FARMERS' FRIENDLY NUCLEAR ENERGY BASED TECHNOLOGIES

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Energy is essential for the survival and growth of modern human civilisation. All available sources of energy, therefore, must be optimally developed and deployed to meet the short as well as long term energy needs of our country. Nuclear energy and related technologies are the safest options that can be used in diversified fields of agriculture and health for peaceful purposes. Many misconceptions and rumours are associated with the nuclear energy based technologies, like nuclear energy fosters nuclear weapons, nuclear radiation is deadly and nuclear reactors are not safe for human-beings and environment etc. This technological awareness gap of understanding nuclear energy and its applications is the most challenging area in India today. India faces formidable challenges in meeting its energy needs and providing adequate energy of desired quality to consumers in a sustainable manner at a reasonable cost.

Nuclear energy based technologies can play a bigger role offering sustainable solution to not only global energy problems, but also food safety and better farming practices. Agriculture is one of the important sectors under the peaceful uses of nuclear energy having major societal impact. Nuclear technologies are applied to minimize wastage of agricultural produces and at the same time it helps in increasing crop yield and thus adds to food security.

The hot and humid climate of India is quite favourable for the growth of numerous insects and microorganisms that destroy stored crops and cause spoilage of food every year. Spoilage can also occur due to chemical and physiological changes in stored foods. Sea-foods, meat and poultry may carry harmful microbes and parasitic organisms that cause illnesses associated with their consumption. Various methods of food preservation are in practice in the country which are costly and not farmers' friendly such as sun drying, pickling, fermentation and more energy consuming techniques such as refrigeration, freezing and canning. Each of these methods has its merits and limitations.

India's nuclear scientists are involved in a broad based research programme of agriculture and biotechnology for food safety through nuclear radiation (known as radiation processing of food or food irradiation), developing high yielding and early maturing crop varieties with better nutritional quality and wider ecological adaptability using mutation breeding. As many as forty crop varieties have been developed and released so far for commercial cultivation in different agro-climatic zone of India. The other important applications of nuclear technology in agriculture are studies on fertilizer use efficiency, control of insect pests through sterile insect technique, monitoring

Breeder seed plot of Trombay groundnut variety

of pesticide residues and preservation of agricultural produce. Farmer friendly soil organic carbon detection kit for the analysis of soil organic carbon on field has been developed with nuclear radiation technology.

Radiation processing of food or food irradiation is the process of exposing food to ionizing radiation in order to destroy microorganisms like bacteria or insects that might be present in the food. Food irradiation involves exposure of food to short wave radiation energy to achieve a specific purpose such as extension of shelf-life, inhibits the insect infestation and elimination of food borne pathogens and parasites. In comparison with heat or chemical treatment, food irradiation is considered a more effective and appropriate technology to destroy food borne pathogens. It offers a number of advantages to producers, processors, retailers and consumers. This effort is aimed to reduce the waste of food grains in India because of worms and pests. According to United Nations, India is also home to over 194 million people suffering from hunger. Approximately, 38 per cent of India's food grains go waste in storage. Most of the agricultural produce gets wiped out by insects and pests. This means country's farmers produce food grains to feed all hungry population, and some surplus too, but still, 194 million people go hungry. The proportion of food wastage can be reduced by nuclear energy based food irradiation.

The irradiation process involves passing of food through a radiation field allowing the food to absorb desired radiation energy. The food itself never comes in contact with the radioactive material. Food irradiation is like an X-ray, it doesn't remain in the body. So it is a safe process and do not induce any radioactivity in foods. Moreover, it increases the shelf life of the product like in onions, potatoes, mangoes and other fruits and vegetables. It inhibits the sprouts and also delays their ripening. It decontaminates the microbes in food products by making it safe and the availability of food for long time is also assured by this process. At present, all food products, except milk and milk products, are allowed to be irradiated. Large-scale irradiation takes place in medical and food sectors. Medical kits are sterilised using radiation facilities. Many ready-to-eat food items, too, are irradiated to increase their shelf lives. Research has proven that the properties of food items do not change during the irradiation and they are safe for consumption. Traditionally, in India food grains are exposed to sunlight for long hours during summer to kill all pests but irradiation facilities do this work in few seconds.

