

# Update

*Extension Note*



**Tree  
Improvement  
Branch**

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## Breeding Values

### **Background**

Tree breeding programs assess parent trees based on the performance of their offspring. Offspring from the parents are planted in progeny tests and assessed for their performance for traits of commercial interest. Parent trees are assigned "breeding values" which reflect their genetic value for specific traits, using quantitative genetic theory and techniques. Individual parents may have different breeding values for different traits.

The breeding values of parents predict the performance of their offspring. Breeding values are needed to make decisions about which individuals should be included in seed orchards and other production populations. Breeding value information is also useful in making decisions for the selection of advanced generation breeding populations.

"Genetic worth" provides a measure of the genetic quality of a seed or vegetative lot, and is based on the breeding values of contributing individual parent trees. A single seed/vegetative lot may have different genetic worth values for each of several different traits. Knowing the genetic value of seed and vegetative lots helps silviculturists choose which lots are most suited for use in meeting their management objectives for operational plantations.

Breeding values are an important measure of the genetic quality of available material. The use of breeding values is important for everyone involved in tree improvement, whether it be seed users, breeders, seed orchard technicians or orchard managers. This, as well as the long-term nature of tree improvement programs, illustrates the need to develop analytical methods for the estimation of breeding values that are consistent over time and across species. Changes in analytical methods could result in inconsistencies in seed/vegetative lot genetic worth values that would make comparison among lots difficult.

### **The Genetic Concept of Breeding Values**

Breeding values provide a measure of the performance expected from the offspring of individual parent clones. Breeding values are calculated for specific traits such as stem volume at rotation, and wood density.

The genetic superiority of an individual for a specific trait is determined by its genetic make-up or its "genotype." The value of a genotype is determined by the values of the genes it carries and

by the interactions between those genes.

A genetically superior individual is not necessarily a genetically superior parent. "Breeding value" is the value transmitted from a parent to its progeny. A parent passes on its genes but not its genotype to its progeny. The mean value of a parent's progeny is used to describe its genetic superiority as a parent. This value is called the breeding value (BV) of the individual.

A tree's breeding value is expressed by the (numerical) difference of its offspring's from the population mean. This number directly predicts genetic gain and the (mean) genotypic value of its progeny.

Since genotypic values can only be assessed by measuring the phenotypes, the breeding value of an individual is also determined by the environment where the progeny grew. It would be meaningless to speak of the breeding value of an individual without specifying the background population and the target environment. In British Columbia, different breeding zones (or seed orchard zones, selection units, etc.) have been established to make the most effective use of economic constraints and biological conditions. Breeding values of individuals for a breeding zone defines both the background population and the target environment.

In real situations, it is impossible to measure all the progeny of a parent in all the environmental conditions in a breeding zone. Instead, only a sample of progeny is tested at a sample of sites within a target environment. Also, progeny performance is estimated at an age younger than harvest rotation. This introduces uncertainty, which must be accounted for in breeding value estimates. Therefore, the true breeding value of a parent is always unknown and it has to be estimated from observed data using analytical procedures based on quantitative genetics theory. Because breeding values are estimated and have error associated with them, the analytical procedures include adjustments which reduce the measured progeny performance based on test precision and age correlations.

For more information please refer to *Breeding Values (Bvs) of Parent Trees in Commercial Tree Breeding Programs in British Columbia: An Interim Report*. This report provides updated breeding values for parent trees currently under genetic testing in the commercial tree breeding programs conducted by the British Columbia Ministry of Forests. This report provides the first listing of breeding values using new analytical methods that are consistent among species. These analytical methods will continue to be used and future updates will only reflect breeding value changes due to better available data.