GENOMICS & FORESTRY

PRODUCING AND PROTECTING CANADA'S TREES

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Making the most of our forests in a sustainable way is a crucial economic and environmental challenge for Canada. With a contribution of roughly $24B to the country's GDP, forestry provides jobs and creates a lucrative export market. And as forests cover almost half of our country, they play a critical role in Canada's complex ecosystem, not to mention an important part of our culture and lifestyle. Genomics can play an important role in helping us manage this invaluable natural resource in the face of changing climate, insect infestations and increasing demand for quality wood products.

PEST MANAGEMENT

Pests can cause massive damage to our forests, costing millions in lost exports and wages, and increasing our use of chemical inputs.

One pest species can devastate millions of hectares of coniferous forests. Two cases in point: Quebec and Atlantic Canada had a Spruce Budworm (SBW) outbreak that lasted from 1967 to 1992, which caused the loss of 12.9 million hectares of commercial forests.Since the 1990's, the Mountain Pine Beetle has destroyed over 16 million hectares of pine forest in British Columbia and is spreading east, abetted in part by higher survival of the insect over our steadily warming winters.

Because of the potential environmental and economic impact, researchers and foresters are always looking for new tools to help manage tree pests while maintaining an ecological balance with the rest of the forest and the surrounding habitats. Genomics can be an important tool in that quest.

For example, genomics was involved in the process that Canadian Forest Service (CFS) researchers used to characterize and commercialize (via Sylvar Technologies) a naturally occurring insect virus as a pest management product (Abietiv™) to kill balsam fir sawfly. This approach is also being studied to see if it would be amenable to other pests such as Spruce Budworm.

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Genomics research is also helping to monitor the quality of our wood exports. For example, a kit developed by the CFS is being used in Canada and the US to certify that Canadian nurseries are free of the pathogen that causes sudden oak death, thereby allowing Canadian producers to export their materials.

Other research is underway that is looking at pests like the Spruce Budworm and Mountain Pine Beetle. In both, the genomes of the trees, the pests and other organisms involved in the infestation process are all reviewed and assessed. The genome sequence of the Mountain Pine Beetle was recently completed by Canadian researchers and is now available to guide development of more effective controls.

THIS RESEARCH CAN HELP US:

Understand why some trees are more resistant to certain pests, which could lead to the development of new cultivars that are pest resistant.

Track the migration of certain pests, creating valuable insights to better treat and prevent outbreaks.

Understand the life process of the pests, leading to more effective and targeted management practices such new pesticide formulas, and the timing and range of pesticide application.

TREE BREEDING

Genomics has the potential to greatly accelerate the tree breeding and selection process, making it easier for producers to develop trees with desired traits such as wood strength and straightness, pest and disease resistance, and drought tolerance.

Researchers are also looking at tree genomics for ecological traits in order to determine how trees adapt to ever changing climate. This could help us select trees most able to adapt to climate change, and help us better predict the performance of our forests in future climatic conditions. For example, genomic work in European oaks has provided understanding of post-glacial migration of the species, which has led to information about their adaptive responses throughout the centuries. Until recently, complete genome sequences were available for only two tree species, the poplar and the papaya, while major efforts for other species of commercial importance have released genomes for spruces, pine, and birch.

Finally, lumber and paper production are the foundation of the forestry industry, and have been for years. Now Canada's forest producers look to build on that foundation by researching new ways to use trees as sources of biomass for a range of uses from energy (pellets) to petroleum based replacements. This means that tree qualities are being looked at in a whole new light, making genomics a valuable tool to explore the potential of trees with different traits such as biomass that is easier to break down, or tree varieties that grow faster for more frequent harvest, or that produce more O2 to release back into the environment.

WHILE GENOMICS HAS THE POTENTIAL TO SPEED UP THE PROCESS, TREE BREEDING IS NOT NEARLY AS ADVANCED AS BREEDING PRACTICES IN AGRICULTURAL SECTORS FOR THREE REASONS:

1. Tree breeding has only become widespread in the last 50 years, compared to thousands of years for agricultural species;

2. Trees take a lot longer to grow to maturity levels where you can observe traits such as growth, disease resistance and pole straightness; and

3. Trees have a more complex gene-trait relationship – it's simply not as easy to find a single gene that is responsible for a single trait, such as disease resistance. It essentially means we are much earlier in the game for trees than we are for other plants. But we are catching up. Researchers are now proposing that genomics can speed up the selective breeding process by twenty years.

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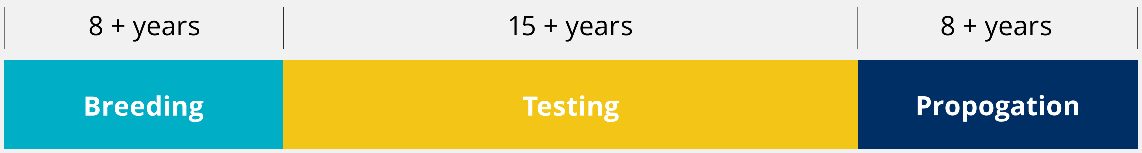
BREEDING, TESTING & PROPOGATION

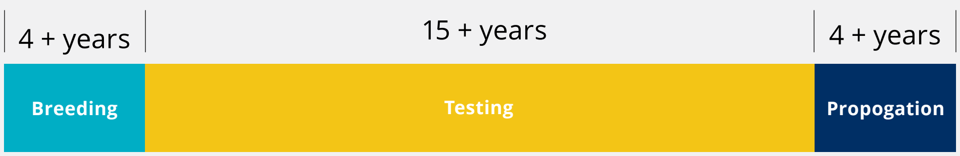
The following chart shows the duration of the three phases of tree selection: breeding, testing and propogation.

With the use of genomics and DNA tools, all three phases can be significantly reduced, shortening the overall timeframe from 31 years to 10.

TRADITIONAL BREEDING PROGRAM: 31 YEARS



ACCELERATED BREEDING: 23 YEARS



TESTING WITH DNA MARKERS: 10 YEARS

In addition, traditional selective breeding programs have seen growth and productivity gains of 10-15% per cycle. With the use of genomics and other DNA information, researchers think that similar gains could be achieved for wood density and strength, and tree trunk straightness without having to run expensive wood testing, providing significant improvements per breeding cycle.

Researchers are continuing to work closely with industry to ensure that the research results they are finding can be validated and applied to provide sustainable improvements in the real forestry environment.

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