Nuclear co-operation in Africa: Developing expertise and resources

Through a regional co-operative agreement known as AFRA, African countries are working to solve common problems

by Ali Boussaha and Mokdad Maksoudi

During the past decade, regional activities in the field of nuclear science and technology have assumed greater importance in Africa. This is especially the case in areas of common interest, such as radiation protection and safety, agriculture, nuclear medicine, and maintenance of scientific instruments. Today, important activities are being carried out through a regional mechanism known as AFRA, which stands for the African Co-operative Agreement for Research, Development, and Training Related to Nuclear Science and Technology.

AFRA is an inter-governmental arrangement established at the initiative of several African countries and concluded under auspices of the IAEA. In September 1994, the current agreement, which entered into force on 4 April 1990, was extended for another 5 years, to the year 2000. To date, 19 countries have become members: Tunisia, Egypt, Algeria, Nigeria, Madagascar, Libya, Morocco, Kenya, Sudan, Ghana, Tanzania, Mauritius, Cameroon, South Africa, Zaire, Ethiopia, Zambia, Niger, and Côte d'Ivoire.

Since its inception, AFRA has proved to be an important mechanism to promote regional co-operation, to co-ordinate intellectual and physical resources, and to enhance capabilities in the diversified areas of nuclear technology. Countries participating in AFRA aspire to build on achievements attained under national efforts or with IAEA assistance, so that available resources, facilities, and expertise can be most effectively shared and not unnecessarily duplicated. Financial support is provided by the IAEA from its own budget and from extrabudgetary contributions made by donor countries and organizations. AFRA countries also provide in-kind contributions by, for example, hosting and supporting training activities.

This article provides an overview of activities being carried out through AFRA in various fields where nuclear techniques are being applied. It additionally addresses areas in which countries are working together with the IAEA to strengthen their basic national infrastructures related to the safe and effective use of nuclear and related technologies.

Addressing issues of development

Food and agriculture. The agriculture sector is the mainstay of the economy of many African countries and sustains the lives of more than 80% of the population. Many adverse factors affect development — unfavourable climatic conditions, recurrent droughts, insufficient water resources in the Sahel, North, Eastern and Austral Africa, and accelerating environmental degradation, notably desertification, deforestation, declining soil fertility, and erosion.

Analysis of current trends reveals that in order to meet the needs of the continent's population, a 70% increase in crop production up to the year 2010 will have to be attained through yield increases and intensified farming. This will require an agricultural development strategy that combines the imperative of food security with the rational management of natural resources and protection of the environment.

Within the agricultural sector, the rearing of livestock is a key component. On average, when both their direct and indirect contributions are taken into account, livestock account for half of the agricultural output and may represent up to 25% of the gross domestic product of African countries as a whole. The productivity of livestock greatly affects the livelihood of small holdings that constitute the majority of farming systems in sub-Saharan Africa. Besides being a

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Bringing the benefits of nuclear techniques in agriculture to small farm holders is one AFRA objective. *(Credit M C N Jayasunya, IAEA)*

source of draught power, they produce meat, milk, and wool for local populations and, in some countries, for export.

The AFRA programme in food and agriculture supports collaborative efforts to use appropriate technologies to consolidate and improve research capabilities for crop and livestock production. Current projects deal with food preservation using irradiation technology, animal reproduction and nutrition, and crop improvement by mutation breeding and biotechnology.

Food preservation. Post-harvest losses of foodstuffs in Africa sometimes run as high as 50%, and the technology of food irradiation is seen as playing a potentially valuable role in reducing these losses, especially for grain, vegetables, root plants and fruits. Several African countries have shown keen interest in the use of this technology for food preservation and some have already established pilot food irradiation facilities to pave the way for the introduction of the technology on a commercial scale. This common interest has prompted Algeria, Egypt, Ethiopia, Ghana, Kenya, Libya, Madagascar, Mauritius, Morocco, Nigeria, South Africa, Sudan, Tanzania, Tunisia, and Zaire to initiate an AFRA programme based on mutual co-operation and sharing of experience. Activities were initiated in 1991 and since then 55 scientists from these countries have been trained in basic aspects of food irradiation technology.

