Genetic engineering of a different kind: Using nuclear energy in Burundi to attack cassava diseases

When Burundian cassava farmers split open the plant's starchy root, they're hoping to find white flesh that resembles coconut meat. If instead the inside is marked with brown patches, it's likely suffering from cassava brown streak disease (CBSD) — bad news for the farmer, who can no longer eat or sell the produce, and whose entire harvest may be at risk of loss due to the disease.

Cassava, a carbohydrate-rich root vegetable, is the second most important staple crop in Burundi. Low cassava yields can exacerbate the country's food insecurity, from which half of the population already suffers.

"The average fresh yield of cassava in Burundi is 9.9 tonnes/ha, which lags behind yields of 15–40 tonnes/ha achieved elsewhere," said Ernest Vyizigiro, Head of the Institute of Agronomic Sciences (ISABU).

One reason for the lower yields is that cassava productivity in Burundi is significantly constrained by CBSD and another viral plant disease called cassava mosaic disease (CMD). According to the International Institute of Tropical Agriculture (IITA), these two diseases cause an estimated loss of US $1 billion in East and Central Africa annually.

The IAEA, in partnership with the Food and Agriculture Organization of the United Nations (FAO), is supporting Burundian scientists in using nuclear technology to develop high-yielding varieties of cassava resistant to these diseases.

Some existing cassava varieties in Burundi are resistant to CMD, but not to CBSD, which first appeared in the country in 2011. "To date, all five cassava varieties resistant to CMB have succumbed to CBSD," Vyizigiro said. "This results in root rot nine months after infection."

Developing a new variety resistant to both diseases, however, is a lengthy and technically challenging process due to cassava's biology and long growing period.

"New cassava varieties are more difficult to develop than other crops such as rice or corn because seed germination is very low in cassava," said Isaac Kofi Bimpong, plant breeder and geneticist at the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. "Furthermore, it's only possible to confirm that a cassava plant is free of CBSD by looking at the tuberous edible root. Cassava takes up to a year to mature, so you have to wait a long time to see if efforts have been successful."

IAEA provides expertise and equipment

IAEA experts trained Burundian scientists in plant breeding techniques, using induced mutation and tissue culture techniques to develop a new cassava variety. Induced mutation using nuclear techniques speeds up natural changes in the genetic make-up of crops, so scientists can select mutant lines with desired traits such as disease resistance and eventually the best variety. Since cassava plants take a relatively long time to grow, tissue culture techniques, where the cassava is grown in a controlled environment, are useful in multiplying the plants much faster than if they were planted on a traditional farming plot.

Cassava cuttings were irradiated under controlled conditions at the Joint FAO/IAEA Plant Breeding and Genetics Laboratory in Seibersdorf, Austria before being sent back to the Gisozi research station in Burundi for further development and selection. With support delivered through the IAEA technical cooperation programme, the tissue culture laboratory at the Gisozi research station was refurbished and endowed with modern equipment, which helps to provide the controlled environment needed to undertake advanced applied research in the field of crop improvement.

After a year of research and development, Burundian scientists have produced advanced cassava lines that are candidates for the development of cassava varieties resistant to both CMD and CBSD. Thanks to training provided by the IAEA and FAO, these scientists are now able to study the mutant lines to see how well they perform in a new screenhouse at the research station. The screenhouse was financed by the IAEA.

“Using a screenhouse is important because you can’t take a plant directly from the tissue culture lab to the field – it will die. The best method is to expose the plant slowly to an outside environment in a screenhouse where certain environmental parameters are controlled,” said Bimpong. “Then it’s possible to evaluate the mutant lines to see which ones perform best.”

After further developing the mutant lines in the screenhouse, they will be taken to known hotspots in Burundi’s highlands, where both plant diseases are prevalent, to see which ones withstand the diseases.

Developing a disease-resistant cassava variety is particularly important for subsistence farming in Burundi, upon which 90% of the population depends. “Subsistence farmers rely on cassava for vital nutrition, as it can be planted and harvested throughout the year, tolerates periods of unpredictable drought and grows on marginal soils,” said Dieudonné Nahimana, Director General of ISABU. “Studies suggest that cassava may be highly resilient to future climate change and could provide Africa with adaptation opportunities which are not offered by other staple foods crops.”

For the best chance at the highest, healthiest yields possible, any new variety should be used in combination with soil fertility and water management methods, said Bimpong. On research managed plots in Burundi, IAEA experts saw a significant increase in cassava yields using inorganic fertilizer and nuclear isotopic techniques to help manage water resources.

“More research and development is needed before a variety can be released, multiplied on a large scale and distributed to the country’s cassava farmers,” said Remmy Phiri, the IAEA Programme Management Officer responsible for Burundi. “Burundian scientists now have the proper equipment and training to

further develop cassava varieties resistant to CMD and CBSD.”

Read the original post