



The Forest Value Chain: Stakeholder Engagement and Strategy Session

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VENUE

Genome BC, Vancouver

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Summary

The major challenge to the Canadian forestry sector has been the declining harvestable land base because of climate change. The effects include stress to trees due to insects, pathogens, heat and drought, that have collected led to low fiber supply. There is a clear need for resilient trees with resistance to these biotic and abiotic stresses. Furthermore, the land base decline has led to increased emphasis on value-added forestry products from the residual fiber - from biofuels to specialty materials. Cross-laminated timber as a value-added product has been an important advance, but more work is needed in this area. There is also a case for the use of forests for carbon sequestration in the amelioration of climate change, something that will have to be rationalized with respect to other forestry activities. The session brought forward topics such as understanding plant-microbe interactions and soil carbon stocks in forests, the decline in urban forests, effects on forest-dependent communities and the understanding and acceptance of the applications of biotechnology in forestry which were highlighted as important considerations for this sector.

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Introduction

On October 31st, 2019, in an effort led by Genome BC and co-championed by Genome Alberta and Genome Quebec, a locally attended and web-based forestry stakeholder engagement and strategy session was held in Vancouver (see Appendices for the final program and presenters' slides). The goal of the meeting was to bring together stakeholders in the Canadian forestry sector to discuss the challenges and opportunities facing the industry. This report is a record of the Forestry session and is intended to inform the Request for Applications (RFA) of forest sector priorities for the Large Scale Applied Research Project (LSARP) competition which Genome Canada is expected to launch in early 2020.

The meeting was attended by those with interests in the Canadian forestry sector from government, industry, and academia. The program included nine presentations, emphasizing national and regional issues, both technical and societal, as well as past Genome Canada-supported research.

Invited Presentations

LSARP 2020 AND GE³LS – KAREN DEWAR, DIRECTOR OF PROGRAMS, GENOME CANADA

Karen Dewar spoke of the upcoming LSARP competition in 2020 on Natural Resources and the Environment and approaches to successful GE³LS research. The competition, focusing on Natural Resources and the Environment, will likely be announced in January 2020, and Registrations will be received through regional centers likely in March 2020. Other regional genome centers will be holding stakeholder engagement and strategy sessions on various topics such as Conservation and Wildlife Management, Mining and Energy, and BioProducts and BioManufacturing, relevant to the Natural Resources and Environment competition.

In terms of GE³LS research, Dr. Dewar emphasized that projects could be GE³LS-led or be integrated into a project which includes technical/genomics research. In the latter case, the level of integration is

important - the test for the strength of GE³LS integration is the predicted effect of removing the GE³LS component from the project.

Successful GE³LS *integration* at the proposal stage relies on relevant expertise, pre-existing relationships with collaborators, early involvement in proposal development, and recognition of end user needs. Along similar lines, successful *execution* of funded projects requires mutual respect among collaborators, good communication, user involvement, and good guidance from the research oversight committee.

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The Canadian Forestry Sector – (James Farrell, James Sandland, Andy Benowicz, Jean-Pierre Saucier and Werner Kurz) – speaker affiliations and their presentations are appended

Based on the presentations in the forestry sector session, in Canada, the sector provides \$64B in annual revenues, \$21B in GDP which is 1.7% of GDP. Almost all regions are involved in forestry to some extent. Forestry is particularly important to British Columbia, which accounts for 46% of Canada's softwood lumber production. The industry is very export dependent – Canada is the 4th largest forest products exporter in the world, and a leader in softwood lumber and newsprint exports. The U.S. is Canada's biggest market, but other markets are increasing in importance, especially China, Japan, and the E.U. Most forest products are derived from crown land, although, in Nova Scotia, more than 50% of the land base is private.

In recent years, harvest has declined dramatically. For example, in BC, they peaked in 2005 and have been falling since then. Much of this decline is linked to climate change and the concomitant effects of

heat, drought, insects and pathogens, most significantly the Mountain Pine Beetle infestation (see below). On the demand side, Ontario has been affected by a downturn in the market for newsprint.

Werner Kurz discussed climate change along with possible mitigation strategies. He emphasized that mean temperature changes at higher latitudes have been larger than near the equator. In Canada, some regions have seen seasonal mean temperature increases of more than 5 C over the last 50 years. Regionally, climate change may enhance or reduce growth and mortality in forests. The net effect of this is very difficult to predict. It is expected that vegetation zones will continue to shift over time. It is also notable that climate change can increase the risk of forest fires, with detrimental effects on CO₂ levels. Thus, it is important, within regions, to be able to predict the direction and magnitude of changes in tree growth and mortality and soil carbon stocks. An additional issue with respect to climate change is the thawing of permafrost and the subsequent release of greenhouse gases into the atmosphere.

