Pattern and Impact of the Agency's Technical Assistance Programme in the Asia and Pacific Region

by D.A. Nethsinghe

INTRODUCTION

The main objectives of the Agency's technical assistance programmes are to promote the transfer of skills and knowledge relating to the peaceful uses of atomic energy to developing countries, to support the efforts made by these countries in carrying out their atomic energy activities safely and more efficiently, and to ensure that the technology transferred can continue to be applied usefully for the countries' economic and social development after the Agency's assistance has been completed.

Technical assistance, provided in the form of fellowship awards for training, expert and consultancy services, and equipment, covers a wide field of activities ranging from the application of isotopes and radiation in agriculture, medicine and industry, to nuclear physics and chemistry, nuclear electronics, research reactor utilization, uranium ore exploration and processing, nuclear fuel fabrication, nuclear power development and safety in nuclear energy (including nuclear power plant siting and safety, radiation protection, radioactive waste management and environmental protection).

Assistance is provided for technically sound projects which are likely to play a meaningful role in the country's development programme. The recipient country is expected to have an adequate infrastructure (particularly in relation to physical facilities such as laboratory space, stable water and power supplies, managerial capability, and appropriately trained manpower) to absorb and make effective use of the assistance provided. It is also expected that there would be effective co-operation between the atomic energy authority, national planning secretariat and other national institutions involved (eg. agricultural departments, agricultural research institutes and university faculties of agriculture in the case of projects in agriculture, geological survey and mineral prospecting departments in the case of uranium exploration projects). However, it cannot be said that these criteria are always met.

Funds for the Agency's technical assistance programme are made available through the Agency's own resources, the United Nations Development Programme (UNDP), governmental aid organizations such as the Swedish International Development Agency (SIDA) and other major donor countries such as Australia, Japan and the USA. In recent years, 15 countries in the Asia and Pacific region have been provided with technical assistance by the Agency (Bangladesh, Burma, Democratic Republic of Korea, Hong-Kong, India, Indonesia, Republic of Korea, Malaysia, Mongolia, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, and Viet Nam).

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This article deals with the pattern of technical assistance provided to the Asia and Pacific region during the ten year period 1969–1978 in relation to the various components of assistance (training, expert services and equipment), and fields of activity, and the extent to which the objectives of the Agency's technical assistance programme have been realized. It should be mentioned that while the pattern of assistance can be defined in quantitative terms, the impact of this assistance cannot be measured statistically. In many cases assistance is provided as part of a continuing programme of atomic energy development in the recipient country, the results of which may not be apparent for several years, and even then its effect could not be measured in isolation from the programme as a whole, eg. research reactor programming and utilization, strengthening of nuclear facilities for application in research aimed at increasing food production. Often, the assistance provided is intended only to fill a gap in the recipient country's programme, and, in monetary terms is only a small fraction of the total costs involved. The assistance provided acts more as a catalyst which activates national interest in the subject and its impact will often be apparent only a few years after the Agency's assistance has been completed.

PATTERN OF ASSISTANCE

In the early years, the Agency's technical assistance activities, particularly those in the fields of nuclear physics, chemistry, agriculture and industry were largely focused on small unrelated projects at national atomic energy institutions, research reactor centres, and universities where small scientific communities tended to work in isolation. Little effort was made to co-ordinate and dovetail their efforts with the larger national development plans. Perhaps the only exceptions were projects associated with research reactors and nuclear power development The early years might be considered as the period of learning and demonstration, when isolated groups of scientists gained experience in the application of nuclear methodology to such diverse fields as agriculture, medicine and industry, and demonstrated the value of nuclear techniques to scientists, technologists, administrators, and policy makers involved in national development programmes in the various sectors. During the last decade, national atomic energy activities have shown an increasing involvement with national development plans, and countries in the region have shown interest in larger and long term projects. In 1978 the Agency initiated planning and advisory missions for assisting Member States in the identification and formulation of such large and long term projects, integrated with national, social, and economic development plans. Missions visiting countries in the Asia and Pacific region in 1978 covered the fields of agriculture, industry, nuclear power development and nuclear physics/chemistry. As a result of these missions, large scale assistance projects (of the order of one million dollars or more each) have been identified and formulated for UNDP support in the fields of agriculture and industry. A few multi-year projects have been included for support under the Agency's regular programme of technical assistance in the fields of nuclear power, environmental protection, agriculture, and nuclear physics and chemistry.

