

Engineering an Improved Cassava Plant To Help Fight Malnutrition

Food security has been an issue of great importance to African nations for decades, as regions face dwindling water resources, soil erosion and nutrient depletion, and poor management of farms. It's not enough to ensure that food supplies remain available for the people—those foods must be suitable to provide enough nutrition to sustain a healthy lifestyle. Cassava, one of the most prominently grown crops in Africa, falls below acceptable standards of micronutrient levels for a staple crop, and diets heavy in cassava can lead to malnutrition.

One research group, called BioCassava Plus, is working to improve these micronutrient levels and ensure that cassava can remain a source of nourishment for a large population of the continent. The team of scientists has been working to develop a new variety of cassava that, in addition to producing a higher yield, is also more nutritious and more marketable for farmers.

Cassava is a tuber high in starch that is grown most prominently in Af-

rica and originated in South and Central America. Of all the major crops grown in sub-Saharan Africa, cassava has the highest rate of production, yet it ranks second to maize in terms of calorie production, primarily because of its high water content, according to Dr. Richard Sayre, professor emeritus at the Ohio State University Department of Plant Cellular and Molecular Biology and director and principal investigator of BioCassava Plus. However, even this lack of calories does little to underscore the overall nutrient deficiencies present in cassava.

"Among the world's 10 most important crops, cassava has the lowest protein-to-energy ratio," Sayre said during a presentation at this year's Annual Meeting of the American Association for the Advancement of Science held in Chicago, IL in February. "It's a very protein-deficient energy source."

In addition to being low in protein, cassava also does not provide a reasonable source of zinc, iron, or vitamins A and E. Despite this, it remains the primary crop for more than

250 million Africans living in the sub-Saharan region, creating a high risk of malnutrition for those who rely upon it as a food source. These micronutrients have been targeted for biofortification by the developers of a transgenic cassava at BioCassava Plus.

Beyond Nutrition: Developing an Economically Viable Crop

The development of a more nutritious cassava is only part of the goal of creating an improved variety, as other constraints of the crop have created major barriers to it being a more economically viable commodity for producers. These limitations include a naturally occurring toxicity, a brief shelf life, and a vulnerability to viral diseases.

Cassava contains a high amount of cyanogenic glucosides, making it a toxic substance before it is processed. This trait creates a natural resistance against pests, and some who grow cassava even use this as a deterrent against theft. Farmers have been known to sometimes plant varieties of cassava with high toxicity to prevent others from stealing their crops. This toxicity is responsible for creating neurological disorders, including a condition known in Africa as kongo, a paralytic disease which can spread as an epidemic given proper circumstances.

The productivity of cassava is also threatened by its rapid deterioration post harvest. Once harvested, farmers have only 24 to 48 hours to process the crop, or else it will rot very rapidly. Destruction of the crop can also come from viral diseases, and it is particularly vulnerable to the African cassava mosaic virus, which has created great losses over the years.

Despite these severe limitations, cassava has developed into an essential staple crop, primarily due to environmental and cultural reasons. First, it is a drought-resistant crop, which is



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Cassava being sold at a market in Mozambique. Photo by Dominic Chavez (CGIAR).

a major advantage for African farming regions that have limited water resources. Also, cassava is farmed at a low intensity, meaning that regions that have been plagued by AIDS and other diseases are more likely to expend the physical energy necessary to plant and harvest the crop. Finally,

it is also a preferred food, making it culturally important to the people who rely upon it.

"There is no other crop in sub-Saharan Africa that provides as much food security as cassava," Sayre said.

Given the importance of the cassava crop to food security, the process

of biofortification of cassava has become a primary objective of BioCassava Plus. Sayre noted that cassava has natural advantages for incorporating genetic modifications.

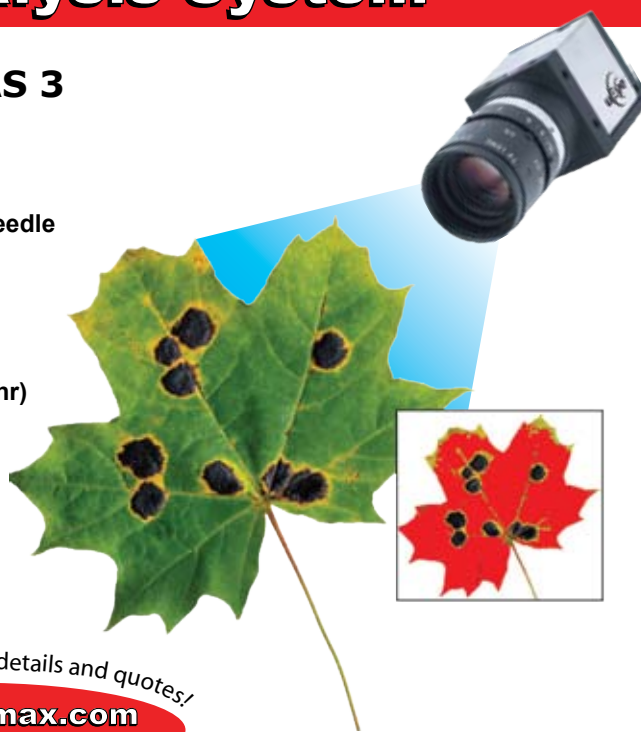
"This is a crop that is propagated clonally by stem cuttings. It's not propagated by seeds, and in fact, many varieties of cassava do not flower or produce very few seeds," Sayre said. "This is a feature that is very attractive for genetic engineers because if we're going to modify cassava, then the progeny that we'll produce as a result of genetic modifications will be clonally propagated."

Field trials for all of the traits are now in place in Puerto Rico, and Sayre predicted that by the end of the year, data will be available on a significant percentage of these trials. The importance of the project is in its translational nature, and positive results are ultimately needed in tests conducted in Africa. One variety has been approved for field trial in Nigeria and will be the first transgenic plant approved for trial in that country.

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