Natural Resources Canada | Ressources naturelles Canada

CANADIAN FOREST SERVICE

Focus on Innovation

INFORMATION NOTE 3

The Canadian Forest Sector Innovation System

Introduction

In the last decade, the Canadian forest sector has been focusing on innovation and innovation systems to increase economic competitiveness and support sector transformation. Partly due to Canadian Forest Service (CFS) leadership in aligning forest sector science and technology (S&T) capacity, the key actors in the forest sector innovation system are now in place (CFS 2013).

In this Note, we will describe the Canadian forest sector innovation system as well as its key actors, their respective roles, and the innovation activities they perform. We will identify the linkages between the actors, the impacts and outcomes of their innovation activities, and the framework conditions influencing and supporting the system. Essentially, we will address the what, who, how, where, and why of the Canadian forest sector innovation system.

What Is the Purpose of the Canadian Forest Sector Innovation System?

Innovation is about developing new products, processes, organizational structures, or marketing methods. From a CFS perspective, an innovation system is **an interactive process among a wide variety of actors for the generation and exchange of relevant knowledge to support innovation along the value chain.**

The purpose of the forest sector innovation system is ultimately to support a forest sector firm's[1] ability to commercialize new products and/or processes for the marketplace, i.e., innovation. In the forest sector, the objective of innovation is to improve the sector's productivity growth and competitiveness. Economic competitiveness is necessary for Canadian forest sector firms to succeed in global markets. This in turn is based on social license and environmentally responsible harvesting and manufacturing practices. If Canadian harvesting methods are not perceived as being sustainable, forest sector firms' competitiveness would be impaired. A forest sector firm can obtain knowledge to increase its sustainability through the forest sector innovation system.

Who Are the Key Actors in the Canadian Forest Sector Innovation System and What Are Their Respective Roles?

The Canadian forest sector innovation system currently comprises five key actors: FPInnovations, industry, government, academia, and the investment community. Each key actor comprises various subactors. For example, government includes departments, ministries, agencies, funding councils, etc. Figure 1 identifies these actors and some subactors and outlines their relationships and interactions. It is a CFS interpretation of the current status of the Canadian forest sector and is not intended to show every possibility. The diagram attempts to describe a dynamic system that will likely change.

Focus on Innovation Series

Focus on Innovation is a series of Information Notes designed to provide insights on innovation and innovation systems based on CFS experience in innovation research in the forest sector. The Notes are not intended to outline Government of Canada opinions but rather to provide a basis for discussions on innovation as it relates to Canada's forest sector. In the Notes, we will cover a wide variety of topics related to innovation to foster thinking on how best to support a sustainable, innovative, and globally competitive forest sector.

[1] "Firm," not "company," is used to agree with OECD terminology.

FPInnovations

Description — FPInnovations is among the world's largest not-for-profit forest research centers. FPInnovations is of a sufficient scale to have the critical mass to implement collaborative projects with other funding agencies and industrial sectors. Its membership also comprises a diversity of forest sector innovation system actors, including federal and provincial governments, forest sector firms, and suppliers and firms from other industrial sectors (e.g., the petrochemical sector) (CFS 2013). It uses knowledge and expertise from other industrial sectors and actors to constitute the critical mass of knowledge to facilitate innovation in the sector. Through these mechanisms, FPInnovations is establishing itself as the innovation intermediary of the Canadian forest sector innovation system.

Role 1. Conduct innovation activities to develop innovative forest products and processes to support the forest sector's competitiveness. FPInnovations considers the entire value chain and the market demands within a framework of environmental sustainability. This is achieved both directly through innovation activities performed in FPInnovations laboratories across Canada and indirectly by participating in aligning the research objectives of the Canadian Wood Fibre Centre (CWFC) with those of other collaborators.

Role 2. Strengthen the linkages between actors in the innovation system to accelerate knowledge adoption by forest sector firms, and engage key actors of the forest sector innovation system to collectively set innovation priorities for the sector that respond to market needs. Given its role as an innovation intermediary of the forest sector innovation system, and the diversity of its members, FPInnovations is in a unique position to undertake this second role. Setting collective innovation priorities for the sector requires active engagement with all the key actors. This was highlighted by the Canadian Forest Innovation Council as a specific role of FPInnovations Board, allowing the sector to speak with one voice on innovation.

