Trained to adapt: researchers from Pakistan, Mauritius and Afghanistan breed mutant plants to take on a changing climate

By Nicole Jawerth

From cotton in Pakistan to tomatoes in Mauritius and wheat in Afghanistan, many crops around the world are being devastated by erratic rains, droughts, diseases and relentless heat, which are being exacerbated by climate change. As the global search for solutions to climate challenges continues, three researchers are using their training with the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture to develop new plant breeds that can withstand these adverse conditions and help keep their countries' crops growing strong.

Cotton in Pakistan

"Climate change is causing major damage to crops in Pakistan, and having serious adverse effects on growth, maturity and productivity of cotton plants and the lives of farmers," said Mehboob-ur Rahman, Principal Scientist and Group Leader of the Plant Genomics and Molecular Breeding Laboratory at the National Institute for Biotechnology and Genetic Engineering, Pakistan Atomic Energy Commission. "I am using my training towards different projects for developing new plant variations, including mutant populations of cotton and wheat that tolerate higher temperatures, and are more resistant to diseases. So far, my group has developed seven cotton varieties." Cotton is one of the most important cash crops for Pakistan and a major source of foreign exchange. With more than 70 per cent of the population living in rural areas, it is also a significant source of livelihood for many people.

Mehboob-ur Rahman, Principal Scientist, Pakistan Atomic Energy Commission (left), and Bradley Till, Technical Officer, FAO/IAEA Plant Breeding and Genetics Laboratory (right).
(Photo: A. Qaiser Khan/Pakistan Atomic Energy Commission)

Rahman trained twice at the Plant Breeding and Genetics Laboratory, one of five laboratories that make up the Joint FAO/IAEA Agriculture and Biotechnology Laboratories at Seibersdorf, Austria, first in June 2012 and then in February 2013. He learned how to create new plant varieties using mutation breeding (see box on page 13) and worked closely with IAEA experts and scientists from around the world.

"Before my training, I had never been exposed to such kind of research work, and I found it most fascinating for creating novel plant variations within a limited time period. It shows that this tool can work better compared to the conventional breeding tools," said Rahman. "In addition to the training, we also developed a working relationship with the IAEA technical officer, and we now usually seek guidance from him for arranging new experiments."

Rahman is now working with a team at the Institute through an IAEA technical cooperation project, applying his skills to developing new cotton and wheat plant varieties resistant to environmental stresses and diseases like cotton leaf curl disease — a virus that can cause stunting and drastically reduced cotton plant yields.

"Every year, I create mutant lines of cotton and wheat crop," said Rahman. "Once these mutant lines are tested further, the best ones will be selected for multiplication and after their release, distributed to the farmers." The new mutant lines are expected to be available in 2016 to 2017 for testing at various farms and will help to maintain yields and improve the socioeconomic conditions of the rural community, he said.

Tomatoes in Mauritius

"The heavy rainfalls interrupt certain socioeconomic activities, schools and the tourist industries, and they affect the agricultural sector, damaging many plantations. And the increase in temperature affects cropping patterns, flowering and productivity of some vegetables and fruits. This has had a direct effect on the flowering stage of tomatoes, which causes flower drop that leads to decreases in fruit production and eventually a reduction in yields," said Saraye Banumaty, Senior Research Scientist at the Food and Agricultural Research and Extension Institute in Mauritius. "The mutation breeding programme for tomatoes is addressing the climate problem by breeding a heat-tolerant tomato line that will hopefully adapt to the rising temperatures."

Banumaty is using her training at the FAO/IAEA laboratories in 2011 and 2014–2015 to help her to advance her research, she said. "Both training courses have broadened my knowledge of the use of mutation induction using nuclear and other techniques for crop improvement. Moreover, I was able to understand and make use of biotechnology for detection of mutants. I also participated in the development and making use of a low-cost method for the characterization of mutants," she said. "The training I received from the IAEA has helped to improve my capabilities to undertake research here at home."

The new mutant tomato plants are still under evaluation and development through an IAEA-funded project, but preliminary results show that some mutant lines are showing tolerance to heat stress. The variety is expected to be released for distribution by late 2016 and "will help improve the tomato production locally especially during summer months," said Banumaty. "This will increase the revenue of small growers, and there will be a greater supply of tomatoes on the local market at a reasonable price."

Saraye Banumaty, Senior Research Scientist, Food and Agricultural Research and Extension Institute, Mauritius
(Photo: D. Ndeye Fatou)

Wheat in Afghanistan

"An average Afghan farmer owns one hectare of land, and an average Afghan family has seven members, so with 50 000 hectares of land cultivated with the new wheat seed variety I developed after my IAEA training, the plants' higher yields and resistance to diseases have been benefiting 350 000 people," said Sekander Hussaini, Head of the Chemistry, Biology and Agriculture Research Centre of the Academy of Sciences of Afghanistan. "Picking mutations that fit the climate and using the new varieties are very important for Afghanistan and for farmers' livelihoods. Over 70 per cent of Afghans depend on agriculture and related agribusiness, so having plants with good yields and resistance to diseases and that are able to thrive in the changing climate is very important."

Hussaini learned how to use nuclear techniques for plant mutation breeding through training at the FAO/IAEA laboratories in 1992. He returned to the laboratories in 2012, where he trained with the Agriculture and Biotechnology Laboratory, as well as the Plant Breeding and Genetics Laboratory.

"This training helped me to learn radiation techniques for plant breeding and to identify the best variety of wheat that is suitable for the Afghan climate and soil," said Hussaini. Many of Hussaini's seed varieties have already been successfully used by farmers in several provinces of Afghanistan. This and other areas of Hussaini's work in plant breeding earned him a 2014 FAO/IAEA Achievement Award in plant mutation breeding and a nomination for the World Food Prize in 2012–2014.

He is now working on a new series of wheat seeds that are still under evaluation, but he expects good results. "Six experimental varieties were selected because they are better than others, their yield is more than twice that of their parents and they are more disease resistant too," he said. "Now we are studying and researching the next generation of these seeds for the future to see how we can make them better."

Sekander Hussaini, Head, Chemistry, Biology and Agriculture Research Centre, Academy of Sciences, Afghanistan
(Photo: FAO/IAEA)