Government institutions involved in nuclear agriculture and biotechnology are preparing to establish a big network of food irradiation facilities across the country. At present, India has 21 irradiation centres where food grains, fruits, ready-to-eat food, mutton and chicken are also being irradiated. They are all under strict regulation of the Atomic Energy Regulatory Board. The Joint Expert Committee of the Food and Agriculture Organization (FAO), World Health Organization (WHO), and International Atomic Energy Agency (IAEA), in 1980 concluded that irradiation does not induce special nutritional problems in food.

Mutation breeding is other important application of nuclear radiation. In this process seeds are exposed to nuclear radiation in order to generate better varieties with desirable traits, which are known as mutants. Plants created using mutation breeding or mutagenesis are called mutagenic plants or mutagenic seeds. Bhabha Atomic Research Centre and Indian Council of

Agriculture Research have various research programmes in food and agriculture involving genetic improvement of crops through mutation breeding. The major emphasis in mutation breeding programmes is on oilseeds and pulse crops for higher productivity, resistance to biotic/abiotic stress and quality improvement.

Scientist at BARC has developed more than 200 plant varieties of grains, fruits and vegetables through nuclear radiation based mutations encompassing different crops including oilseeds like groundnut, mustard, sunflower, linseed, pulses like pigeonpea, moong, urad and cowpea; cereals like rice and wheat; other crops like soya bean and jatropha for bio-diesel. These varieties are endowed with improved characters such as early and higher yield, large seed size along with resistance to biotic stresses like insects, heavy metals etc. and abiotic stresses like shortage of water, drought, salinity etc. Mutation breeding in wheat and *sesbania* crops is also being carried out. Benefits of high-yielding ability of groundnut varieties by harvesting record groundnut yields in many parts of the country have been realized by farming communities. By cultivating the mutant varieties, groundnut productivity in major groundnut states like, Gujarat, Andhra Pradesh, Maharashtra, Karnataka, Orissa and Rajasthan has been increased. A drought tolerant variety, **TG-37A** has rekindled groundnut cultivation in desert areas of Rajasthan state. Large seed varieties like **TPG-41** and **TLG-45** benefited many farmers, traders and exporters by virtue of their earliness in ripening, moderate seed dormancy and superior productivity. According to the scientists involved in mutation breeding, the deployment and dissemination of crop technology and large scale production of breeder seeds of these varieties are being undertaken in collaboration with central and state governmental institutions, seed corporations and NGOs. The societal impacts of these varieties are reflected in terms of enhanced productivity, popularity and extensive cultivation with financial benefits to farmers.

The sterile insect technique (SIT) is one of the major applications of nuclear radiation technology in which male insects are made sterile. Females that mate with a sterile male produce no offspring, thus reducing the next generation's population. Repeated release of sterile males can diminish small populations, although success with dense target populations has not been demonstrated. The technique has successfully been used to eradicate the screw-worm fly. Many successes controlled species of fruit flies, most particularly the Mediterranean fruit fly (Ceratitis capitata) and the Mexican fruit fly (Anastrepha ludens). Sterile insect technique for the management of red palm weevil and potato tuber moth insects and bioinsecticidal formulations based on bacillus thuringiensis and Bacillus sphaericus for the control of mosquito larvae have been developed.

The applications of nuclear energy are bringing forth revolutionary changes in human life and life expectancy by contributing in food security, healing and wellness. Misperception, that nuclear power poses a unique and enormous threat to public health and environment, is out of proportion, and is actually undermining the public interest. The only answer to the misinformed and mis-communicated society is lack of awareness. Public understanding on the issues like nuclear energy and nuclear technologies is required to develop a knowledge based society.

