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**ACQUISITION AND TRANSFER OF NUCLEAR SCIENCE AND TECHNOLOGY
FOR AGRICULTURAL PRODUCTION AND FOOD PRESERVATION**

ACQUISITION AND TRANSFER OF NUCLEAR SCIENCE AND TECHNOLOGY FOR AGRICULTURAL PRODUCTION AND FOOD PRESERVATION

Introduction:

1. The potential of nuclear science and technology in food production and preservation has been known for nearly a century and has been exploited industrially for over forty years. The technology is widely used in developed countries and it is spreading quickly in the developing countries. It is to be noted that the growing food deficit in the African region has drawn attention to the potential contribution of nuclear science and technology to the attainment of food self-sufficiency through better plant and animal production, and in the reduction of post-harvest losses. In recognition of these developments, the secretariat undertook a study on experiences in nuclear technology transfer for agricultural production and food preservation in the African region. The report of the study was considered by an Ad-hoc Expert Group Meeting on Nuclear Science and Technology for Food and Agriculture in October 1992 which proposed a regional project to further promote nuclear science and technology among the member States of the region.

Use of nuclear science and technology in food and agriculture

2. In spite of its relative newness in its use, nuclear science and technology is already making considerable contributions through applications in many human endeavour including food and agriculture. Specifically, nuclear technology is being used in studies and applications on soil fertility, water management, crop improvement, animal production and health, insect and pest control, monitoring of agrochemicals and residues and food preservation.

Acquisition and transfer of nuclear technology

3. The International Atomic Energy Agency (IAEA) is the main promoter of the peaceful uses of nuclear energy, and operates very closely with the Food and Agriculture Organization of the United Nations (FAO) in the application of nuclear technologies to food and agriculture. The Joint FAO/IAEA Division responsible for food and agricultural research and development involving nuclear techniques, promotes the acquisition and transfer of nuclear technologies to member States through the research contract programmes, technical cooperation projects, training and information exchange. Under the research contract programme qualified individuals or research institutions are assisted in tackling a food and agricultural problem requiring the use of nuclear technology. A variant of this is the Coordinated Research Programme whereby institutions or researchers in developed countries collaborate with those in developing countries in pursuing a specific research activity. Assistance is also provided under the Technical Cooperation Projects in solving technical problems or introducing specific nuclear technology, the long term objective being to enhance self-reliance in the recipient institutions.

4. The programmes for transfer of nuclear science and technology place a lot of emphasis on the development of human resources through various forms of training. Offers of fellowships enable qualified individuals to acquire additional research skills in the use of nuclear technology.

Various regional and interregional training courses are conducted to build up the necessary capabilities in nuclear technology and thereby enhance the process of technology transfer in this field. Another important channel used in the acquisition and diffusion of nuclear technology is through conferences, symposia, seminars, advisory groups, consultative committees which enable scientists to share information amongst themselves. Additionally many publications relating to activities of the Joint IAEA/FAO Division, technical documents, periodicals and newsletters are made available to the relevant researchers and institutions.

Experience of nuclear science and technology transfer in the African region

5. In 1990, out of the 119 member States of IAEA only 27 were from Africa. These were Algeria, Cameroon, Côte d'Ivoire, Egypt, Ethiopia, Gabon, Ghana, Kenya, Liberia, Libya, Madagascar, Mali, Mauritius, Morocco, Namibia, Niger, Nigeria, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Tunisia, Uganda, Zaire, Zambia and Zimbabwe. These countries are in different stages of development and use of nuclear science and technology. A global picture of Africa's participation in programmes and projects is illustrated by Table which provides a breakdown of the 181 operational contracts in 1990 in the main classes (D1 through D6) and categories (country, regional, interregional). See Table. It should be noted that in spite of the importance of food preservation in Africa, this class had the smallest number of operational contracts. Out of the total number of contracts, 60 or 33.1% were on country projects, 83 or 45.9% on regional coordinated programmes, and 38 or 21% on interregional coordinated programmes. Only four countries, Egypt(14), Ghana(21), Nigeria(20), Zambia(11) have operational contacts in all the six classes D1 to D6.

