Serving human needs: Nuclear technology for sustainable development*

In public perception, nuclear technology is associated with weapons of mass destruction or, at best, with nuclear power. Way back, after the end of the Second World War, the then Atomic Energy Commission of the United States of America had initiated a global programme 'Atoms for Peace' to promote applications of radiations and radioisotopes in different areas of human endeavour. Later, the development and applications of these technologies have been promoted by many countries. From 1958, the International Atomic Energy Agency (IAEA), Vienna has played a significant role through technical cooperation at an international level. As a result, nuclear techniques are widely used, especially in the area of health care and sterilization of medical products; in agriculture for insect pest control and irrigation management. Other applications are in agricultural research for enlarging the genetic diversity through induced mutations, and as tracers in studies on soil, water, plant and environment. These techniques have contributed a great deal towards increasing crop productivity, improving human and animal health and finding ways for sustainable growth.

The objective of the Forum was to take stock, and create awareness of the lesser known non-power applications of the nuclear technologies. International development experts, leading scientists and subject specialists were invited to present status papers and participate in the panel discussions. Ten speakers presented examples of the applications in the areas of food security, managing water resources and improving human health. Presentations were followed by panel discussions, and a concluding roundtable discussion titled 'Matching Needs and Technologies'. Due to the tragic events of 11 September in USA, and subsequent disruption of the flights, invited participants from USA could not reach. Some sent the videotapes of their presentations or interacted through live video arrangements in the conference hall.

*A report on the two-day Scientific Forum 'Serving human needs: Nuclear technology for sustainable development', was organized by the IAEA at the Austria Center, Vienna during 18–19 September 2001.

The Forum started with the opening comments by M. ElBaradei (Director General, IAEA), followed by remarks by V. S. Ramamurthy (Forum Chairperson, and Secretary, Department of Science and Technology, India). ElBaradei wanted the recommendations of the Forum on four issues regarding the technology transfer. (1) Assessment to ensure that the nuclear technology in any given area is the best available technology. (2) Importance of the government commitment and investment in determining the success of the technology. (3) The factors that contribute to the successful partnerships, both between publicly funded institutions and between public and private, profit-motivated organizations. (4) Who 'picks up the ball' after initial support to continue the development process? Ramamurthy, in his opening remarks stressed on capacity-building in all areas of technology development, transfer, implementation and monitoring.

Science, Technology and Development Interactions were covered in the first session which started with the video presentation by Jeffrey Sachs (Director, Center for International Development, Kennedy School of Government, Harvard University). Sachs, an economist, reminded that the gap between the rich and poor nations of the world is widening, which is a matter of great concern. He attributed this to the fact that 'The science and technology operates most powerfully in those places that already have highest income, whereas in the low-income countries, those impulses tend to be weak and sometimes essentially non-existent'. The profit motive drives the scientists to focus on problems that have a higher rate of return. The rich countries with large markets provide greater incentive for private R&D, while very poor countries give little market impulse on their own for R&D. He further identified the other constraints – lack of critical mass for scientific creativity in the developing countries and ecological barriers that hinder technology transfer in areas of agriculture and health care. Technologies developed in the rich temperate ecozones which include the US, Europe and Japan are not applicable in the tropical and subtropical regions. The Consultative Group of International Agricultural Research (CGIAR) which supports the international agricultural research institutes in the tropical and subtropical regions, is under chronic budgetary constraints. He said 'the worldwide budget of the CGIAR is less than the budget of individual life science companies in the US and Europe'. The need for public and private sector partnership to address the problem of the poor, especially in the area of health care was stressed. His presentation concluded with the hope that large-scale international support can be mobilized to address the problems of the poor.