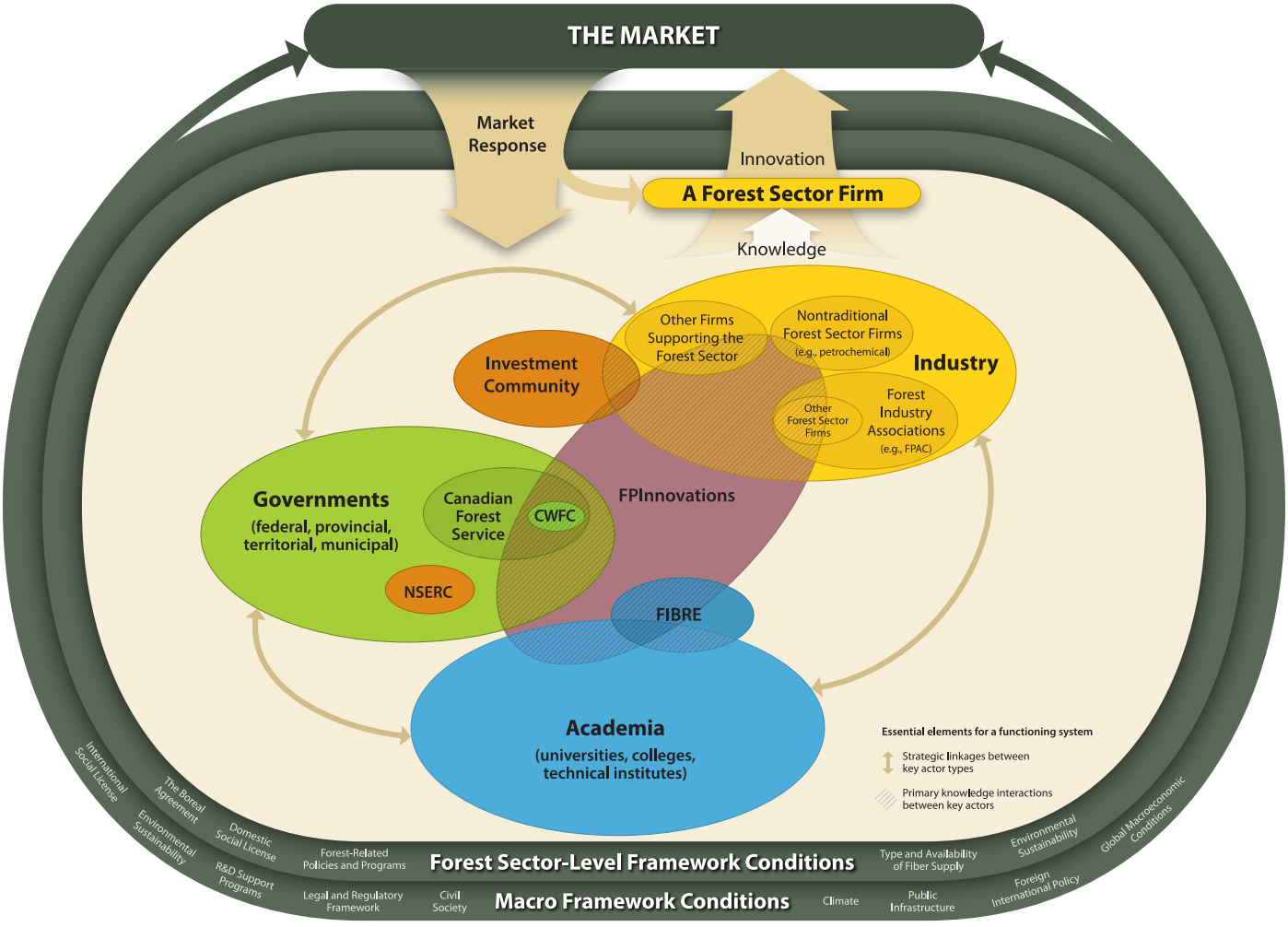

Figure 1. The Canadian forest sector innovation system including all key actors, subactors, and the linkages between them, 2013.

