

Ionizing Radiation Technology for Food Security in Nepal

SDPU Activity Report

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The Sustained Dialogue on Peaceful Uses of nuclear energy, science, and technology (SDPU) aims to expand the conversation on peaceful uses of nuclear science and identify opportunities for using nuclear technology in pursuit of the United Nations Sustainable Development Goals (UN SDGs). With a participant-driven approach, the program brings together diverse stakeholders including national policy makers, the private sector, and the broader international development community. Dialogue among these diverse international organizations and their members fosters new relationships so that nuclear science and technology can most effectively serve the shared interest of sustainable development while identifying and addressing barriers to access. The program is focusing initial efforts on nine SDGs where nuclear science is currently poised to make a direct contribution, addressing development challenges related to food, water, health, and the environment. By creating a cooperative and engaging environment, the Sustained Dialogue aims to cultivate greater awareness of where nuclear technologies deliver the greatest impact. For more information, go to www.sustaineddialogue.com.

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Executive Summary

A core project team including the U.S. Department of State (DOS), the U.S. Agency for International Development (USAID), the U.S. Department of Energy (DOE), the UK Department of Energy Security & Net Zero (DESNZ), Texas A&M University (TAMU), and Kansas State University (KSU) conducted a consultative meeting with key stakeholders in Nepal on “Ionizing Radiation Technology for Food Security in Nepal” from January 29 to February 2, 2024, facilitated by the Nepal Development Research Institute (NDRI) and held under the Sustained Dialogue on Peaceful Uses of nuclear energy, science, and technology (SDPU). These stakeholders in Nepal included key ministries and departments of the Government of Nepal, national research institutes, universities, the Federation of Nepali Chambers of Commerce, private sectors, and individual experts. The aim of the consultative meeting was to conduct stakeholder outreach, explore the understanding of ionizing radiation technology, the prospect for its application in Nepal in food, health, and industry, the challenges in implementation, and perspectives for private and public support for its application.

All Nepali stakeholders with which the team engaged conceptually welcomed this new technology and were eager to learn more about its potential applications and the steps required to establish an e-beam facility in Nepal. Those stakeholders already familiar with the technology or who have supported similar initiatives in the past took the opportunity to share their achievements to inform potential work in Nepal. The core team took the opportunity to share with Nepali stakeholders an overview of the SDPU's objectives, the technological advantages of ionizing technology as compared to other techniques, the emerging global interest in this technology including in many Asian countries, and the next steps to undertake a more in-depth feasibility study. All stakeholders, notably including the Ministry of Education, Science, and Technology (MoEST) and the Nepal Academy of Science and Technology (NAST), welcomed the proposal for a feasibility study, expressing their commitment to cooperate and collaborate with the study to evaluate the potential construction of an irradiation facility in Nepal.

This consultation meeting with major stakeholders in Nepal has elucidated a clear interest the application of this technology and has laid the foundation for the detailed research and planning process to follow.

Keywords: SDG2 – Zero Hunger, UN Sustainable Development Goals, Electron Beam Technology, Food Security, Food Safety, Nuclear Technology, Peaceful Uses, Central and South Asia, Agriculture Research.

Overview

Ionizing Radiation Technology in Nepal

Ionization radiation technology, implemented as a dedicated electron-beam facility, uses a focused beam of electrons or x-rays to alter the properties of materials. Treating material with this radiation effectively eliminates bacteria, viruses, and other pathogens without the need for chemicals or thermal processing, making it a safe and efficient alternative method to sterilize medical devices, develop pharmaceuticals, treat food products, or improve industrial processes in an environmentally friendly way, as it does not produce harmful by-products. This technology is most commonly used in the medical field, for example in diagnostic equipment and cancer treatment, as is the case in Nepal.