Jose Vargas' (Brazil's Ambassador to UNESCO) presentation was titled 'Science and Technology in a Developing Country: The Brazilian Case'. He traced the history of S&T in Brazil stating that the first printing press in the country was established in 1808 and the university in 1922. Exploitation of African slaves in sugar and coffee plantations, and gold mining contributed to the prosperity during the colonial period. After the Second World War, the Brazilian R&D efforts were based on 'import substitution model' in a protected market. However, since the beginning of the nineties 'open market' policies have been adopted, which are conducive for the growth of more creative knowledge-based enterprises. New laws to promote integration of S&T with entrepreneurial skills have been enacted and financial resources allocated for the same. Scientists in Brazil publish about 60,000 scientific papers with mean citation impact of over 1.5. It was significant to note that annual mortality due to AIDS in Brazil has started to decline from the peak in 1995.

The second session was devoted to promoting food security. Ms. Joyce Turk (Office of Agriculture and Food Security, USAID, Washington, D.C.) raised the questions related to the new realities of globalization, integrating the world's poor into the global economy, and producing food needed for 800 million people in a sustainable way. Four papers were presented: 'Tsetse Fly and African Trypanosomiasis: Towards a Lasting Solution' by J. Kobayo (Pan African Tsetse and Trypanosomiasis Eradication Campaign, Ethiopia); 'The Sterile Insect Technique: Cost-effective Control of Mediterranean Fruit Fly' by P. Gomez Riera (INTA La Consulta, Argentina) 'Global Impact of Induced Mutations in Plant Breeding' by

this author, and 'Utilization of Saline Water and Land: Reclaiming Lost Resources' by N. Naqvi, (Pakistan).

Tsetse fly is the carrier of parasitic microorganisms (Trypanosomes) which cause sleeping sickness in humans and equally devastating nagana disease in domestic animals. Over 10 million square kilometres area in 37 countries of sub-Saharan Africa from Senegal in the north to South Africa is infested with the tsetse fly. It is because of the tsetse that horses and animal-drawn farm implements are not seen in most of Africa. All productive breeds of cattle are susceptible to nagana and can therefore be raised only in the highlands free from tsetse. Sterile insect technique (SIT) was used in Zanzibar on the east coast of Africa, and tsetse was eliminated from the island. In the post-tsetse era, milch cattle are thriving in Zanzibar and livestock population is contributing to increased income of the poor farmers. Successful eradication of tsetse in Zanzibar has led to the implementation of similar programmes in many African countries. Organization of African Unity has initiated joint efforts for a phased systematic elimination of tsetse from the African continent.

Seventy-five species of plants of economic value, that include tropical and temperate fruits and vegetables, are infected by fruit flies in 77 countries. SIT has been used for the control of fruit flies since 1956, when the first mass rearing facility was set-up in Hawaii. Currently it is used in 13 countries which have more than 40 'fly factories' with capacities to raise up to 500 million flies per week. The results of the programme covering 160,000 ha in the citrus fruit-growing area of Mendoza, Argentina were presented. The cost-effectiveness of SIT for the control of fruit fly was demonstrated from the programmes in Israel and Argentina.

More than 2250 new cultivars in different crop and ornamental plants have been developed globally using induced mutants. Hundred and fifty malting barley cultivars used for the production of beer in all five continents carry the *denso* semi-dwarfing gene which was isolated as an induced mutant. *Durum* wheat cultivars in Italy contribute to an additional annual income of US $ 180 million, mutant rice cultivars in Japan US $ 937 million, and in California US $ 20 million. The black gram (*Urid*) cultivar TAU-1 developed at the Bhabha Atomic Research Centre (BARC) has contributed to additional production of 1.3 million metric tons in Maharashtra which in monetary terms amounts to nearly Rs 260 billion, while the total investment on mutation research for black gram at BARC would not exceed Rs 10 million. Many other such examples were presented.

In a model project on the utilization of saline water and land in nine countries of North Africa, West and South Asia, it has been demonstrated that saline water can be fruitfully utilized in the wastelands to grow a number of salt-tolerant grasses, bushes and trees. The sustainability of the system depends upon use of groundwater and irrigation management in such a way that salts do not accumulate in the top soil. This is a low-cost technology.

