Tree Improvement in BC: Developing Durable Trees

BY ALVIN YANCHUK

A rich history of tree improvement in the Pacific Northwest exists, and British Columbia's involvement started with the pioneering work of Dr. Alan Orr-Ewing in the mid-1950s with inbreeding and wide-crossing studies of coastal Douglas-fir. British Columbia's Douglas-fir tree improvement program developed further in the 1960s with an enormous controlled crossing program. Currently, coastal Douglas-fir seed orchards are producing third-generation seedlings with predicted volume gains of 25% at rotation ages about 60.

In the late 1960s and 1970s, British Columbia's work expanded to include improvement programs for interior spruce and world-class provenance testing—under the auspices of the International Union of Forest Research Organizations—for lodgepole pine, true firs, Sitka spruce, coast and interior Douglas-fir, and other species of lesser commercial importance. While provenance trials were done primarily to identify superior provenances, this work was later instrumental for the delineation of seed zones. During this period, forest industry became much more interested in tree improvement and started to help the province with seed orchard establishment, test site selection, and funding for research. Various cooperative "councils" were formed to move the program forward, and for the past 20 years, the Forest Genetics Council of BC has served as the over-arching coordinator, reporting to the chief forester in BC, for tree improvement (www.fgcouncil.bc.ca).

The heyday of tree improvement in BC, and actually, even around the world, were the 1980s and 1990s. Universities were producing more forest geneticists and there was a small hiring pulse by the public and private sector during that time. However, the BC government slowly changed its fundamental funding structure for forestry investment: i.e., provincial forest tree nurseries were privatized and funding for tree improvement largely moved to third-party "crown corporation" agencies. Ironically, while we were enduring more government downsizing, there was pressure to develop improvement programs for lodgepole pine, western larch, white pine, and interior Douglas-fir as the number of trees being planted increased to over 200 million. Despite these fiscal pressures, tree improvement programs progressed nicely, with first- and second-generation breeding and seed orchards now in place. In 2017, over 260 million trees were planted in BC and about 75% of these were from seed orchards.

The science of tree improvement became more complex in the late 1990s when issues like biological diversity came to the forefront. Many questions were asked, including: "How do the products of tree improvement fit with provincial biodiversity conservation concerns?" and "How do we conserve genetic diversity in tree improvement programs while breeding for gains in volume?" and "How can tree improvement programs maintain or enhance adaptive capacity to changing environments?" To show that species diversity was also a part of the genetic improvement pro-

gram, projects were initiated for hardwoods (birch, alder, cottonwood, maple) and other softwood species of minor commercial importance, such as ponderosa pine. The establishment of high-quality genetics field trials are the mainstay of BC's tree improvement program, and as of 2017, forest geneticists working with the BC government have planted approximately 1,500 trials in the ground, ranging from 1 to 50 years old, with 15 species.

Initially, early volume growth was the principal target trait for improvement in BC's programs, but over time other traits were included in the selection and testing programs. For example, wood density, although a very important trait for structural wood properties, is now being measured to ensure this key wood property doesn't decline during selection and breeding. During the 1990s many species were tested for disease resistance and with some species, such as white pine, "silviculturally" useful gains have been made for blister rust resistance. Over the last 20 years, tree improvement programs have placed significantly more effort on screening for disease and pest resistance including screening for resistance to spruce weevil (e.g., Sitka and interior spruce), pine rusts, and deer browsing (western redcedar), to mention a few. These efforts have focussed on using the current disease and pests we now face as a "venue" to look for more durable resistance features of trees that could guard against future pests and diseases. New pests and diseases in eastern North American forests, such as birch bronze borer, butternut canker, and emerald ash borer, are examples of the new forest health challenges we can expect in the west. All in all, BC tree improvement programs are aimed at developing more durable trees!

Tree improvement programs in BC continue to be an important element of managing and conserving the forest genetics resource. Work is currently focusing in three major areas:

1. ***Climate change.*** Our current populations of trees may not be suitable for future environments, and we are proposing to model future environments based on the suitable "climate spaces" that each species has been tracking over their history in BC. The challenge here is to align the trees coming from our seed orchards to the new projected climates zones in the province.

2. ***Genetic conservation.*** While breeding is another form of genetic conservation (e.g., we are developing multiple populations with multiple traits), geneticists are well aware of the value of the native gene pool that forms the basis of forests in BC. With climate change, and the introduction of new pests or disease, gene conservation populations in reserves, clone banks, or the seed center are valuable resources. It's our form of forest insurance!

3. ***Innovative tree breeding science.*** Many new techniques are available to us, such as better analytical tools to evaluate the best parent trees, optimization software to balance genetic gain while minimizing inbreeding, more efficient field test designs, improved GIS modeling techniques for climate predictions, LiDAR technologies for measuring trees in our trials, and better wood quality assessment tools and genetic markers. Many of us envy the next generation of tree breeders; these new tools will go a long way to meet the challenges of climate change and keeping forestry as a key industry in BC.

The future for tree improvement remains exciting. Despite the reduction of forestry-related research in BC, the products of tree improvement are being widely used and appreciated, and most foresters view genetics as an important tool to combat the challenges that nature, and us humans, can throw at forests. ◆

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