Genetic Resource Management to Mitigate the Effects of Climate Change

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The Intergovernmental Panel on Climate Change (IPCC) projects that global average surface temperatures will rise about 1.8 to 4.0ºC during the 21\textsuperscript{st} century. Accompanying these changes in climates are projected changes in the distribution of vegetation and other ecosystem components including the expectation that current plant populations will be largely maladapted to future climates.

Genetic strategies for the mitigation of the negative effects of climate change depend on knowledge of genetic variation within and among populations and the relationship to environmental variation. Three approaches have been used to characterize genetic variation of populations and the relationship to environment: (1) genecological approaches which consider genetic variation in several traits as a function of source environments, (2) response function approaches that characterize the growth (and sometimes survival, productivity or fitness) responses of populations to environmental variation at planting environments, and (3) physiological/morphological approaches that consider variation in specific physiological or morphological traits in response to environmental variation. This information is important to evaluating effects of climate change whether exploring management options using native, unimproved populations or populations derived from tree improvement programs.

Genetic management options are largely concerned with trade-offs in attempting to match populations with known characteristics to expected future climates versus planting a diversity of genotypes to allow for selection in the face of uncertain future climates. Recommendations for genetic resource management include: (1) fully characterize populations that might be deployed in future plantations, (2) relax seed transfer guidelines to allow planting of populations from warmer environments, (3) plant a diverse array of genotypes from different sources and with different characteristics including mixtures from different seed or breeding zones and mixtures of improved and unimproved genotypes, (4) breed for broadly adapted genotypes, (5) use higher planting densities followed by thinning to allow for a combined natural and artificial selection. In addition, gene conservation will likely become increasingly important as we face new climates and new pests in the future. \textit{Ex situ} conservation may become more important as populations in \textit{in situ} reserves become increasingly maladapted.

Ensuring ecosystem productivity by planting adapted, diverse forest tree populations will contribute to carbon sequestration. Tree improvement activities may further contribute to carbon sequestration by increasing productivity and carbon storage in wood and wood products.