The annual monetary value of the Agency's technical assistance programme (funded from all resources) in the Asia and Pacific region for the period 1969–1978 is shown graphically in Figure 1. At first glance it would appear that there has been a three-fold increase in the value of assistance provided in 1978 (over $3.3 million) compared to the assistance provided 10 years ago ($1.1 million). However, considering inflation and the decline of the purchasing power of the dollar, the real value of assistance provided over the last decade has

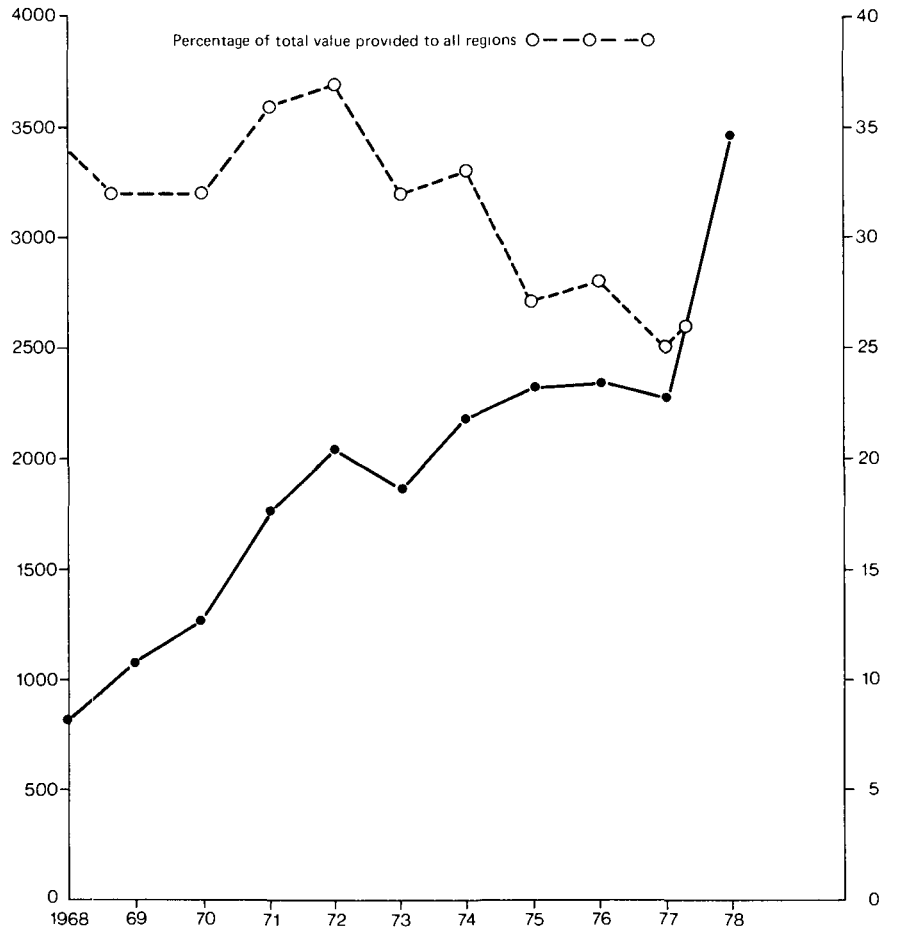

Figure 1. Total value of Technical Assistance provided to the Asia and Pacific Region annually, 1968–1978.

increased by somewhat less than 10%. During this period the total value of technical assistance provided to the Asia and Pacific region amounted to $20.6 million of which about 30% was from UNDP and other external resources. The proportion of assistance provided to countries in the Asia and Pacific region was over 32% of the total assistance provided through the Agency to all countries until 1974, and thereafter a significant reduction is observed (down to 26% in 1978). During the ten year period 1959–68, 37% of the Agency's total assistance went to the Asia and Pacific region, while in the last decade (1969–78) this figure dropped to 30% With the increasing demand for assistance from other regions and the limited resources available, it is inevitable that the share of assistance for the Asia and Pacific region should decrease, unless there is a considerable increase in the funds made available for technical assistance.