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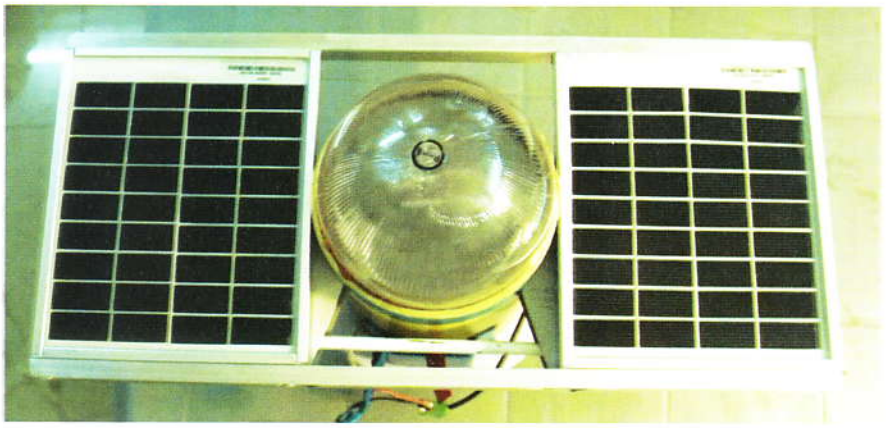
Low Cost Micro Solar Dome Surya Jyoti to lit rural homes



Union Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan, recently launched the Low Cost and Environment-friendly solar lighting device, which would prove to be a boon for the urban and rural households in the country that do not have reliable access to electricity. The device has been developed under the aegis of the Department of Science & Technology.

Describing the salient features of the device, the Minister said that the potential users of this device are10 million households. He said that according to preliminary estimates, if this technology is adopted in 10 million households only, it has the potential of saving 1750 million units of energy. It would also lead to an emission reduction of about 12.5 million ton of CO2 equivalent, hence giving a fillip to the mission of 'Clean India, Green India'. The manufacturing process, being labour-intensive, would also generate huge job opportunities in the economy.

Dr. Harsh Vardhan, while explaining the working of the device, said that the Micro Solar Dome captures sunlight through a transparent semi-spherical upper dome and concentrates it inside a dark room. The light passes through a sun-tube having a thin layer of highly reflective coating on the inner wall of the passage. It also contains a lower dome having a shutter at the bottom that can be closed if light is not required in the daytime. It is leak proof and works for almost 16 hours daily i.e. throughout the day and 4 hours after sunset.

The Minister said that the Photo-Voltaic Integrated Micro Solar Dome costs about Rs.1200 and the Non Photo-Voltaic version around Rs. 500. These cost figures are expected to get further reduced to Rs.900and Rs.400 respectively post the scaling-up of the manufacturing process and future linkages with the subsidies under various schemes of the Ministries of Urban Development, Rural Development and Ministry of New and Renewable Energy.

The Minister of State for Science and Technology and Earth Sciences, Shri Y.S. Choudhary said that this technology would lead to the saving of fossil fuels to a great extent as 1 unit of energy saved is equivalent to 3 units of energy generated. He envisaged the corporate sector to play its role under their Corporate Social Responsibilities Schemes for the manufacturing process to scale up. He said that incubation centres are being brought up under the 'Start up India, Stand up India' programme which would encourage entrepreneurship in the solar sector to make commercialization of the device viable.

According to a TERI University test report, the illumination level of the light during mid-day goes as high as a 15W LED bulb. Extensive Testing of the device for select parameters has been completed at IIT Bombay, TERI University and Indian Institute of Engineering Science and Technology (IIEST), Kolkata. Field trials have been conducted and 300 Micro Solar Domes are being installed in the slums of Delhi, Mumbai, Kolkata, and Bengaluru.