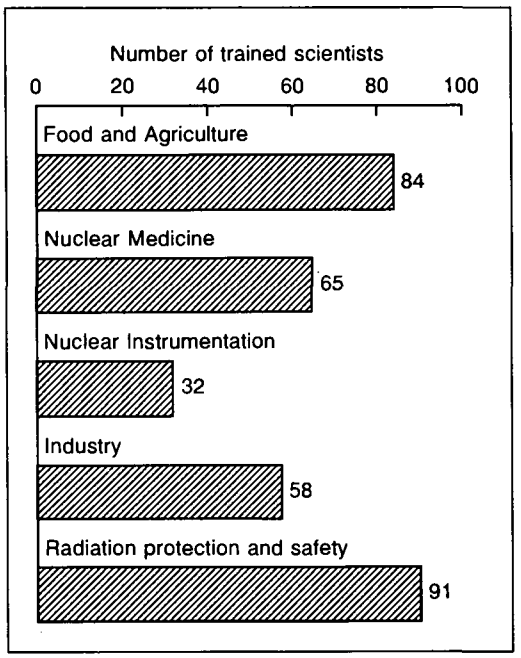
Animal reproduction and nutrition. Although many African countries have established national laboratories, mainly through IAEA assistance, for studies on animal reproduction and nutrition, many of them realized the need to enhance their facilities. As a result, they initiated an AFRA programme to use standardized services for radioimmunoassay (RIA) and for blood nutrient analysis, and to facilitate co-ordination and promote the exchange of information and experience. Eleven countries now are participating in this endeavour, and their present emphasis is on conducting intensive training courses for scientists. Areas covered include milk production and reproductive performance of indigenous and crossbred dairy cattle; supplementary feeding strategies using locally available feed resources; an investigation into the effect of trypanosomiasis on the reproductive performance of goats; a field study to investigate the influence of mineral deficiency on fertility of dairy cattle and camels and its impact on productivity; and a project to develop facilities and sustainable systems for agriculture and animal production in desert conditions.

Plant breeding and genetics. Africa's future food production depends to a significant extent on the ability of crops to tolerate difficult soil and water conditions. The application of radiation-induced mutation techniques combined with selected biotechnologies can play an important role, and most AFRA States have established national capabilities in mutation breeding. Some of them are already using their irradiation facilities for routine irradiation of seeds and plantlets in efforts to breed crops that are more resistant to disease or which require little water, for example. *In-vitro* culture laboratories are now established in at least five countries.

IAEA-supported activities have led to some achievements, in particular the development of improved varieties of cassava, plantain, and wild African rice. In general, however the results have not yet been transferred to the end users. The need to consolidate experience and to bridge the gap between research laboratories and farmers prompted 12 AFRA countries to establish a regional programme for this purpose. So far, the activities have concentrated on training, and plant breeders from 11 AFRA countries have been trained.

Human health. In one form or another, most hospitals in Africa use radiation and radionuclides for medical and biological purposes, primarily for the treatment of cancer and for medical diagnosis. RIA is currently widely used as a diagnostic technique of thyroid-related hormones, a part of efforts to investigate ever-increasing thyroid and iodine deficiency disorders. However, its application requires reagents which are imported by most countries in Africa in the form of prepared kits. The quality of the assays

AFRA training by field of activity, 1991-94



is often jeopardized by limited access to foreign exchange and by uncertainties associated with importation procedures and unreliable logistics.

An AFRA project was initiated in 1991 to develop the capability for the local preparation of radioimmunoassay reagents. Activities have focused on the introduction of bulk reagent methodology, standard RIA practices including quality control, and RIA data-processing procedures so as to initiate local production of at least some of the simpler primary reagents required.

By now, most of the participating laboratories have acquired the technical expertise and established the facilities to prepare locally a number of required reagents. Sixty-four participants from 10 countries have benefitted from training events organized under the project in bulk reagent methodology, data processing in radioimmunoassay, and the preparation of basic reagents. In addition to these achievements, a regional external quality scheme is being set up to pave the way for gradual introduction of early screening of neonatal hypothyroidism.