In the third session devoted to managing water resources, two papers 'Ethiopia's National Strategy for Improving Water Resources Management' by M. Amhain (Ethiopian Science and Technology Commission) and 'Understanding Arsenic Contamination of Groundwater in Bangladesh' by Babar Kabir (Bangladesh Arsenic Victims Rehabilitation Trust, Dhaka) were presented. Use of isotopes in hydrology studies has contributed to the understanding of the groundwater resources, flow and quality in arid regions of Ethiopia. Nuclear techniques are helping in identification of arsenic-free sources of water in Bangladesh.

The fourth session was devoted to the nuclear applications in the area of human health. Radiation therapy for treatment of cancer, and nuclear medicine are well known, but the role of nuclear techniques using stable isotopes in human nutrition is less known. Three papers were presented in this session. 'Neonatal Screening for Treatable Congenital Disorders' by W. Charoensiriwatana (National Institute of Health, Thailand) reported screening for congenital hyperthyroidism (CHT) and phenylketonuria (PKU) in Thailand. So far, over 1.4 million new-born babies have been screened. About 0.24% for CHT and 0.02% for PKU were above the cut-off limits. It was reported that by the year 2002, all new-born will be provided the screening services. 'Stable Isotopes for Improving Human Nutrition' by Ricardo Uauy (Institute of Nutrition and Food Technology, University of Chile); 'Radiotherapy for Cancer Treatment: A Growing Priority for Developing Countries' by R. P. Evans (Ministry of Health, San Jose, Costa Rica) were also presented. Malnutrition or 'hidden or silent hunger' is receiving greater attention since the 1990s. Nuclear and isotopic techniques are emerging as a valuable tool to address the problems of malnutrition such as micro-nutrient deficiencies, estimation of energy expenditure, determination of lean body mass, nutrient absorption and utilization, analysis of food and detection of stomach infections. These techniques use stable isotopes iron, zinc, carbon, oxygen and deuterium. When rice labelled with C-13 is cooked and eaten, the degree of malabsorption can be estimated by the proportion of tracer carbon to the total carbon in the stool.

The concluding roundtable panel discussion was summarized by Margaret Catley-Carlson (Chairperson, Global Water Partnership). She said that the market forces do not drive the nuclear technologies in the developing countries. At the same time, the private sector provides the best mechanism for the delivery of the products and services, both in the developed and developing countries. How to draw the private sector to provide these technologies in the developing countries remains a question. An example of SIT was cited for the control of fruit fly, where the operational part of the programme is supported by the fruit grower's association in South Africa. Good demonstrations of the technology are necessary for its acceptance and take-off. What are the factors that make partnerships in technology transfer successful, and how to build such partnerships? There are no easy answers to these questions. Since some of the technologies are needed by the developing countries alone, increased technical cooperation amongst them is needed. Survival in an intensely competitive world requires capacity-building in S&T, and delivery of the services. The message for success is 'globalize opportunities, and nationalize problems', as the national problems will have to be solved by the local efforts.

Jeffery Sachs responded to the summary by Catley-Carlson and questions from the floor through video. He pleaded with the rich donors to allocate more funds for international agricultural and health care research programmes. He and his colleagues have been advocating commitment of the rich governments to buy, at a reasonable price, future vaccines

for AIDS, malaria and tuberculosis for the use of impoverished people in the developing countries. This would give positive signals to multinational drug companies as well as small biotechnology start-ups that there is a market for malaria and TB vaccines, and money can be made in these areas as well. It was indicated that the Bill Gates Foundation is considering possible support for such a programme. He stressed that every country has to define its own priorities. However, most governments either neglect this or set wrong priorities. Citing the example for AIDS control he stated that against the estimated demand of 7–10 billion US $, the commitments so far are in the range of 1–2 billion. It was stressed by many speakers that for the new technologies, the governments should have a promotional and regulatory role, while delivery should be left to the private sector. Besides the applications of nuclear technologies, the issues that came up are equally relevant to science and technology development, technology transfer and management. Additional information can be obtained from www.iaea.org/worldatom

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Russia's supercomputer follows PARAM-10000

Following India, Russia has developed a supercomputer MVS-1000, capable of 1 trillion operations per second. This new machine ranks 30th in the list of the world's 500 most powerful supercomputers.