Industry

Description — Industry is composed of various subactors encompassing traditional and nontraditional forest sector firms, service firms, and associations.

- Traditionally, **forest sector firms** are part of the logging, the pulp and paper, or the wood product manufacturing sectors (as defined by the North American Industry Classification System). More recently, firms from other industrial sectors have begun partnering with forest sector firms to capitalize on the emerging opportunities in the area of bioenergy, biomaterials, and biochemicals. These firms may be referred to as **nontraditional forest sector firms** (e.g., petrochemical). They are part of the forest sector innovation system because they use forest-derived fiber as an input in their production process. Through these partnerships, it is expected that the Canadian forest sector will improve its economic competitiveness by making better use of forest fiber and by-products to create a more diversified, higher-value product mix.
- **Other firms supporting the sector** include consultants, machinery and equipment retailers, service firms, etc.
- **Forest industry associations** (e.g., Forest Products Association of Canada (FPAC)) provide many different services to their members, including developing strategic orientations and acting as the liaison between individual forest sector firms and other actors in the system.

Role. Commercialize innovative products and processes and implement innovation marketing and organizational methods to increase economic competitiveness by leveraging knowledge developed both internally and by other forest sector innovation system actors.

Government

Description — In Canada, federal, provincial, and territorial governments have complementary roles and responsibilities related to Canada's forest sector.

- The **CFS** is part of **Natural Resources Canada (NRCan)** and is the national focal point on forest-related matters. The federal role the CFS fulfills regarding innovation is to provide national thought leadership and establish institutional arrangements and partnerships to improve the performance of the forest sector innovation system, ultimately supporting forest sector transformation and therefore contributing to its competitiveness. The CFS also conducts innovation research and supports innovation in the sector through targeted program investments. Overall, the CFS, in collaboration with FPInnovations, is a catalyst in integrating and aligning the work of other forest sector innovation system key actors.
- The **CWFC** is the national authority on the characterization, development, and use of Canadian wood fiber in support of the economic competitiveness of the Canadian forest sector. Although the CWFC takes its administrative direction from NRCan, CWFC research priorities are aligned with FPInnovations research priorities.
- **Other federal government departments and agencies** also play a role in the forest sector innovation system mostly through funding support directly to academia or industry-focused initiatives. Notably, through the Natural Sciences and Engineering Research Council (NSERC), Industry Canada funds the Forest Sector R&D Initiative. Although identified as government in the forest sector innovation system, the role these research councils play is more similar to that of the investment community.
- **Provincial and territorial forest agencies** are responsible for the sustainable management of forest resources, including allocating forest resources to logging firms for harvesting purposes. To do this, they provide funding and coordinate research programs within their jurisdiction. They also cooperate with the federal government on S&T through the Canadian Council of Forest Ministers.
- **Municipalities and regional development agencies** can support the establishment of forest sector firms within the limits of their territory as part of their economic development activities. In some provinces, local actors are also performing an increasingly active role in fiber supply allocation.

Role. Creating and disseminating scientific knowledge, developing and implementing policies and funding programs, enforcing regulations, managing the framework conditions, and enhancing the performance of the innovation system by optimizing linkages and strategic partnerships between actors in the forest sector innovation system.

Academia

Description — Many scientists and research staff in Canada are affiliated with various universities, colleges, and technical institutes, and work on different aspects of forest sector S&T. Academia transfers its knowledge to other actors in the system, including industry and government, through graduating students becoming part of the work force, research collaborations and contracts, as well as through publications. As part of forest sector transformation, it is important to incorporate research from other disciplines beyond traditional forestry (e.g., chemistry, business administration).

Role 1. Training highly skilled personnel.

Role 2. Performing research and development activities.