Industrial applications. A number of industrial applications of nuclear techniques have attracted the interest of AFRA States. They include non-destructive testing (NDT) techniques, widely used throughout the world in the quality control of industrial products, and radiation processing, mainly for radiation sterilization of single-use medical supplies and pharmaceuticals.

Several African countries have taken steps over the past years towards establishing NDT facilities. However, the infrastructure in the region is still in general inadequate and NDT services are performed by foreign companies. While NDT training opportunities are regularly available in a few countries (Algeria, Egypt, Kenya, South Africa, and Tunisia), the certification and qualification of NDT personnel relies mainly on programmes of the IAEA and other organizations. In 1993, some AFRA countries initiated NDT activities which included the organization of several training events on certification and qualification of NDT personnel. They have resulted in the training of 40 persons from 9 countries in two NDT techniques (ultrasonic and radiographic testing.)

In the field of radiation processing, AFRA States in 1991 initiated a project on the radiation sterilization of medical supplies and pharmaceuticals. Through this project, 30 radiation technologists from eight countries have received training. No further activities are foreseen in this field, however, because of the lack of irradiation processing facilities in participating countries.

Sources of AFRA funds, and their allocation

Sources of AFRA funding, 1991-94

Source	Budget (US$)	Percentage
IAEA	1 402 576	72%
France	404 000	21%
Spain	129 080	7%
Total	**1 935 656**	**100%**

Note:Table does not include "in-kind contributions".

Allocation of funds to AFRA activities from the IAEA's Technical Assistance and Co-operation Fund

	1991-92		1993-94		1995-96	
Sector	**Budget US$**	**%**	**Budget US$**	**%**	**Budget estimates US$**	**%**
Food and agriculture	99 570	33	552 686	50	763 200	30
Human health	50 000	16	60 000	5	722 400	28
Industry	97 230	32	140 890	13	45 600	2
Nuclear technology infrastructure*	58 150	19	344 050	32	1 052 600	40
Total	**304 950**	**100**	**1 097 626**	**100**	**2 583 800**	**100**

* Includes nuclear instrumentation, radiation protection, waste management, and research reactor utilization

Hundreds of African scientists have received training through AFRA programmes, including participants in a medical training course on radioimmunoassay and in courses on nuclear instrumentation. *(Credits R. Piyasena and V. Markovic, IAEA)*

Strengthening nuclear infrastructures

Radiation protection and safety. As the use of radioisotopes and radiation technologies has grown in AFRA States over the years, so has the IAEA's assistance in areas of radiation protection and radioactive waste management. The basic infrastructure for radiation protection and radioactive waste management requires the setting up of a competent national authority, the establishment of a legislative and regulatory framework, and the development of operational services for the proper enforcement of radiation safety standards.

However, for various reasons, in a number of countries radiation safety infrastructures are still either deficient or essentially non-existent, which impedes the development of nuclear technology programmes. As to radioactive waste management, expertise in the region is limited. Although radiation sources and radioactive materials are essentially used in connection with medical care and in limited research and industrial applications, the fate of the generated wastes remains an issue of major concern in the absence of comprehensive waste management strategies. The issues which need to be addressed include proper handling of different types of radioactive wastes, adequate treatment and conditioning, and safe disposal. An AFRA programme aims to improve the managerial capability in the region to manage radioactive wastes properly; and to harmonize environmental monitoring approaches and measuring methods.

Under a project on waste management initiated in 1991, several regional training courses and workshops were organized which enabled about 80 scientists to gain practical knowledge and skills, particularly regarding radioactive spent sources generated from hospitals and research laboratories. Current activities include the design of a waste processing and storage facility for the management of low-level radioactive wastes in line with the needs of most AFRA countries.

The project on environmental radiation measurement and harmonization started in 1993. A mechanism has been established under the project in close collaboration with the IAEA's Seibersdorf Laboratories to carry out programmes on quality assurance and intercomparison of gamma spectrometry data of environmental samples. Training of scientists in gamma spectrometry and other analytical techniques represents an important component of the project; 30 scientists from eight AFRA countries have already been trained.

