

Gene editing could save Ghana's cocoa from extinction, scientists say

A new study warns that climate change could drive Ghana's cocoa (cacao) industry to extinction — a fate that scientists say could be reversed through gene editing.

A study by the Climate Change Unit of Ghana's Environmental Protection Agency (EPA) and the Cocoa Research Institute of Ghana is predicting the country's environment will no longer be conducive to growing cocoa by 2080 if current climate change trends continue. The study supports a 2017 prediction by scientists that cocoa could go extinct across the world in 40 years.

Ghana is the world's second largest producer of cocoa, which is the main ingredient in the production of chocolate.

The Ghana study found that the reduced rainfall and increased temperatures resulting from climate change will make the country's cocoa belt unsuitable for production of the crop by 2080, Angelina Mensah, public affairs director of Ghana's Environmental Protection Agency, [told a Ghana newspaper](#).

"In the study, it was identified that due to warm temperature conditions being experienced currently in the country, the dry season, which spans from September to March, has exacerbated. This means cocoa, which is very sensitive to drought, in terms of growth and yields, would be affected," she explained. "(Soil) moisture level in the years ahead will not be adequate for profitable cocoa production. Unless immediate interventions are rolled out to tackle climate change, cocoa would only be in the history books for the next generation to read."

If such interventions are not forthcoming, gene editing could be the solution to breeding new cocoa varieties that can survive the changing conditions.

"Gene editing has the potential to accelerate the breeding of new cocoa varieties with resistance to climate stress and pests and diseases," said Mark Guiltinan, professor of molecular biology at Pennsylvania State University, in an interview with the Alliance for Science. He noted that gene editing has already been used to develop other crops with improved resistance to some of the same climate-related stresses that cocoa is facing.

"A key advantage of this approach is that it could be used to edit varieties with special characteristics and locally adapted to environmental conditions, which will avoid the very time-consuming process of moving traits from one access into another, which could take decades," Guiltinan added.

Ongoing work with CRISPR

Guiltinan is leading a [research project](#) at Penn State that will help produce better cocoa plants using the CRISPR-Cas9 gene editing tool. CRISPR (clustered regularly interspaced short palindromic repeats) is a DNA sequence found in single-celled organisms. It can be used to introduce an enzyme called Cas9 in organisms to precisely edit their genomes and delete, silence or replace specific DNA regions.

The researchers have used CRISPR-Cas9 to knock out a cocoa gene called TcNPR3 that suppresses the plant's disease response. The researchers also created [gene-edited cocoa embryos](#) which they hope will grow into mature trees to test the effectiveness of this approach at a whole plant level.

"We have regenerated some CRISPR-mediated gene-edited plants with mutations in a repressor of the pathogen defense system," Guiltinan said. "These plants show strong resistance in lab tests. The plants are now about 2 feet tall and growing fast. Soon we will be able to perform further testing."

Low cocoa productivity in Africa

In addition to climate change, cocoa growers in developing nations are facing other challenges, including lack of irrigation and the inability to purchase inputs like pesticides and fertilizers. In Ghana, [cocoa orchards are also being displaced](#) by more profitable rubber plantations.

An estimated 30 percent of all cocoa produced in West Africa is destroyed by disease before it can get off the farm, which creates an enormous financial burden for farmers. In Ghana, the world's second-largest cocoa producing country, state regulator COCOBOD [revised the expected cocoa output for 2019 downward](#) earlier this year because of an increase in pest attacks and disease.

The increased pest and disease attacks have have been exacerbated partly by climate change, which encourages the rampant spread of disease-causing organisms that become more active in warmer weather. The Cocoa Swollen Shoot Virus (CSSV) disease, for example, has destroyed more than 200 million cocoa trees in West Africa and continues to spread on farms in the sub-region.

Although it will take some time, Guiltinan is confident that gene editing technology will in due course be able to help farmers deal with diseases on cocoa farms.

"The cocoa farmers around the world should know that it will be many years before these efforts find their way to their fields because on top of the technical challenges, there are also legal regulations and the public acceptance of these products that need to be addressed as well," he said. "In the meantime, we are working to develop transgene-free gene editing in cacao and we are targeting several other genes for traits of interest, such as disease-resistance and quality traits. One trait of special interest for West Africa is CSSV resistance."

If all goes well, Guiltinan said, "I see a strong possibility of the first gene-edited cacao being ready for farmers in about five to 10 years."

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