Most experiments to genetically engineer trees are focused on plantation trees, to increase the productivity and profitability of monoculture plantations used to produce timber, paper, and other materials.[11] Trees are being experimented with to exhibit characteristics that could result in them becoming invasive and outcompeting other trees. For example, trees engineered for faster growth or with bigger leaves could outcompete other tree seedlings. Genetically engineering trees for altered wood characteristics can increase or decrease the rate of wood decomposition, with implications for nutrient cycles and biodiversity in a forest.

Changing the traits of trees grown in plantations could have ecological impacts beyond the plantation. In particular, the unwanted escape and spread of genetically modified organisms (GMOs) or genetic material from GMOs to non-GM/GE organisms is a clear risk with GE trees. The contamination risks are increased because trees are large, long-living organisms that produce abundant pollen and seed designed to travel long distances, with help from wind and animals. Once released into our environment, GMOs can be difficult or impossible to control or recall. **Once GE contamination in forests begins, it cannot be stopped. I**f GE trees contaminate native forests, these forests will themselves become contaminants, creating a never-ending cycle.

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Endnotes

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The Environmental Risks of Genetically Engineering Trees

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"Attempts to promote forest health by circumventing evolution and genetically engineering trees… is bound to fail, with potentially irreversible impacts on the very ecosystems they ostensibly are intended to help."

– Rachel Smolker, Anne Petermann and Rachel Kijewski, 2018[1]

Genetically engineered trees present vast uncertainties and pose a wide range of new, unique risks to forests and other ecosystems.

The unique and inherent risks of genetic engineering

The processes involved in genetic engineering, including gene editing, commonly result in unintended changes to DNA and traits.[2] Altering or introducing genes can result in changes, not only to the target gene(s) but also elsewhere, in unexpected, often surprising, and unpredictable ways that can have profound impacts on the organism. Unwanted genetic errors can occur even when the intended changes themselves are small.[3]

Genes do not function as isolated units but interact with each other and their environment in complex ways that are not well understood or predictable. The concept that one gene determines one trait is overly simplistic and outdated.[4] Rather, many genes may interact to determine a particular trait, and one gene can be involved with multiple traits. Changes made to any of the genes involved can therefore have far-reaching impacts, even on seemingly unrelated traits.

Unintended traits are common in commercialized GE crops.[5] In the case of trees, unintended effects from genetic engineering could, for example, unexpectedly alter the nutrients in seeds upon which so many animals depend,[6] or the ability of the tree to collaborate with the mycorrhizal community and thus compromise the tree's resilience or defences.[7] **Unexpected traits can also be the product of gene-environment interactions** and only become apparent, for example, during times of environmental stress such as drought.

New GE traits can perform as intended for their desired purpose, while simultaneously behaving in unanticipated ways. For example, the level of GE Bt toxin present in commercialized GE insect-tolerant corn varies in different plant tissues as well as in different stages of development and across generations.[8]

Intended GE traits can also fail to function over time, leading to possible unexpected impacts in the long term. This is a particular concern with the project to genetically engineer a blight tolerant American chestnut tree. Even if GE blight tolerance appears to be achieved, American chestnut trees can live for over 200 years, and the performance of a GE trait can be affected by environmental conditions experienced over the lifespan of a tree, such as drought, flood, heat, pests, as well as by basic changes associated with aging.

Altering traits can result in trade-offs against other functions, some more predictable than others. For example, the GE tree company ArborGen found that genetically engineering eucalyptus for increased wood density resulted in slower growth.[9] Trade-offs could result in weaker trees. For example, reducing the lignin content is a commonly attempted GE trait that is desired for biofuel production, but could compromise the structural integrity of trees and their defences against pests and other (abiotic) stresses, such as storms or floods. Trees genetically engineered to grow faster may exhibit similar vulnerabilities. The spread of such traits from plantations into neighbouring forests and ecosystems could lead to serious impacts on forest health.

"Genetic changes introduced into trees to address forest health threats have the potential to take on characteristics of invasive species that tip the balance of ecosystems."

– National Academies of Sciences, Engineering, and Medicine, US, 2019[10]

Altering forest ecosystems

Forest ecosystems are highly complex and poorly understood. Assessing how the release of GE trees will affect other trees, understory plants, insects, soils, fungi, wildlife and human communities over time, would require a far better understanding of forest ecology than we currently have. **This incredible complexity increases the unknowns and uncertainties of introducing GE trees.**