Nuclear instrumentation. Nuclear-related activities in AFRA countries involve specific and often complex equipment and microprocessor-based electronic instrumentation. These tools are often used in an unfavourable working environment (power disturbances, dust, high humidity and temperature). Furthermore, most instruments which are imported are not serviced in the region owing to lack of suppliers' representatives. With IAEA support, most AFRA States have established service and maintenance facilities well equipped for preventive maintenance and repair. However, all of them suffer from the turnover of key personnel, shortage of spare parts and appropriate technical documentation for servicing, and lack of opportunities for exchange of experience with other institutions in the region.

Fourteen AFRA States decided to adopt a regional approach to consolidate or upgrade their national instrumentation and electronics laboratories for the repair and preventive maintenance of nuclear and medical equipment, and to develop adequate capabilities in the designing and

manufacturing of simple instruments to sustain research activities. The proposed approach offers many advantages, including exchange of experience, cost-effective local training of personnel, shared use of expensive equipment, and implementation of common policies to tackle instrumentation problems, especially with regard to maintenance and utilization. Training of electronic engineers and technicians in the field of repair of instruments and preventive maintenance is given particular attention. Presently, 20 technicians from 10 AFRA countries have been trained to be trainers in their home institutions.

Future activities and prospects

AFRA countries have decided to particularly intensify their co-operative activities in a number of areas. One area is food irradiation, where training, demonstrations, workshops, and techno-economic feasibility studies of the technology will be emphasized so as to enable each AFRA country to acquire the necessary information for decision-making.

Another area of special interest is radiotherapy. Costly radiotherapy facilities for curative and palliative treatment of cancer have been established in many African countries. However, most of these facilities are not providing optimal services owing to several factors. These factors include the inadequate supply of indigenous specialists, such as radiotherapists, medical physicists, and radiographers, which is limited by the high cost of overseas training and the attractive job opportunities offered by foreign clinics to graduates. A related problem affecting the quality of treatment appears to be the various standards of quality for radiotherapy, which results from the fact that the practice covers a wide range of techniques and approaches. Several AFRA States are now working to introduce a regional quality assurance programme to improve their national capabilities for radiotherapy practice, to optimize the utilization of existing radiotherapy facilities by introducing new clinical techniques in teletherapy and brachytherapy, and to upgrade and support existing regional training centres to enable them to answer the most pressing needs of the region for trained personnel. These activities should also contribute to increased awareness in countries about rational and comprehensive programmes for early detection of cancer.

Particular attention also is being attached to the further strengthening of basic infrastructures to promote nuclear technology development. Considering the increasing number of research reactors in the region — there are now six operational and three under construction — some AFRA States intend to adopt a common approach to optimize the utilization of these facilities and to enhance their capabilities for safely and efficiently operating the units.

Assessing achievements. During the first 5 years of its existence, AFRA concentrated on laying down the foundation that can best enable African countries to translate their commitment to regional co-operation into technically and economically sound co-operative projects. Its first phase has successfully established a suitable scientific framework in Africa which enables African scientists and technicians to share the available resources and facilities, to exchange information and experience, and to help those countries still in need of expertise in the field of nuclear science and technology. This achievement contributed a great deal to increasing awareness among AFRA countries that regional co-operation holds considerable benefits. Another important result is the better understanding of the infrastructure and the expertise in the nuclear field that is available in the region. At the same time, there has been greater appreciation of the many constraints and weaknesses that still prevent nuclear techniques from contributing effectively to the region's social and economic development.

Modest as they are, these achievements have strengthened the concept of regional co-operation and self-reliance in the continent. Greater use is being made of experts and lecturers from the region. Moreover, because AFRA has strengthened personal contacts and relationships between African scientists and between their institutions, there are now more and more AFRA countries offering training opportunities. The region's most developed countries are expected to play a paramount future role in further consolidating the spirit of mutual assistance and regional co-operation by opening their available facilities to other countries and by financially supporting AFRA activities.

AFRA also has greatly contributed towards the elimination of some barriers that were preventing any institutionalized co-operation in nuclear science and technology from taking place in the region. During its second phase, from 1995-2000, the AFRA programme will continue placing greater emphasis on building up regional capacities, and on improving the programme's operation, management, and scientific scope.

It is hoped that through these initiatives, and continuing financial support, the foundation for nuclear-related regional co-operation in Africa will not only be strengthened but increasingly tailored to the conditions and needs of the region. ❐