In Nepal, there is growing interest in utilizing ionization radiation technology more extensively for peaceful uses and development. A program was organized on 6th August 2023 at the NAST in coordination with NDRI under the leadership of MoEST, inviting the key stakeholders to discuss the prospects of ionization technology extensively, during which they expressed a keen interest in understanding the prospects of this technology and pursuing its application in Nepal. In support of these and other nuclear technologies, the Nepali government recently ratified the Nuclear Science and Technology Act-2078 in 2022, which broadly includes regulations for the application of ionization radiation technology. This new enabling legislation builds on activities supported under the International Atomic Energy Agency's (IAEA) Technical Cooperation program which have successfully developed laboratory facilities and human resources, mostly through short-term exposure visits. The commitment to engage with the IAEA to build national capacity in nuclear science was most recently reaffirmed by the Nepali government and is also evident in the continual execution of the Country Program Framework (the latest for 2022-2027). Several projects, coordinated by the IAEA, have been implemented. Traditionally, the focus of this engagement has been in the medical sector, both in diagnosis and treatment, and the use of nuclear science and technology has made noteworthy progress since Nepal joined the IAEA as a Member State in 2008. However, the great potential for using ionizing radiation technology in food safety and security remains largely unexplored, even though it is conceptually highly viable.

Support for Food Security Under the SDPU

Recognizing the importance of food safety and food security in Nepal, under the SDPU, CRDF Global is seeking to identify areas of potential collaboration with Nepal to advance national development priorities related to agriculture and agriculture trade.

As a part of this effort, a core team visited Nepal from January 29 to February 2, 2024, to consult the key stakeholders in Nepal regarding a potential feasibility study of ionization radiation technology, particularly for application in the agricultural sector. This team included members from the U.S. Department of State (DOS), the U.S. Agency for International

Development (USAID), the U.S. Department of Energy (DOE), the UK Department of Energy Security & Net Zero (DESNZ), Texas A&M University (TAMU), and Kansas State University (KSU). NDRI, a national thought leader in the domain of sustainable development, facilitated the consultative meetings and provided expert guidance to the SDPU on considerations specific for the type of support necessary to address pressing development needs in Nepal. NDRI was central to stakeholder outreach, meeting scope refinement, and in identifying success parameters for the week's discussions.

The meeting sessions included discussions on ionization radiation technology by experts from the core team, focusing both on the policy and infrastructure prerequisites for the application and sharing international experiences. The consultation featured engagements with key government ministries that are essential to developing a potential future facility, including MoEST, the Ministry of Agriculture and Livestock Development (MoALD), and the Ministry of Health and Population (MoHP) of the Government of Nepal.

The core team also met with stakeholders from the premier research institutions including Nepal Agriculture Research Council (NARC) and NAST, who could use a potential future facility to enhance their capabilities.

To capture the state of the art in academic training, research, workforce development in nuclear science, consultations were organized with the Central Department of Physics and the Central Campus Technology (Food Science) of Tribhuvan University.

Additionally, to further understand how development and food systems policy is crafted and implemented in Nepal, the team met with the National Planning Commission (NPC), the Nepal Food Scientists and Technologists Association (NEFOSTA), and the Department of Food Technology and Quality Control (DFTQC). The team observed the related laboratory facilities of key stakeholders such as DFTQC, NAST, and NARC. Most of these laboratories collaborate with the IAEA to strengthen their capabilities in equipment and human resources development. The team discussed with scientists working in these research institutes their perceptions of ionization radiation technology, its potential use in Nepal, anticipated constraints, and the imperative for potential collaboration.

Finally, to begin understanding the potential future demands from the private sector, as the most likely primary user of any future facility, the meetings included site visits at two major grocery retailers in the Kathmandu Valley, including Bhat-Bhateni Supermarket & Department Store and Big Mart, the Federation of Nepali Chambers of Commerce and Industries (FNCCI) and the Nepal Chambers of Commerce (NCC), as well as the meat processing facility at Valley Cold Store and Nepal Dairy.

All discussions with local experts focused on their perceptions of ionization radiation technology, its potential use in Nepal, anticipated constraints, and the imperative for potential collaboration. From these consultations, the team found varying levels of knowledge about

ionizing radiation technology. Research institutes like NAST and NARC, who conduct technical related research related to food science or nuclear technology and operate laboratory facilities possess a good understanding of ionizing radiation technology and have collaborated on internationally funded projects such as those supported by the IAEA. Notably, NAST provides services to public and private hospitals in Nepal for occupational radiation dosimetry for workers, indicating a strong institutional capacity in nuclear science and technology and an ability to support a potential future project. On the other hand, for most stakeholders from the private sector, this was the first time they were learning about ionizing radiation technology and its broad applications. Despite this being an introduction, these participants were receptive to the potential and eager to learn about the salient features of the technology from the core team, indicating that there is support among a critical base of stakeholders who could provide demand for the technology and help ensure that a potential future facility can be operated sustainably.