Table 1. Technical Assistance provided to Asia and Pacific Region, 1969–1978

	Fellowship Awards				Scientific Visits and Training Courses		Experts				Equipment	
Year	Number	% of number, all regions	Man-months	% of man-months, all regions	Number	% of number, all regions	Number	% of number, all regions	Man-months	% of man-months, all regions	$ (1000s)	% of total for all regions
1969	85	29	849	32	62	33	47	28	232	31	214 5	20
1970	111	31	1160	33	101	36	45	29	172	27	245 5	23
1971	90	23	909	24	164	46	62	28	206	28	687 7	46
1972	100	31	932	31	70	37	58	30	229	31	837 4	43
1973	103	31	918	31	102	42	53	26	197	26	788 7	38
1974	128	31	1137	31	61	28	65	29	214	29	953 5	35
1975	160	36	1392	37	109	33	46	20	171	22	1024 3	30
1976	114	30	1100	32	111	40	52	24	163	23	890 7	31
1977	153	38	1421	41	157	37	72	26	226	28	584 4	19
1978	155	39	1159	37	124	25	91	26	169	21	1250.1	23
Total 1969-78.	1199	–	10977	–	1061	–	591	–	1979	–	7476 8	–
Average:	–	32	–	36	–	35	–	26	–	27	–	30

Table 1 gives a breakdown of the value of equipment provided, and the number and man-months of expert services and training awards provided under the Agency's technical assistance programme from all resources for the period 1969–78. Figure 2 shows the pattern of total training awards for the same period. The statistics in Table 1 on expert services and training awards are presented in numbers of individuals and months rather than dollar equivalents, as the former is a more realistic measure of the assistance provided. The data show that, proportionately, the Asia and Pacific region has laid increasing emphasis on manpower development through fellowships and scientific visits and participation in training courses. It will be seen from Figure 2 that the total number of scientists trained annually has increased from 147 in 1969 to 300 in 1978, the percentage share of the Asia and Pacific region remaining consistently in the range of 30–37 percent (despite the drop in the share of the total assistance received by the region). A total of about 1200 scientists received fellowship awards during the decade 1969–78, (32% of the total for all regions), while a further 1061 (35% of the total for all regions) received short term training through participation in training courses and scientific visits. About 20 regional training courses, mainly in the fields of nuclear power and agriculture, were hosted by Member States in the Asia and Pacific region during the period 1969–1978

The share of the expert services and equipment delivered to the Asia and Pacific region during the last decade was 26 and 30 percent respectively, with no discernable trends over

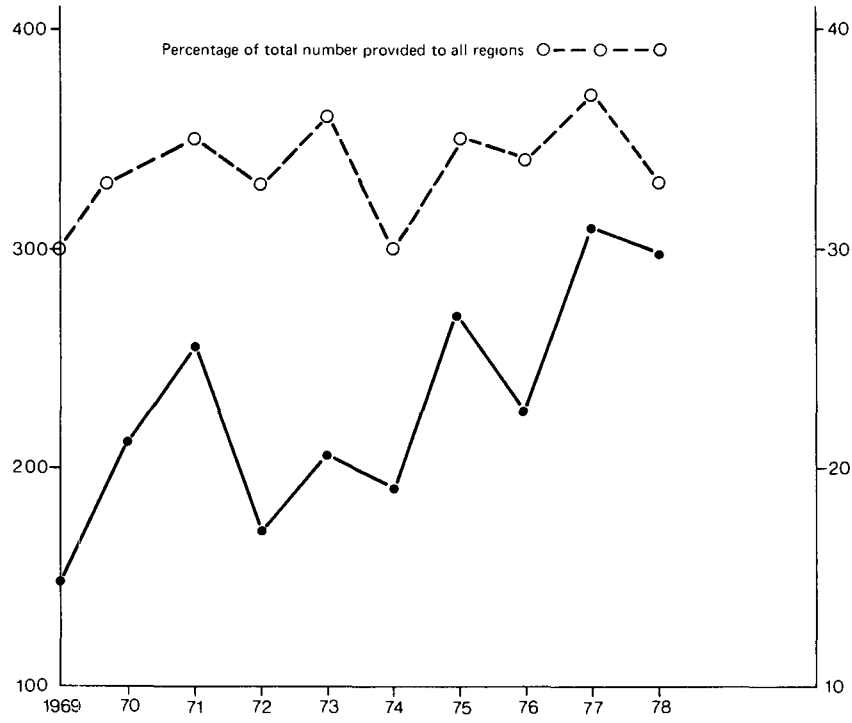

Figure 2. Total number of Fellowship awards to Asia and Pacific Region.

