

Using Science to Save the American Chestnut Tree

During the past 100 years, chestnut blight and ink rot disease decimated an estimated four billion American chestnut trees and brought the iconic species to the edge of extinction. Human interference triggered the American chestnut's demise – and now scientific innovation offers us the best chance to save it.

The American chestnut tree was a vital component of the eastern U.S. ecosystem, economy, and landscape. Before the blight, it was an important food source for a wide variety of wildlife and a valuable cash crop for rural communities from Maine to Alabama. But as reliable and productive as the American chestnut tree was, it cannot recover fast enough to sustain itself in the wild. That is why The American Chestnut Foundation (TACF) is leading an unprecedented rescue mission.

Our species-saving strategy is a powerful combination of traditional breeding, biotechnology, and biocontrol. Since our founding in 1983, the field of genomics and biotechnology has burgeoned in scope and affordability. Based on new insights into the complex inheritance of blight tolerance, TACF is charting a new course for our restoration program. We continue to improve the disease tolerance in our traditional breeding program, while embracing innovations which can integrate the mechanisms of disease tolerance at the molecular level. Our approach follows multiple pathways to create a disease tolerant and genetically diverse population of American chestnut that will be adaptable to broad and changing climate. We call it 3BUR.

3BUR: Breeding, Biotchnology and Biocontrol United for Restoration

B1—Breeding. Our traditional breeding program is carried out at our research farm in Meadowview, VA, and at more than 500 orchards planted, largely by volunteers and partners, across sixteen TACF chapters throughout the American chestnut's native range. During the past 36 years, offspring from two blight-tolerant hybrids have been bred with American chestnuts from across the species range. Three generations later, our traditional breeding program has produced a genetically diverse population of American chestnut hybrids with improved blight tolerance. Moving forward, our breeding efforts are focused on further improving blight tolerance and incorporating resistance to *Phytophthora cinnamomi*, which causes a fatal root rot in chestnuts. We are using genomics to increase the speed and accuracy of selecting trees with the greatest tolerance to chestnut blight and root rot.

B2 – Biotechnology. At the core of our biotechnology program is *transgenics*, the science of introducing genetic material across species in order to safely create desired traits. Scientists at the State University of New York, College of Environmental Science and Forestry (SUNY-ESF) have discovered a gene from wheat that produces an enzyme that enhances blight tolerance significantly. Incorporating transgenics into TACF's breeding program allows us to stack multiple blight resistance genes and increase the proportion of American chestnut genes in the resulting progeny. The SUNY-ESF research is so promising, that we believe TACF can obtain the governmental approval required from the USDA, FDA, and the EPA to plant transgenic American chestnut trees in the wild in three to five years.

B3 – Biocontrol. The primary biological control method being explored by TACF and its partners is called hypovirulence. This is the term used for the infection of the chestnut blight fungus by a virus, thereby sickening the fungus and reducing the ability of chestnut blight fungus to cause lethal infections. Using this method, the natural defenses of the chestnut tree may enable the tree to halt canker growth. These methods can keep blight-susceptible American chestnut trees alive and healthy so that they can be used in our transgenic and traditional breeding programs. Other fungi and bacteria are being investigated which may play additional roles in reducing the effect of the chestnut blight fungus on American chestnut trees.

The American chestnut is an historic and beloved part of America's landscape. Its extinction would be the loss of a symbol of American strength, endurance and resourcefulness. Saving the chestnut and restoring it to its native range at scale could also help give other endangered tree species a new lease on life and directly offset the effects of climate change and deforestation. While no single intervention can completely eradicate chestnut blight, together the science of breeding, biotechnology, and biocontrol (3BUR) offer our best hope for rescuing the American chestnut tree.