A major theme with respect to challenges and opportunities in the Canadian forest sector is the effort needed to move from volume to value. Historically, the value proposition in the forestry sector has been based on high volumes of fibre for low value products with small margins, e.g., lumber, pulp products, and pellets. *As harvestable land area declines, it has become increasingly important to squeeze more value from trees.* Thus, the challenge is to shift to higher value, lower volume products relating to materials, chemicals, energy and engineered wood. Cross laminated timber (CLT) is a good example of a “major step forward” in value-added forest product development with applications in the construction industry. Other possibilities include the production and application of high value ingredients and products such as lignin, nanocrystalline cellulose (NCC), biofuels, chemicals and polymers.

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On a somewhat longer timescale, given the decades from planting to harvest, tree improvement will continue to be important for dealing with existing and future issues, especially the effects of heat, drought, insects and pathogens on forest health and productivity. In Alberta, more than 90 million trees are planted annually (mostly white spruce and lodgepole pine). However, only 15% of reforestation seed is improved. Thus, there is further opportunity for tree improvement, although there are issues with understanding the value of various traits (especially in changing environments), measurement of the effectiveness of improvements, and important bottlenecks in the mass deployment of genetically improved trees. In Quebec, there are ongoing genomics projects relating to the improvement of three species of spruce. This work has leveraged the knowledge of spruce genomes to allow for early selections of individual trees, prior to phenotypic testing (*i.e.*, genomic selection), highlighting the importance of genomics in advancing forest sector outcomes.

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Each of the 2010 and 2015 Large Scale Applied Research Programs (LSARPs) funded five forestry-related projects on four topics - climate change adaptation, marker-assisted selection, forest health diagnostics, and biomass valorization. Many of these projects (AdaptTree, CoAdaptTree, SMarTForest, Spruce-UP, RES-FOR, POPCAN) involved support for tree breeding and enhanced our understanding of the genetics of abiotic (heat, drought) and biotic stress (insect, microbe) resistance, through the use of genome sequencing, genetic mapping, genomics tools development, metabolic profiling and/or mathematical modelling. In other projects (SYNBIO-MICS, “Microbial Diversity”) microbes and microbial enzymes were investigated with the goal, for example, of the conversion of lignocellulose to useful products. The TAIGA and bioSAFE projects dealt with

disease and pathogen diagnostics and invasive alien species, respectively.

A presentation was given on Genomics and Society with emphasis on forest-dependent communities. It was noted that GE³LS research has explored the effects of the application of genomics to trade and market access and the effects of national policies and regulations on the uptake of genomics-based applications. There is a clear need to understand the effects of genomics applications on forest-dependent communities, to consider these impacts early on and to take into consideration community values. Of prime importance is the need to find ways to engage and work with First Nations communities as true partners with joint decision-making and respect for their rights related to conservation of the environment.

The Brainstorming Session

FOREST HEALTH AND PRODUCTIVITY

In this first section of the brainstorming session, the topics discussed fell generally under the categories of desirable tree traits, urban forestry, carbon sequestration and invasive species. In terms of desirable tree traits, the question was asked with respect to planting for reforestation - "Do we know enough about desirable traits?". Climate change is considered to be one of the biggest challenges for this. Disease and insect research are important and there is an important role for genomics and related research in this area. A comment was made that tree performance in natural plantations are not a good predictor of the performance of genetically improved trees in forests.

Urban forests were discussed at some length. It was noted that in recent years, we have seen considerable loss of trees from urban environments. Trees in urban areas affect microenvironments; they ameliorate pollution and provide shade, reduce energy costs and improve human health. They tend to be more at risk from invasive species. The relatively small area of urban forests may prevent significant investment in their protection. Genomics and related

research could be applied to the non-commercial species in these forests. One of the challenges is the need for less expensive ways of genotyping individual trees.

The genetic modification of non-commercial species was discussed. Chestnut was raised as an example of an urban species for which transgenic trees with blight resistance have been generated in the U.S. It was indicated that GM chestnut had public support a result of the consideration of the trade-off between dealing with an invasive species and the use of genetic modification. It was suggested that newer gene-editing methods may be more socially acceptable than the traditional (*Agrobacterium*-mediated) methods of genetic modification used for GM chestnut. It was also noted that from a regulatory point of view, in the E.U., gene editing is equivalent to other forms of genetic modification.