the years except for a tendency towards shorter duration of expert assignments. The latter perhaps reflects to some extent the success of the technical assistance programme in manpower development in the recipient countries

The annual distribution of technical assistance by field of activity is shown in Table 2. The dominant areas of activity are in agriculture and in the combined fields of nuclear engineering and technology and safety in nuclear energy (including nuclear power development and nuclear plant safety), where the share of total assistance to the region fluctuated between 19 and 39 percent, and 17 and 30 percent respectively. A clear increasing trend is observed in the share of assistance provided in the fields of nuclear raw materials prospecting and safety in nuclear energy during the later years, while in the fields of nuclear chemistry and industry the trend has been towards a decrease in the share of assistance.

IMPACT

The effectiveness of the Agency's technical assistance programme can be best illustrated by referring to some examples of activities in the various fields which have contributed to the recipient countries' development

(i) Research Reactors and Nuclear Power Plants

A high proportion of the activities in the fields of "nuclear engineering and technology" and "safety in nuclear energy" has been directed to the development and utilization of research reactors and nuclear power plants. Research reactors are now in operation in seven countries of the Asia and Pacific region receiving technical assistance from the Agency: Democratic Republic of Korea, India, Indonesia, Republic of Korea, Pakistan, Philippines and Thailand Two other countries, Malaysia and Viet Nam, are expected to have research reactors in operation during the early 1980's Nuclear power plants are operating in India, the Republic of Korea and Pakistan, while the Philippines is constructing its first plant. Bangladesh, Indonesia, Malaysia and Thailand are also considering the establishment of nuclear power plants.

In the field of nuclear engineering and technology the Agency has assisted many countries in the region in the evaluation of their feasibility studies for nuclear power plants, planning and constructing research reactors and associated laboratories, and establishing training centres for nuclear engineering and technology. For instance, during 1964–66 a UNDP-financed project helped to carry out a pre-investment study on energy, including nuclear energy, in the Philippines This was followed by a UNDP-supported feasibility study on nuclear power in 1972–73 on the basis of which the Philippines embarked on the construction of the country's first nuclear power plant. Technical assistance for research reactor utilization has been mainly directed to the provision of expert services, training, and facilities for research in nuclear physics, radiation chemistry, radioisotope production, activation analysis and reactor instrumentation.

Both in the development of research reactors and nuclear power plants, the Agency's assistance in the field of safety in nuclear energy has covered a number of subject ranging from legislative, regulatory and licensing aspects to reactor site selection, studies on environmental radioactivity prior to reactor operation in order to establish base levels of radioactivity, health physics and personnel protection, radioactive waste management, and the application of safety criteria and standards to the planning, design, construction and

Table 2. Percent of Total Technical Assistance Received by Asia and Pacific Region, by Field and by Year

Field of Activity	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
General atomic energy development	2	1	2	3	2	2	2	1	3	4	5
Nuclear physics	14	10	11	8	5	10	5	9	5	13	13
Nuclear chemistry	11	8	12	4	8	6	4	5	4	3	4
Prospecting, mining and Processing of Nuclear Materials	1	1	1	12	7	9	20	18	14	13	12
Nuclear engineering and technology	24	22	25	11	17	11	10	14	17	19	16
Application of Isotopes and radiation in Agriculture	24	31	22	39	31	25	22	23	26	19	23
Application of Isotopes and radiation in Medicine	12	8	6	7	11	8	13	7	12	9	6
Application of Isotopes and radiation in Biology	2	2	2	2	4	2	2	2	2	5	2
Application of Isotopes and radiation in Industry and Hydrology	5	12	14	8	12	20	15	14	7	4	5
Safety in nuclear energy	5	5	5	6	3	7	7	7	10	11	14

