

Keeping Canada competitive: the genomics advantage

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Faced with intense global competition, Canada's forest sector is seeking improved solutions and new ways to add value for customers and end consumers. FPIInnovations plays a lead role, working with research partners, in helping the forest industry innovate based on transformative breakthroughs in science. Among such game-changing opportunities are technologies based on the rapidly advancing study of genes, known as genomics.

"Genomics has created waves of innovation all around the world, particularly in the areas of human health and medicine. Now, the game-changing potential of genomics is ready to be brought to our forests," says Pierre Lapointe, FPIInnovations' CEO.

Genomics is the study of a species' DNA, known as its genome. In sequencing the genome of individuals of a species, scientists find differences between them at given positions in their DNA. These differences are called DNA markers. These markers help identify genes that code for particular traits expressed in individual organisms of that species.

Lapointe is enthusiastic about the prospects of genomics solutions to put Canada on a strong competitive footing.

"Forest genomics is giving us the knowledge to grow better forests, faster. FPIInnovations is eager to help turn this knowledge into powerful innovations that will give Canada's forest sector a significant competitive advantage," Lapointe adds.

Already, Canada's forest research community has completely or partially sequenced genomes for a few commercially important tree species and for some pest species that impact the forest resource.

A research team centered at Laval University is helping to accelerate traditional tree breeding using genetic markers, a method called genomic selection. In the case of white spruce, conventional methods require up to 30 years to breed and test trees in the field for improved growth, adaptation and wood fibre value. With genomic selection, the time is significantly

reduced—to six years—permitting nurseries to rapidly select trees for reforestation programs.

The Laval University team is led by Dr. Jean Bousquet, Canada Research Chair in Forest Genomics. The team includes collaborators from Natural Resources Canada's Canadian Forest Service and the Canadian Wood Fibre Centre, among others.

"Just as we can decode the genomes of trees to select for the best growth and wood quality, so too can we use their genetic profiles to identify trees that have an inherent level of resilience," says Bousquet. "Genomic selection is also very promising when it comes to breeding trees that will be more resistant to pests and pathogens, and current efforts focus on developing planting stock with such attributes," adds Bousquet.

An advantage of this approach is that it does not modify the genetic material of an organism. Its focus is on learning how genes naturally control physical characteristics, then using this knowledge to support particular management objectives. "Such objectives include producing wood for desired end-uses, growing forests to survive in the face of pests and changing climate, and providing customers and producers with more certainty about the source of products," as indicated by Dr. Jean Beaulieu, member of this team and research scientist with the Canadian Wood Fibre Centre and NRCan.

Furthermore, genomics applications have a role to play in protecting Canada from invasive species. "The increase in international trade means that we are constantly under threat of attack from invasive species and pathogens that could be devastating to Canada's forest sector," says Dr. Richard Hamelin, a senior research scientist with Natural Resources Canada's Canadian Forest Service and professor at the University of British Columbia. "The horticulture industry alone imports millions of plants each year and some of those plants may carry pathogens that can be damaging to commercial forest tree species. Just like a person with the flu can contaminate other persons even before they show symptoms, plants can be infected with-

out showing symptoms and become dangerous carriers of pathogens."

Hamelin's research team has developed DNA diagnostic kits to detect markers of pathogens before there are visible symptoms, permitting the early identification that is key to quarantining and destroying the infected plants before the contagion spreads. Likewise, these diagnostic kits can be used to identify traces of pests when the insects are too early in their development for a reliable visual identification.

Looking beyond the cost-savings from improved and accelerated breeding, and reduced risk of losses from pests and pathogens, genomics can give Canada's forest products an edge on international markets. "Using genomics, we can certify that our wood products are of a certain quality, and free of pests and pathogens," Hamelin explains.

There is more than promise to the rapidly progressing field of forest genomics. There are already some tools available—and more in mature stages of development—that can change the way industry does business, from rapidly producing genetically improved planting stock to reliably detecting the presence of damaging agents, to certifying the quality of raw materials and end products. It all adds up to a greater ability to manage for value along the supply chain.

However, Canada is not the only country to see the benefits of genomics. "We're among the world leaders in forest genomics but other countries are moving fast," according to Hamelin. Among the developed countries, Sweden, the U.S. and France in particular are investing significantly in forest genomics, and developing countries such as China and Brazil also have strong forest genomics programs. The race is on to remain competitive. Effectively harnessing and applying Canada's forest genomics capacity will help our industries stay in the game.



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