The most common response of all stakeholders was an expressed interest in engaging in a more in-depth feasibility study to more fully understand the multipurpose benefits of the technology in various sectors. However, these consultations also elucidated that the awareness about the technology, the required enabling infrastructures, and other limitations are critical factors that must be understood more fully to determine the scale and potential benefit of any potential future ionizing radiation facility.

Nuclear Applications

The application of ionization radiation technology shows great promise for application in Nepal in several sectors, most notably in food security and medicine.

Food: Ionizing radiation technology can reduce post-harvest losses, improve food quality, address sanitary and phytosanitary concerns, enhance exports, and advance research and development in agriculture, which are the major issues in the food security sector. Agriculture losses due to spoilage, nutrition degradation, and harvest and transport damage put significant stress on Nepal's food system, adding risk and volatility to the country's public health and economic prosperity. Though the level of post-harvest loss varies by commodity, it averages approximately 25% across sectors and can reach up to 70% for some crops including potatoes.

MoALD, DFTQC, and NEFOSTA, who together represent the diverse interests in developing food technologies and applying them in Nepal view ionizing radiation technology as a potential significant contributor to reducing post-harvest losses, expanding potential market exports, and advancing research and expressed their commitment to adopting it in Nepal. One of the most telling experiences was expressed by the Plant Quarantine and Pesticide Management Center (PQPMC). The PQPMC is responsible for regulating the import and export of plants and plant products to prevent

the introduction and spread of pests and diseases and is aware of the prospect of ionization radiation technology. The PQPMC with support from the World Bank, established a fumigation plant in Kirtipur, Nepal. Fumigation is a widely used method to eliminate pests from various goods, including grains, fruits, and vegetables, before they are exported or distributed. However, the disadvantage of chemical treatment as compared to ionizing technology is the potential harmful residues left on food products after treatment which do not exist when food is irradiated instead. The establishment of this fumigation plant in Kirtipur highlights the commitment of the PQPMC and the World Bank to enhancing agricultural safety, quality, and compliance with international standards in Nepal by using advanced science and technology capabilities.

Health: The use of ionizing radiation technology has already been adopted in the health sector and is being refined for both diagnosis and treatment (e.g., cancer radiotherapy). Health service centers in both the government and private sectors are making significant investments, driven by high demand resulting from the increasing prevalence of non-communicable diseases in Nepal.

During the consultation meeting, MoHP affirmed that the use of ionizing radiation technology is rapidly advancing in the medical community and expressed the need to scale up its application both the public and private sectors for disease diagnosis and treatment in Nepal.

Others: Though this visit focused on food systems and the health sector, there is great potential for the application of ionizing technologies for wastewater treatment and industrial applications, including for packaging, insulation, and wire fabrication. As articulated throughout the consultations, addressing these interests through sustained engagement during a more detailed feasibility study will ensure that any future investment is used to its full capacity.

Cooperation & Inclusivity

During the consultative meetings, stakeholders and the expert team cited examples from different neighboring countries where ionizing radiation technology is emerging, such as India, Bangladesh, and China. The story of Pakistani mangoes treated in U.S. ports and supplied through the United States fascinated the Nepali stakeholders. Moreover, the progress made by the Bangladesh Institute of Nuclear Agriculture (BINA) to use this technology for economic prosperity and secure food supplies in Bangladesh was incredibly encouraging and provides a potential opportunity for future collaboration. In considering regional collaboration, the Secretary of MoEST recently led a team to engage in a workshop held under the IAEA's Regional Cooperative Agreement for Cooperation on Nuclear Energy, Science, and Technology in Thailand where the aims of the Government of Nepal were reaffirmed. These examples of applications of this technology throughout Asia builds confidence among Nepali stakeholders

for potential future collaboration, especially in mutual benefits in capacity development, sharing services of this technology, and promoting trade.