operation of reactors. An on-going UNDP-funded project in the Philippines, for example, has helped to develop local manpower requirements for safety analysis review, regulation and licensing of nuclear power plant design, construction and operation through the provision of expert services and fellowships for training abroad. Similarly, in the Republic of Korea technical assistance provided under the Agency's regular programme has helped to build up the manpower for the country's regulatory body responsible for the safety analysis review and licensing of their nuclear power plants, the first of which commenced operating in 1978. A training course on Safety Analysis Review was held for Korean nationals in 1979. Apart from the training of local manpower, the expert services provided to both these countries have played a key role in evaluating and advising on safety at various stages of nuclear power plant development. Technical assistance under the Agency's regular programme has helped in site selection, preparation of a detailed safety analysis report, base-line studies on environmental radioactivity, and manpower training for the research reactor now under construction in Malaysia

A major impact of research reactors in national development plans of countries in the Asia and Pacific region has been in the training of nuclear scientists and technologists for the countries' atomic energy programmes in a variety of sectors ranging from nuclear power plant development to the application of radioisotopes and radiation in agriculture, medicine and industry. Reactor centres have served as focal points for research and training in nuclear science and technology.

The production of radionuclides (particularly those required for medical diagnostic purposes, and biological and agricultural research) neutron activation analysis (geological, industrial and biological samples) and the use of slow neutron diffraction and scattering techniques in the field of solid state physics for studying the structure of materials (eg. in metal industries) are other major contributions of research reactors which have made an impact on a number of sectors in the recipient countries.

(ii) Prospecting for uranium and other nuclear raw materials

Technical assistance has been provided for prospecting for uranium and other nuclear raw materials both under the Agency's regular programme and with UNDP financial support in Bangladesh, Burma, India, Indonesia, Republic of Korea, Malaysia, Pakistan, Philippines, Sri Lanka, and Thailand. Today, most of these countries are seriously committed to continuing activity in this field. The Agency's assistance has also helped to establish facilities for ore analysis in many of these countries.

In Thailand, for example, Agency project support in 1976–77 indicated that uranium occurs in sandstone-type deposits in the Khorat Plateau in the north-eastern parts of the country which is similar to the Colorado Plateau of the USA where deposits of uranium have been found. Further assistance for more detailed and systematic exploration is being provided under the Agency's 1979 regular programme. Thailand is also planning for the processing and export of monazite sands.

The promising results obtained in Bangladesh under an Agency-assisted project for uranium and thorium prospecting in 1975 have led to further support from the Agency and UNDP for a more detailed exploration programme. Agency assistance has helped to build up a facility for uranium ore analysis at the Atomic Energy Centre in Dacca.

In Pakistan, Agency and UNDP support for uranium exploration and drilling programmes led to considerable development in the country's programme for exploiting available resources of uranium and other nuclear raw materials (monazite and zircon). Agency assistance is being provided to develop a pilot plant for uranium ore processing at the Atomic Energy Minerals Centre in Lahore.

(iii) Agriculture

Most of the Agency's Member States in the Asia and Pacific region receiving technical assistance have agriculture-based economies. It is therefore not surprising that over 30% of the Agency's technical assistance provided to the region over the last 20 years should have been directed to increasing agricultural production. Bangladesh, Burma, India, Indonesia, Republic of Korea, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam have received assistance for developing facilities for the use of isotopes and radiation in practically-oriented research. This research relates to problems in fertilizer use and crop nutrition, soil moisture conservation and irrigation, production of high yielding and disease resistant crop varieties, animal health and nutrition, control of insect pests, food preservation and environmental pollution from agricultural chemicals. Large-scale assistance by UNDP and SIDA have helped to establish agricultural research institutions specially equipped for the use of nuclear techniques in Bangladesh and India the Institute for Nuclear Agriculture (INA) in Mymensingh, Bangladesh, and the Nuclear Research Laboratory (NRL) of the Indian Agricultural Research Institute (IARI) in New Delhi, India. Technical assistance has also been provided under the Agency's regular programme for the development of three similar institutions in Pakistan (in Tandojam, Faisalabad and Peshawar). Some examples of specific project activities and results which are of practical and economic significance in various countries are discussed below.

