are being produced locally, the cost per test is significantly lower. More important than the lower cost is the fact that many people now have access to reliable diagnostic tests that play a key role in the improvement of their health care and treatment.

Future directions

In its current and planned programmes, the IAEA is placing increasingly more emphasis on cost-effective projects that promise significant social and economic benefits, that have a lasting and environmentally sound impact on a country's development, and that clearly demonstrate the value of nuclear applications for end users. The IAEA's Member States have strongly supported this move towards impact-oriented technical co-operation. At an IAEA Technical Co-operation Policy Review Seminar in September 1994, for example, governmental representatives provided the Agency with valuable recommendations regarding the practical implementation of projects important to them.

Undoubtedly the major challenge facing the IAEA's technical co-operation programme in years ahead is the availability of sufficient financial resources to effectively carry out approved projects. In terms of its funding base, the IAEA occupies a place far behind large bilateral and multilateral agencies. Even so, the trend in contributions to the IAEA's technical co-operation programme over the past 5 years has been negative, and many sound projects have had to go unfunded. In response to the situation, the IAEA has taken a number of administrative and programmatic measures intended to stretch its limited resources so as to obtain the best possible results.

These efforts are part of steps to improve programme efficiency, and to attract greater resources enabling the IAEA to enhance its support for technology-transfer activities that are not only operationally sound but visibly effective. As the main channel for global nuclear co-operation, the IAEA possesses an exceptionally high level of technical expertise and experience to identify and carry out a multitude of projects that can make a lasting difference to a country's sustainable development. ❐