

THE GENETIC (AND FUNDING) OPPORTUNITIES, CHALLENGES AND EXPECTATIONS FACING TREE IMPROVEMENT, EVEN WITH WORLD-CLASS GENOMICS RESOURCES: A *POPULUS* CASE STUDY

Gerald A. Tuskan¹

¹ Director, The Center for Bioenergy Innovation, Oak Ridge, TN USA 37831 (gtk@ornl.gov)

The current U.S. Administration has a focus on renewable energy, climate change and environmental justice. All of these issues contain forestry related opportunities and challenges. Application of molecular biology and genomics offers potential to ameliorate these problems but the quick delivery window for solutions for these global challenges is confounded by the long reproductive cycles of many long-lived perennial plants and the lack of foundational genomics resources. New sequencing technologies and applications of advanced computing offer hope, but for most species, the realization of that hope is not happening fast enough. In *Populus*, where we have a world-class genomics resources, including high-quality assemblies and annotations for multiple species, fully genotyped association mapping and QTL populations replicated in multiple common gardens, as well as a reliable transformation system based on CRISPR. Using these resources, we have made progress in identifying and validating genes and their associated phenotypes. Examples include EPSP synthase, a novel gene that functions as a transcriptional regulator in the lignin pathway, a lectin kinase that controls colonization by the mycorrhizal fungus *Laccaria bicolor*, and a series of receptor kinases that control Septoria disease resistance. These genes, and many additional SNP markers linked to growth and cell wall traits, are being used in a machine learning approach to stack favorable genes in a genomic selection context. Still, the path to delivering solutions to issues related to renewable energy, climate change and environmental justice remain challenging. Part of the answer is greater funding at all levels, inclusive of federal, state and private sources. Continued improvements in genomics resources, transformation efficiencies and development of early flowering technologies are desperately needed in the conifers and many other hardwood species. The *Populus* case study suggest that rapid progress can be made once such resources are in place. In *Populus*, and all forest tree species, we also need broader field testing of selected and improved plant materials, as well as integrated studies on soil health, carbon sequestration, and water quality. All of us need to become active advocates for the development of these resources. There will be no solution to issues related to renewable energy, climate change and environmental justice without forest trees.