Field experiments on rice grown under flooded conditions using fertilizers labelled with the isotopes nitrogen-15, phosphorus-32 and zinc-65 have been carried out in most of the above mentioned countries, under the FAO/IAEA Joint Division's co-ordinated research contract programmes. These have helped to develop efficient fertilizer management practices This work was made possible as a result of technical assistance provided by the Agency for the development of analytical facilities and manpower training.

In Bangladesh, radiation-induced mutation breeding research under the large-scale SIDA-assisted project at the Institute of Nuclear Agriculture has helped produce two early maturing and high yielding varieties of rice (IRATOM 24 and IRATOM 38) which have now been released for use by farmers. Two early flowering radiation-induced jute mutants have also been evolved and recommended for release to farmers.

In Pakistan, under a UNDP-supported project at the Nuclear Institute for Agriculture and Biology in Faisalabad, radiation-induced mutants of wheat, rice, mung bean and cotton, having one or more of the desirable characteristics of high yield, short straw, disease resistance and early maturing have been developed and recommended for release to farmers.

Similarly, in Indonesia, a small UNDP-supported project has helped to evolve a radiation-induced mutant of rice resistant to the brown plant hopper — an insect pest causing considerable damage to rice fields in many countries in the region. This mutant has been tested and found to be promising in Malaysia and the Philippines too.

In India, nearly all of the 4 million hectares of hybrid millet resistant to a major disease, downy mildew, is based on radiation induced mutants developed at the Nuclear Research Laboratory of the Indian Agricultural Research Institute. Also, in India, two radiation-induced mutants of ground nut with very large seeds, which are in particular demand for export, and a high oil-content mutant of mustard have been developed at the Bhabha Atomic Research Centre and released to farmers. These resulted from the large scale UNDP-supported project.

Another result of the large scale UNDP-supported project in India was the development and use of a radiation-attenuated vaccine against lung-worm in sheep in Kashmir. This has brought about a significant improvement in the health of the animals and in the quality of their products. The results of the vaccination programme have been so successful that there is now a heavy demand by nomads for the vaccination of their flocks. At present, the limited supply of vaccine produced enables only 50 000 animals to be vaccinated annually – about 15% of the total needing vaccination. It is hoped to increase the vaccine production under the on-going SIDA-supported project "Strengthening of Nuclear Research in Agriculture" which, like the previous UNDP project, is supporting the development of nuclear agriculture research in four institutions – the Indian Agricultural Research Institute, Indian Veterinary Research Institute, National Dairy Research Institute, and Bhabha Atomic Research Centre.

Root distribution studies on sorghum and millet using radioisotope methods at the NRL in India have helped to identify deep rooting varieties which are particularly suited for growing under conditions of limited soil moisture availability.

A particularly striking feature of the application of nuclear techniques in agriculture in India is the machinery established by the Indian Agricultural Research Council for collaboration between various agricultural institutions and universities in the country so that the results of research are tested in various parts of the country and finally carried to the farmers for practical application.

In Sri Lanka, fertilizer placement studies on coconut palms, (a major export crop) using fertilizer labelled with phosphorus-32 has helped to develop a more efficient method of fertilizer application, reducing the costs of production. Other projects of national importance supported under the Agency's regular programme of technical assistance are investigations, using phosphorus-32, of the efficiency of locally available rock phosphate as compared with imported phosphate fertilizers in connection with the economically important crops rice, tea, coconut and rubber, and the development of effective soil moisture conservation practices on tea, rubber and coconut plantations with the aid of the neutron soil moisture meter. These projects have helped to establish close collaboration in the use of nuclear methods between the various agricultural research institutions in the country – the Central Agricultural Research Institute and the Tea, Rubber and Coconut Research Institutes.

An on-going Agency regular programme project in Malaysia, at the National University in Kuala Lumpur is aimed at developing teaching and research capability in plant breeding, particularly in relation to rice and soybean. A notable feature of this project is the successful co-operation which has been built up between various agricultural institutions in the use of nuclear techniques – the National University, the University of Malaysia, the Rubber Research Institute, and the Malaysian Agricultural Research Institute.