Soil Fertility, Irrigation and Crop Production (D1):

6. Programmes and projects in this class use stable and radioactive isotopes to detect, measure and track fertilizer derived nutrients in soils and plants, determine the availability of soils moisture and study the natural process of nitrogen fixation. The objective of these studies is to attain greater and stable yields by improving water management, optimizing the use of fertilizers and enhancing the fixation of atmospheric nitrogen by field crops. Of the 37 operational contracts, 15 are for country projects, 11 for regional coordinated programmes, and 11 for interregional coordinated programmes. Besides these projects, there was a regional African technical coordination project (involving 14 member States) on biological nitrogen fixation with the objectives of developing human resources and enhancing collaboration in the use N-15 technique to increase the capability of trees and pasture legumes to fix nitrogen and improve soil fertility.

Plant breeding and genetics (D2)

7. Nuclear radiation is applied to seeds to induce genetic variations from which mutants with the desired characteristics e.g higher yield, better plant quality, resistance to disease, are selected. Out of the 22 operational contracts, 8 were country projects, 11 regional coordinated

programmes, and 3 interregional coordinated programmes. A few African countries have already used this method to release improved seed varieties.

Animal production and health (D3)

8. Nuclear technology contributes in three main areas: (a) using isotopes in tracing elements and compounds in animal feeds into the animals (mostly ruminants- sheep, goats, cattle, buffalo, camel) to study the efficiency in digesting different types of foodstuff and in protein absorption. This helps to determine the best combination of locally available materials for optimum yield of animal products. (b) Using radioisotopes to measure levels of reproductive hormone progesterone and how this varies in relation to different diets. This knowledge is used to improve reproductive efficiency. (c) Development of materials and methods, based on isotopic tracers, for diagnosing diseases. Of the 58 contracts, 21 are on country projects, 35 on regional coordinated programmes, and 2 on interregional programmes.

Insect pest Control (D4)

9. Emphasis is on the application of the sterile insect technique (SIT) as a major component of integrated pest management systems. Radioactive and stable isotopes are used to study insect populations, ecology, migrations. Of the 21 operational projects, 10 are country projects and 11 interregional coordinated research programmes.

STI techniques have been extensively used in important programmes in the region, notably the eradication of the New World Screwworm which was discovered in Libya in 1988; and in the campaigns to eradicate the Mediterranean fruit fly in northern Africa; and the tse-tse fly in Eastern and Western Africa subregions. Regional training courses have been conducted on the integrated tse-tse fly control using the SIT. It is to be noted that the International Centre for Insect Physiology and Ecology (ICIPE), based in Nairobi, has been particularly successful in such research and training activities.

Agrochemicals and Residues (D5)

10. Modern agriculture relies on the use of chemical fertilizers to boost production and pesticides to suppress weeds and insects. However excessive use of these may harm the environment and the non-target flora and fauna. Isotopic tracers are used to study the behaviour, breakdown, and residues of agrochemicals in the soil, water, plants, animals and their products with a view to devise safe ways of application of agrochemicals. Of the 30 operational contracts in this class, 3 are country technical cooperation projects, 17 are on regional coordinated research programmes, and 10 are on interregional coordinated research programmes

Food preservation(D6)

11. Nuclear science and technology is used to curtail food losses, diminish incidence of food-borne diseases, extend shelf life and facilitate trade in food and agricultural commodities, especially for those items which cannot be treated satisfactorily by other methods e.g. canning or freezing. This is achieved by irradiation of food products for microbial disinfection and reduction of microbial spoilage agents, insects disinfection, control of pathogenic organs and

parasites, delayed ripening and inhibition of sprouting. Of the 13 contracts in this class, 3 were on country technical cooperation projects, 9 on regional coordinated research programmes, and 1 was on interregional coordinated research programme. Since 1988 the potential of food irradiation in Africa was recognised, and various regional training and awareness seminars have been conducted to support the use of this technology in the reduction of food losses. A regional research coordination meeting in 1989 developed plans for A Regional Food Irradiation Programme for Africa and also contributed to the establishment of the African Regional Cooperative Agreement (AFRA). Many countries have expressed interest in food irradiation research, and commercial irradiation facilities are being installed in a few countries.

