Enhancing Crop Production in Bangladesh

Climate change presents challenges for food production systems worldwide.

The escalating frequency of harsh environmental events such as droughts, floods, heatwaves, storms, and soil salinization disrupts traditional agricultural patterns and causes new vulnerabilities in crops. Increased crop vulnerability increases the risk of food insecurity.

Developing sustainable crop production systems is central to ensuring food security and reducing the impact of climate change on agriculture and ecosystems.

Nuclear science can enhance agricultural productivity by supporting the development of new crop varieties that are better able to withstand the effects of climate change – for example, crops that are more tolerant to drought and heat, or that show greater resistance to disease and pests. New crop varieties that can withstand harsh environmental conditions but still are of high quality and have higher yields or harvests are increasingly important to ensuring resilience in food production systems in the face of a changing climate.

The IAEA and the Food and Agriculture Organization of the United Nations (FAO), through the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture, have been working with Bangladesh since 1971 to address agricultural challenges, through training courses, fellowships and expert visits, as well as the provision of the equipment necessary for laboratory enhancement.

In Bangladesh, the dire effects of climate change have posed new threats to food and nutrition security. The country is highly vulnerable to floods, cyclones, storms and droughts, and its agricultural output is heavily affected by these severe conditions. The IAEA, through the Joint FAO/IAEA Centre, has been collaborating with the Bangladesh Institute of Nuclear Agriculture (BINA) with the common goal of protecting agriculture from extreme weather events. Technical support has mainly focused on developing crop varieties that are resistant to climate change, and that show increased crop yield and quality.

Rice is a particularly important crop in Bangladesh and extreme weather events or outbreaks of plant disease can ruin entire harvests, leading to

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poverty and hunger. The IAEA works with BINA to support the development of new crop variants that are less vulnerable to disease and able to thrive in difficult conditions. With this support, BINA has successfully produced 85 different crop varieties, including an improved variety of rice called Bina dhan-14. A conventional plant breeding process typically takes 8 to 12 years, but by using nuclear technology the process was completed in just 4 years. By using an ion beam technique and selecting a specific plant characteristic in the resulting mutant plants, Bangladeshi experts accelerated the timeframe significantly accelerated the timeframe. The new rice variety has the capacity to withstand higher temperatures and has a shorter growth period of 110 to 120 days instead of the usual 140 to 150 days. This opens an extended window for other crops and vegetables to be grown. In addition, the new variety is producing nearly seven tonnes of rice per hectare, nearly 75 per cent more than the global average yield.

Coastal farmers, on the other hand, are confronted by saline soil conditions and soil degradation, which have rendered over one million hectares of land unfit for cultivation. BINA, with the support of the IAEA through the Joint FAO/IAEA Centre, has developed salt-tolerant varieties of rice, providing hope for the affected areas. Two salt-tolerant varieties are now available to coastal farmers, and 40 to 50 per cent of previously fallow lands can now be cultivated. As a result food security and farmer income in these regions are increasing.

Thanks to plant mutation breeding, rice production in Bangladesh has tripled since the 1970s. The new varieties developed by BINA, with the support of the IAEA through the Joint FAO/IAEA Centre, are helping Bangladesh to feed the country's 165 million people, almost a third of whom are moderately or severely food insecure, according to a 2022 report by the FAO. The new crop varieties have also allowed the country to maintain its status as the world's fourth largest producer and consumer of rice.

The Science

Plant mutation breeding is a technique in which plant seeds, cuttings or other plant parts are exposed to radiation such as gamma rays, speeding up the natural process of crop mutation. The irradiated material is then cultivated to generate plants, which are multiplied and examined for favourable traits. To expedite the selection of desired traits, molecular marker assisted breeding, often referred to as marker-assisted selection (MAS), is used to identify plants carrying specific genes that express specific traits. The identified plants are further cultivated.

Plant mutation breeding does not involve gene modification, but relies on a plant's own genetic resources, mimicking the natural process of spontaneous mutation. Radiation accelerates the appearance of beneficial variations. Precise screening techniques focus on specific traits, such as tolerating high levels of salt in soil or resistance to pests. This enables the rapid validation of new varieties for practical use.

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