(iv) Industrial Applications

In this field the major areas of the Agency's technical assistance activities have been in radiation processing and sterilization using gamma radiation, non-destructive testing using gamma and X-ray radiography, and in hydrology. Practically all developing Member States of the Agency in the region have received assistance in one or more of these areas.

Cobalt-60 demonstration plants and radiation processing have been set up in India and in the Republic of Korea under UNDP-supported projects. The Indian plant ISOMED, completed in 1975, is being used for demonstrating the radiation sterilization of medical products such as cotton dressings, surgical sutures, disposable hypodermic syringes and contraceptives. It also serves as a centre for training scientists and technologists in various aspects of radiation sterilization. The Korean facility, completed in 1977, consists of a 100 kCi Cobalt-60 gamma irradiator and a 300 kV electron accelerator. In addition to demonstrating to local pharmaceutical manufacturers the effectiveness of radiation for sterilizing medical products, this project is aimed at developing a programme of radiation technology for the surface coating of plywood products and for the modification of textile fibres. As a result of this project, many manufacturers of medical products in the Republic of Korea have accepted radiation sterilization as an economical and preferred alternative to conventional sterilization processes.

Agency technical assistance projects have helped to develop facilities and expertise for non-destructive testing using gamma radiography in India, Indonesia, Republic of Korea, Pakistan, Philippines, Singapore and Thailand. This technique is now serving local industries such as building and pipeline construction, and the oil industry, for the quality control of welds, piping, etc.

The Singapore Institute of Standards and Industrial Research is a striking example of where Agency technical assistance has been effectively used for the development and application of radiography methods for non-destructive testing in various industries in the country. The Institute has become so well developed in this field that it proved to be a worthy host for the Agency's regional training course on non-destructive testing held a few years ago. The Institute continues to be a training centre on the subject.

Under the UNDP-funded project on agriculture at the Nuclear Research Laboratory of the Indian Agricultural Research Institute, isotope studies on ground water hydrology carried out in collaboration with other national institutes showed that the ground water of the Rajasthan Desert, which has been exploited for agriculture through tube wells, is very old, and that there had been no recharge for at least 3000 years. Accordingly, it was recommended that the ground water should not be over-exploited, and that it should be rationally utilized in order to avoid worsening the desert conditions. Isotope studies also helped to show that the flooding of the river Ganges was mainly due to the melting glaciers in the Himalayas. It was recommended that these waters should be diverted to the ravines of the Rajasthan Desert for recharging the ground water. These suggestions, which provide solutions to the dual problems of ground water recharge and flood damage, have now been taken up by the Indian authorities for action.

(v) Nuclear Medicine

Assistance has been provided for establishing and upgrading nuclear medicine units associated with hospitals and universities in practically all developing countries in the region.

Radioisotopes are used for a wide range of diagnostic tests, in which both *in vitro* and *in vivo* tests are involved.

Technical assistance to Burma under the Agency's regular programme has helped to build up the Rangoon General Hospital's Department of Nuclear Medicine to a high standard It is suitably equipped with appropriate instrumentation and trained manpower for both *in vitro* radioimmunoassay diagnostic tests and for *in vivo* tests using radiopharmaceuticals and scintigraphy.

A UNDP-supported project has helped to establish a nuclear medicine unit at the Faculty of Medicine, University of Peradeniya, Sri Lanka The Unit is now used not only for teaching purposes, but also for clinical diagnosis and treatment of some 3000 patients annually. As a result of the training received by medical doctors and other staff, the new techniques are expected to have wider application in Sri Lanka. In view of the increasing demand for clinical diagnosis for the 14 million inhabitants of the country, it is planned to set up a second nuclear medicine unit in Colombo. The project, (which had an input from UNDP of $15,000 over a period of six years) and the associated assistance provided under the Agency's regular programme serve as a good example of what can be done in a developing country to enable the local people to develop and expand their own potential through very modest external assistance. The Peradeniya nuclear medicine unit has reached a stage where it was competent to host the Agency regional training course on radioimmunoassay techniques held in March 1979