Consideration of stakeholder inclusion is important for the sustainability of any new technology, especially in Nepal. Nepal is a diverse country with many different cultures and lifestyles due to variations in ecology, gender, ethnicity, and occupations. Addressing the aspects of inclusion is crucial for social accessibility and facilitating the scalability of any technological application in Nepal. In designing this consultative meeting, NDRI considered inclusivity with respect to sectorial representation, occupation, and gender. Representatives from various sectors participated in the meeting, including researchers, academia, policymakers, private sector representatives, and regulatory body members. Both men and women were similarly represented in speaking roles throughout the consultative meetings. Ethnic groups such as Bajracharya, Shrestha, Gurung, Chaudhari, Rajbhandari, and Sherchan, representing different ethnicities in Nepal, played a leading role in these consultations. Going forward, it will be crucial to continue building further aspects for diversity and inclusion in designing the feasibility study.

Recommendations

The central theme of the consultation with key stakeholders — including those from governmental bodies, international partners, research institutions, and the private sector — is that there is potential for ionizing radiation technology in Nepal to contribute positively to immediate development challenges. Stakeholders agreed that there would be value in further exploring and evaluating the feasibility, potential benefits, and required infrastructure for harnessing this technology in Nepal to improve food security and food safety and further explore its applications in related sectors.

Throughout the course of the consultations, three core ideas emerged and will be used to shape the future feasibility study:

Legal Provision: The fundamental legal infrastructure is in place to initiate the process for development of nuclear technology, including electron beams, in Nepal. However, important aspects concerning how it is applied, particularly for the processing of food, are still under development. Supporting the relevant government ministries (i.e., MoALD and MoEST) to develop an appropriate regulatory architecture that supports the adoption implementation of this technology is critical to the success of this endeavor.

Willingness: The willingness among experts to have ionizing radiation technology in Nepal is high. All key stakeholders from Nepal agreed during the consultation that the potential development benefits for the country are high and were eager to learn more. They expressed their willingness to commit to cooperation on a more in-depth feasibility study, agreeing that such an intervention would be timely.

Awareness and Acceptance: Questions by some stakeholders highlighted a lack of comprehensive awareness and potential misconceptions about the safety of ionizing technologies. Educating the public, stakeholders new to the technology, and potential investors to increase awareness about the benefits and safety of the technology will be essential to lay a foundation for acceptance and facilitate the successful implementation of a potential future facility.

The workshop served to outline several areas in which follow-on activities can refine understanding on how to improve the food safety and security situation in Nepal with nuclear science and technology and elevate discussions on the adoption of ionizing technology in the agriculture sector and other areas. The understanding of ionizing radiation technology is sufficient among governing authorities (e.g., MoEST) and research/academic institutions (e.g., Tribhuvan University) but is limited among other key beneficiaries (e.g., Valley Cold Store). Despite these varied levels of knowledge, all stakeholders engaged during the workshop were eager to learn about the construction and operation of an e-beam facility, including starting capital, rates of return, system optimization, and human resource development. Constant dialogue is needed with key stakeholders at different stages, sharing best practices and industry knowledge. For example, a series of literacy programs, including interactive knowledge-sharing sessions with examples from other countries would improve understanding and support the acceptance of e-beams technology in Nepal.

The catalyst for these recommendations can come in the form of a feasibility study that unifies the Nepali beneficiaries of this technology and creates a comprehensive assessment on how the technology will be used, who will be responsible for its establishment in Nepal, and how the benefits will be shared across various stakeholders. While incorporating international expertise, the feasibility study should be driven by Nepali needs and perspectives and serve a wide audience including the Nepali public, national decision makers, and the broader development community. Such a feasibility study would provide a foundation on which the Government of Nepal, and other national stakeholders including NDRI, could advocate for financial support from the broader development community, including the World Bank, or regional international financial institutions, including the Asian Development Bank.

Conclusions

Food security in Nepal is precarious, with high amounts of food loss and waste concurrent with expensive imports. This consultative meeting underscored the interest of Nepal's key stakeholders in considering the application of machine-based radiation technologies to help address these challenges facing food security in Nepal. It also increased awareness among these key stakeholders of the real benefits that nuclear science and technology can bring to achieve Nepal's development goals more broadly. It is clear that continuing this discussion and pursuing a more in-depth feasibility study under the SDPU is the next step to pursue these ambitions and bring this new technology to Nepal.

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