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There were comments and questions about the role of forests in the amelioration of climate change through carbon sequestration. It was noted that use of forests is one of the cheapest ways to sequester carbon. Thus, forests may be asked to provide the "environmental service" of carbon sequestration. This would have to be funded and prioritized relative to other forestry activities. It was suggested that broadleaf species may be important for this – they are fast-growing, relatively fire-resistant and have a positive effect on surface reflectance.

Carbon sequestration also came up in discussions of microbial ecology and plant-microbe interactions. There is a positive correlation between tree species diversity and soil carbon storage. In soils, carbon storage is mediated by microbes. More work needs to be done to understand these processes and the details of how particular tree species mediate soil processes.

Invasive species were discussed. The Canadian Food Inspection Agency (CFIA) is responsible for limiting pest and pathogen transfer via imports and exports through appropriate testing. In some cases, product treatments are required, especially those mandated by importing countries. Unfortunately, the requirement for treatments is not always made on scientific grounds. There may be an opportunity to reduce these treatments and the use of the chemicals involved.

FIBRE SUPPLY AND BIOPROCESSING

The theme of “value over volume” in the face of the declining harvestable land base was important throughout the meeting and was reflected in the discussion of fibre supply and bioprocessing. It is important to get more value and product diversification from forests and this idea should be central to the Request for Applications.

The question of the use of low-quality fibre sources was raised. Can low quality, underutilized, and non-commercial fibre sources be exploited? Can low quality fibre be converted to high quality fibre? Can there be a concomitant reduction in wildfire risk? “This represents a cost/technology puzzle.”

“Comments were made about forest sector bioprocessing being a ‘work in progress’ with an ‘exciting future’ and a ‘role for genomics’ research.”

Bioprocessing of forest products, in general was discussed. What products should be made? For example, from lignin? The sentiment was that “we’re not there yet” in finding new value-added forest products and that more research is needed in this area. In addition to lignin utilization, mention was made of bioplastics, renewable natural gas and cellulosic nanomaterials (to replace plastics and in some cases, metals). The question of relevant tree traits important for bioprocessing was also raised. Comments were made about forest sector bioprocessing being a “work in progress” with an “exciting future” and a “role for genomics” research. In terms of

product diversification, a comment was made about the possibilities for non-timber forest products, such as natural products from fungi and medicinal plants.

A few comments were made about forest product traceability. More than half of tropical forest products are mislabelled. There is value in the ability to trace forest products back to sustainably managed forests. Thus, methods for optimizing traceability to such Canadian forests would be useful.

Issues relating to tree breeding programs were discussed. It was noted that, in the last 20 years many tree genomes have been sequenced, especially in Canada, the U.S. and Sweden. A major issue in the exploitation of this genomic data, in breeding programs, is the cost of genotyping individual trees. Ideally this should be US\$10 per tree or less. Costs are currently US\$25-30 per tree (or US\$40 to track 50,000 markers). Commercial methods are more expensive than non-proprietary ones. Cost per tree can be reduced if the numbers are large, e.g., in consortia. Also, new, cheaper methods are being developed, including those based on multiplex PCR and exome capture.

FOREST-DEPENDENT COMMUNITIES, GENOMICS AND SOCIETY

Forest-dependent communities are experiencing major direct and indirect challenges linked to low fibre supply especially in BC, where mill closures are affecting the livelihood of whole communities. It was noted that forest health can also affect the tourism industry.

There was an extended discussion about the perceptions of genomics and related technologies. For example, even industry leaders have been found to conflate the use of genomic tools with genetic modification. Better communication is needed with industry. Social scientists have made progress in understanding how to engage different groups about biotechnology including the molecular breeding of trees and genetic modification. It was found that “how you ask makes a big difference”. There is a need to carefully define technical terms. There is less support for genetic modification than for other approaches. In some studies, even the introduction of trees from outside of their native range was viewed negatively. On the other hand, as mentioned

above, there has been public support for transgenic chestnut for urban environments which is resistant to blight.

The management of issues related to invasive species was discussed. There are threats to forest from invasive species, both known and alien. Despite many developments relating to rapid DNA/ RNA-based testing, regulators have been very slow to implement these. The value of such tests and the barrier to beneficial regulatory implementation needs to be addressed.





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