Conclusion

12. In spite of the interest shown in the acquisition and use of nuclear techniques in food and agriculture, Africa lags behind Latin America, Asia and the Pacific regions. It can therefore learn a lot from their experience. Efforts are still needed to initiate or expand programmes for the development of human resources and infrastructure necessary for effective participation in scientific research in nuclear science and technology. Greater initiatives are needed to diffuse the technology and expand its industrial application in many spheres cited above and also in other sectors of human endeavour.

Recommendations.

13. On the basis of the observations made in the study carried out by the Secretariat in a number of African countries, and those by the Ad-hoc Expert Group meeting on Nuclear Science and Technology for Food and Agriculture, convened by the Secretariat to review the report of the study, the following recommendations are brought before the IGCESTD for its consideration and adoption:-

(i) Member States should initiate policies and plans, if they have not done so already, to foster the acquisition and utilization of nuclear science and technology in food and agriculture.

(ii) Member States should create the necessary capacity both in terms of research institutions and human resources to exploit the potentially available IAEA technical aid and technology transfer facilities in nuclear science and technology.

(iii) Member States should take measures to increase the popular awareness of the potential and practical contribution of nuclear techniques to the development of agriculture and food production. In particular they should ensure broader acceptability of food irradiation as a safe and powerful tool for combating the enormous post harvest food losses currently experienced in Africa, with a view to ensuring its wider application on commercial basis.

(iv) Member States should increase their participation in multinational and regional cooperation in nuclear science and technology through activities such as: training, research, establishment and use of common facilities, exchange of information. In this regard they should join the membership of the African Regional Cooperative Agreement (AFRA) and lend more support to its programmes and activities.

Operational contracts in African member States of IAEA in the categories of technical cooperation project (T); regional coordinated programme (CR); interregional coordinated programme (CI); and in classes of D1 = soil fertility, irrigation and crop production; D2 = plant breeding and genetics; D3 = animal production and health; D4 = insect and pest control; D5 = agrochemicals and residues; and D6 = food preservation

Countries	D1	D2	D3	D4	D5	D6	
Algeria	1T	-	1T	-	1T,2CR	1T,1CR	7
Cameroon	1T	1CI	1T,1CR	-	-	-	4
Cote d'Ivoire	1T, 1CI	2CR 1CI	2T,2CR	-	-	1T,1CR	10
Egypt	1CR,1CI	1CR	1T,1CR,1CI	1CI	1T,2CR,3C	1CR	14
Ethiopia	-	-	2T,2CR	1CI	1	-	6
Gabon	-	-	-	-	-	-	0
Ghana	1CR,2CI	1T,3CR,1	2T,3CR	2T,1CI	-	1CR	21
Kenya	1CR	1CR	2T,2CR	1T,3CI	2CR,2CI	-	13
Liberia	-	-	-	-	1T, 2CI	-	0
Libyan A.J.	-	1T	-	2T,1CI	-	1CR	5
Madagascar	1T	-	-	-	-	-	1
Mali	-	2CR	1T,2CR	-	-	-	5
Mauritius	1T	-	-	-	-	-	1
Morocco	1T,1CR,2CI	1T	2CR,1CI	1CI	-	1T	9
Namibia	-	-	-	-	-	-	0
Niger	1T	-	2T,2CR	-	-	-	5
Nigeria	2T,2CR,2CI	1T,1CR	1T,4CR	1T,1CI	2CR,1CI	2CR	20
Senegal	1T,1CR,2CI	-	3CR	-	-	-	7
Sierra Leone	1T,1CR	-	1T	-	-	-	3
South Africa	-	-	-	-	-	1CI	1
Sudan	1CR	1T	2CR	-	-	-	4
Tunisia	2T,1CR	-	1T,1CR	-	-	-	5
Uganda	1T 1CI	1T,1CR	2CR	1T,1CI	1T,1CI	-	9
U.R.	1CR	-	2T,2CR	1T	1T	-	10
Zaire	1CI	1T	-	-	-	1CR	3
Zambia	1T	1T	1T,2CR	2T	2T	1C	11
Zimbabwe	-	-	1T,2CR	1CI	1CI	-	7
No. contracts	37	22	58	21	30	13	181