Investment Community

Description — The investment community subactors include angel investors, venture capitalists, financial institutions, and some governmental agencies. They all provide funding directly

to forest sector firms to support innovation at different stages of the innovation curve, from the idea to development to large-scale deployment. An angel investor is a private investor who generally provides finance and business expertise to a firm in return for an equity share in the firm. Venture capital is private equity provided by specialized firms acting as intermediaries between primary sources of finance (insurance, pension funds, banks, etc.) and private firms whose shares are not freely traded on any stock market. Venture capitalists typically provide funding at the seed, start-up, and growth phases of entrepreneurial firms (OECD 2011). Banks and other financial institutions also provide a suite of financing options. In addition, governments support innovation through a suite of funding programs (e.g., the Business Development Bank of Canada's venture capital financing solutions, the National Research Council's Industrial Research Assistance Program, and various provincial programs), but these programs are not specific to the forest sector. Canada's major research granting agencies (NSERC and the Social Sciences and Humanities Research Council of Canada) also act as a major funding source for forest sector S&T in Canada, providing research funding to academia.

Role. Provide funding solutions to help bring new business ideas to market.

How Does the Canadian Forest Sector Innovation System Operate?

The purpose of the Canadian forest sector innovation system is ultimately to support a forest sector firm's ability to commercialize new products and/or processes for the marketplace. To achieve this goal, the innovation activities performed by the various actors must be aligned with a common vision, the linkages between the actors must support knowledge flow, and the outcomes must respond to current and future market needs, all while taking into account and/or responding to framework conditions.

Innovation Activities

All the actors described so far perform or indirectly support innovation activities, either alone or in collaboration with other actors in the forest sector innovation system. These activities include the creation, transmission, or use of knowledge such as invention, R&D, and use of technologies (Lonmo and Schaan 2005). In the context of the forest sector, FPInnovations, the Forest Innovation by Research and Education (FIBRE) research networks, and the CFS all perform innovation activities at different stages along the forest sector value chain.

Linkages

Linkages include any interaction between the actors in the forest sector innovation system, such as collaboration, partnership agreements, contracts, joint research, licensing of intellectual property, knowledge and data flow, joint purchase of equipment, and exchange of human resources (Gault 2010). Just as linkages in individual organizations foster effectiveness, strategic linkages between key actors in the forest sector innovation system are essential to support sector transformation. Furthermore, interorganizational linkages are critical for setting collective priorities for the forest sector and ensuring that innovation activities undertaken by individual actors are aligned with the strategic vision for the sector. Specifically, in the Canadian forest sector innovation system, CWFC and FIBRE S&T activities are aligned with FPInnovations research priorities, which themselves are aligned with FPAC's four pillars and Vision 2020.

Outcomes and Impacts

Key actors perform innovation activities and have linkages leading to short-term outcomes such as the commercialization of new or improved products or processes for the marketplace and longer-term socioeconomic impacts such as productivity growth and improved competitiveness of the Canadian economy.

Examples of outcomes from the forest sector innovation system include the work performed by FPInnovations through partnerships with forest sector firms in developing transformative technologies. These technologies include (1) cross-laminated timber, which offers a strong combination of environmental performance and sustainability, design flexibility, cost-competitiveness, and structural integrity; (2) processes like precision forestry operations, which provide for real-time estimates to support economically favorable decisions for harvesting; and (3) one of FPInnovations' most notable achievements, its partnership with Domtar to establish the world's first commercial plant to produce nanocrystalline cellulose, a new forest product with the potential to increase the durability and strength of many industrial materials, representing potentially a $1 billion market in 10 years and positioning Canada as a global leader in transformative technologies.

If these transformative technologies prove to be successful in 10–15 years, they could have significant measurable impacts, for example, in terms of employment opportunities in forest-dependent rural areas and increased international competitiveness of the Canadian forest sector.

Framework Conditions

The entire forest sector innovation system is influenced by its framework conditions. Framework conditions are "those factors that are external to a firm and that drive and shape the innovation activity of firms; and influence their innovation performance and subsequent market success" (Allman et al. 2011). There are two kinds of framework conditions affecting the forest sector innovation system:

1. **Macro framework conditions** include provincial, federal, and international public infrastructure; institutional, legal,

and regulatory framework; R&D support programs; climate; foreign international policy; and macroeconomic conditions.