The capability to make Teraflops machines already exists in the Centre for the Development of Advanced Computing (C-DAC), Pune. The PARAM-10000 supercomputer was exported by C-DAC last year to the Institute for Computer Aided Design (ICAD), Moscow under an Indian export licence (India also has control over high-end computers developed by agencies such as C-DAC). Its present 100 Gigaflops capability is upgradable to Teraflops.

Russia's supercomputer is housed in the Russian Academy of Sciences. This Russian Government-funded $ 10 million computer started functioning in 1998 and was supported by President Putin, the Ministry of Industry, Science & Technology, the Russian Academy of Sciences, the Ministry of Education and the Russian Foundation for Fundamental Studies. The institutes which participated in the project included the Keldysh Institute of Applied Sciences, the State Enterprise Quant, and the Interdepartmental Supercomputer Centre.

Plans for a $ 20 million MVS-5000, which would be five times as fast as MVS-1000, could be realized by 2003.

Change of Guard

Rajagopala Chidambaram has recently assumed the mantle of Principal Scientific Adviser to the Government of India. He takes charge from A. P. J. Abdul Kalam. A dinner was hosted by Murli Manohar Joshi, Hon'ble Minister for Human Resource Development, Science and Technology (S&T) and Ocean Development in New Delhi on 30 November 2001 to bid farewell to Abdul Kalam. The dinner was attended by the Prime Minister, Atal Behari Vajpayee, several scientists and distinguished guests. On this occasion, in his 'before dinner' speech, Joshi said, Abdul Kalam would be using his expertise in many areas and has not left science, calling it 'the beginning of seeding of many Kalam's'. Kalam, he added, would be working in the cause of science with school and college students.

In his speech, Abdul Kalam dwelt on the oft-repeated question posed to him 'what are you going to do?'. Kalam said: 'I have a vision for myself that between August 2001 and August 2003, I must meet 100,000 high school students. From August 2001 up to now I have met 16,000 students'. The students have a lot of imagination, I wish to share with them and ignite their minds for the national development of science and technology. He recounted meeting a fifteen-year-old girl, who enquired of 'Uncle Kalam' as to which of his endeavours and successes had given him happiness. Successes, such as putting the first satellite into orbit using SLV3 rocket, Agni missile or the nuclear mission. To this query Kalam wanted to give the truth and said 'all of it had given happiness and beyond that a bliss'. He also cited a question asked of him in Tripura – 'Why do scientists not visit our State?'. Kalam said, 'we should answer this'. He also said that his own website brought up several comments. One of these was from a young person in Atlanta, United States of America who said, 'I can sing the song of India when my country gets capacity to put sanctions on any country it wants'. Kalam said, 'I want to capture this imaginative spirit'. There was a recital by Sarod Maestro Biswijit Roy Chowdhury in honour of Abdul Kalam who is known also for his love for music.

Murli Manohar Joshi while speaking of the new Principal Scientific Adviser to the Government of India said he hoped that 'S&T would be further strengthened in the country'. He also added that the new millennium final draft policy, a vision of India's S&T policy was now available on various Academy websites and this would be finalized after 8 December 2001.

Speaking exclusively to *Current Science*, Chidambaram said, 'India is too big a country to absent itself from any field of S&T. However its investment in any field, at any point of time is a matter of wisdom'. His 3-fold priorities would be to attract young people to careers in science, to achieve 'techno-foresight' (to lend support to technologies relevant to the country such as rural agro-based food industry) and finally give further impetus for basic research.

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