How genetically engineered crops can boost Africa’s fight against malnutrition

Malnutrition remains a significant problem for Africa and there’s little reason to think that’s going to change anytime soon. Consider a pair of papers published in the journal Nature predicting “No African country is expected to reach the UN target of ending childhood malnutrition by 2030.”

Estimates suggest that 200 million people on the continent lack adequate nutrition as a result of drought, civil unrest, sanitation problems and crop destroying pests and insects. A 2017 report by the World Health Organization said, “undernutrition is still persistent…and the number of stunted children has increased.”

[Editor’s note: This is part two of a series on the potential benefits of genetic engineering technology for Africa. Part one looks at climate change. Part three examines the continent’s growing acceptance of GM crops. Part four explores the fight against pests and disease.]

One of the best hopes for solving this problem is the use of genetic engineering to fortify existing crops with nutritional enhancements. The best known of these crops is the much-debated Golden Rice – enriched with vitamin A – which has been under development since the 1990s.The crop has long been opposed by anti-GMO activists, who call it environmentally irresponsible and argue that it could compromise food, nutrition and financial security in those nations. Supporters, however, say it has the potential to offset vitamin A deficiency, a leading cause of childhood blindness in developing nations. (Read the GLP’s FAQ on Golden Rice.)

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Screenshot at AM

The World Health Organization has classified vitamin A deficiency as a public health problem affecting 48 percent of children aged 6 months to 59 months in sub-Sharan Africa.

Thus far, no nation has yet approved the rice for commercial release. But that could change soon, with Bangladesh moving toward release in mid 2019. An analysis by the Copenhagen Consensus Center suggested that if “30 percent of the population of Bangladesh would adopt Golden Rice as part of their regular diet, it would reduce vitamin A deficiency by roughly 30 percent. It would also decrease stunting by 3 percent.” A similar approval could follow in the Philippines.

But what about Africa?

Researchers across the continent are exploring a variety of nutritionally enhanced crops, including Cassava. The Virus Resistant and Nutritionally Enhanced Cassava Project (VIRCA) is a program to produce a GE cassava that is not only resistant to the brown streak and mosaic diseases but is also nutritionally fortified. Although cassava is an excellent source of calories, it does not contain sufficient levels of key nutrients such as zinc and iron to meet daily recommended requirements especially for women and children.

Iron deficiency can lead to anemia, stunts growth for women and children, impairs cognitive development and compromises the immune system. Zinc deficiency meanwhile can cause diarrhea, stunting and reduced cognitive functions. In Nigeria, 75 percent of preschool children and 67 percent of pregnant women are anemic and in sub-Sharan Africa an estimated 24 percent of the population is at risk for zinc deficiency. The VIRCA program has developed and successfully tested a virus resistant cassava that has ten times the amount of zinc and iron than a conventional cassava plant. Field tests will be conducted in Nigeria and if they are successful, the cassava could be commercialized.

In Uganda, researchers are field testing a virus resistant vitamin A enriched banana. The cooking bananas (matoke) grown in Uganda and much of central and East Africa are good sources of starches but are low in micronutrients, including vitamin A and iron. The new banana was developed in Australia and is golden orange in color. It was created by taking genes from a banana in Papua New Guinea, which is high in provitamin A that can be converted when consumed into vitamin A, and inserting it into a Cavendish banana. Thus far, Ugandan field tests have been successful, leading the way for potential commercialization in 2021.

market plantain banana africa green fruit

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The Africa Biofortified Sorghum (ABS) project is developing nutritionally fortified GM sorghum. By tonnage, sorghum is the second largest crop in Africa after corn. More than 300 million people in sub-Saharan Africa rely on the crop as their largest source of calories. It is heat and drought resistant and therefore can be grown in many parts of Africa which are drought prone. While sorghum provides a large amount of carbohydrates it is an inadequate source of vitamin A. It also contains phytates (anti-oxidant compounds that can bind to certain dietary minerals including iron, zinc, manganese and, to a lesser extent calcium, and slow their absorption). Scientists have been able to genetically modify sorghum to boost the levels of vitamin A to such an extent that it could potentially provide 35 percent to 60 percent of the recommended daily allowance of vitamin A for children. The sorghum also was modified to increase the absorption of iron and zinc.

Three successful confined field trials (CFT) of the biofortified sorghum were conducted in Nigeria between 2011 and 2013. Further trials are being conducted with the hope of commercializing the crop soon. Research is also being conducted in Kenya to develop nutritionally enhance sorghum.

And, of course, research is underway on rice, a staple food particularly in West Africa. Many West African countries have given great priority to increasing rice production in order to reduce imports, which places a strain on their balance of trade. Senegal, for instance, doubled its rice output between 2014 and 2017 when it accounted for 40 percent of annual consumption. Rice production has been growing so rapidly in Nigeria that the government predicts that by 2020 there will be no need to import any rice. As recently as 2014, Nigeria imported $640.8 million in rice.

Although there are no plans for Golden Rice field trials in Africa, it seems likely that if it is successfully commercialized in other areas of the world, it will make its way there.

It is not only with regard to nutritionally fortifying foods that gene editing can potential improve the health of the people of Africa but also with respect to controlling diseases that are spread by mosquitos.

According to an August 9, 2018 article in Cell Press entitled CRISPR in Sub-Saharan Africa: Applications and Education:

> Because of the prevalence of tropical diseases and pests, the public health, medical and agriculture sectors in sub-Saharan Africa would likely benefit greatly from CRISPR. Amongst tropical diseases, malaria ranks first for prevalence and is responsible for about a half million deaths yearly. Mosquitos transmit malaria and other diseases, but control efforts have continued for decades with little success, owing to the complex biology of mosquitoes and limitations of existing strategies. Recently, CRISPR/Cas9-based strategies were developed for malaria vectors.

The CRISPR solutions for mosquitoes that carry malaria however have yet to undergo large scale tests in containment or the field and therefore a gene-edited solution is probably years away. Nevertheless, laboratory tests have been promising.

CRISPR also might be useful for containing other diseases spread by mosquitoes, including chikungunya and Zika viruses, for which good vaccines are lacking. It might also provide a cure for sickle cell anemia which is prevalent in sub-Sharan African. The disease effects 20 million-25 million people of which about 80 percent are located in Africa. Around 50-80 percent of infants born with the disease die before the age of 5. About 240,000 children are born every year in sub-Sharan Africa with the disease

The FDA in October gave authority to the biotechnology company Vertex to begin clinical trials in the US on a CRISPR treatment for sickle cell anemia. At present the only treatment involves a bone marrow transplant.

A GE vaccine has been produced to combat the deadly Ebola virus. An outbreak of Ebola in West Africa in 2013-2016 was responsible for 11,324 deaths. The fatality rate was about 74 percent. The VSV Vaccine has been genetically engineered to contain a protein from the Ebola virus that will prompt an immune system response to protect those who have been vaccinated. It has been approved for use and is currently being used in the Democratic Republic of the Congo which has seen an outbreak of Ebola in the east of the country.

By potentially eradicating crop and human diseases that are plaguing Africa, genetic engineering technologies can help to bolster farm income and sharply reduce the number of deaths resulting from malnutrition and illnesses caused by pests and insects that are carriers of diseases thus saving many lives.

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