2. **Forest sector-level framework conditions** include type and availability of fiber supply, and forest-related policies, programs, and regulations.

In some situations, the government can have direct control over the framework conditions through policy, regulations, and programs (e.g., tax credits on innovation, subsidies, program investment in transformative technology, etc.). Sometimes the framework conditions over which government has direct control can impede innovation; governments may then have the opportunity to address these situations. For example, new innovative building material may require S&T investment to demonstrate its compliance with applicable building codes. In other instances, the government can indirectly improve the framework conditions through diplomatic relations (e.g., the softwood lumber challenge). However, government cannot always control the framework conditions, as illustrated by the collapse of the US housing market leading to reduced demand for Canadian wood products. Regardless of the type of framework condition, they all influence the system.

Where Does the Canadian Forest Sector Innovation System Operate?

Innovation systems exist at different scales. In this innovation system Note, along with the Canadian forest sector innovation system diagram (Figure 1), we describe the national forest sector innovation system, which is a subsystem of the national innovation system. National innovation systems provide the necessary infrastructure and framework conditions that influence all innovation activities in a country (Fagerberg and Sapprasert 2011). They can be further subdivided into sectoral and regional innovation systems. Sectoral innovation systems such as the Canadian forest sector innovation system are innovation systems based around industrial sectors. Other sectoral innovation systems also exist (e.g., mining or energy). Sometimes sectoral innovation systems interact (e.g., the petrochemical and forest sectors interact to produce forest biomass-based biofuels). Sectoral systems may also have unique regional aspects. Regional innovation systems are geographically based, consisting of several regional cross-sectoral clusters involving different industries and institutions working together to support industry in a particular geographic area (A. Holbrook, pers. comm., 2012). Regional innovation systems can include components of several different sectoral innovation systems supporting innovation in a given region.

The following two concepts rooted in geography are important to consider when discussing innovation regionally:

1. **The forest sector value chain** represents all the stages required for the commercialization of a forest product, from collecting the raw materials to manufacturing the final product to bringing it to the marketplace. The value chain can be quite extended, including processing far from immediate harvesting (A. Holbrook, pers. com., 2012). The economic competitiveness of a sector can be optimized by applying different types of innovation (i.e., product, process, marketing, and organizational innovation) along the entire value chain. To make this process as effective as possible, it is necessary to consider not only the individual steps along the chain but the entire chain. For example, the CFS is partnering with FPInnovations to increase communication in the forest sector innovation system to optimize the forest sector value chain. In Canada, the forest industry comprises different value chains that depend on the local and regional quality and availability of tree species. The value chains vary regionally according to markets and industrial infrastructure. The CFS, in coordination with its partners in academia, industry, and government, is funding research to characterize and optimize these different value chains in specific geographic regions of Canada. Activities funded under the Transformative Technologies Program inlcude the BC Coastal Forest Sector Hem-Fir Initiative and the Hardwood Initiative. Both initiatives study the local fiber supply: the first, the western hemlock (*Tsuga heterophylla*)–amabilis fir (*Abies amabilis*) component of the BC coastal forest resource; the second, the eastern hardwoods of New Brunswick, Nova Scotia, Ontario, and Quebec. Both initiatives are designed to increase knowledge about the characteristics of the fiber supply to identify end products that are best suited to optimize the two separate value chains.

2. **Clusters** are significant concentrations of innovative firms around a nucleus of R&D facilities in a single locale (NRC 2009). Innovation is fostered by close geographic linkages between the various actors, which facilitates knowledge flow and promotes synergies. The characteristics of the cluster will be determined by the local value chain. In the Canadian forest sector, there are regional clusters based on fiber distribution across the country. In fact, wherever a federal facility was established, the result was the eventual establishment of a regional S&T cluster composed of provincial institutes and universities. Clusters range in size across Canada based on the economic importance of the resource. British Columbia and Quebec have the largest clusters followed by Alberta and Ontario.

Why Is It Advantageous for the Canadian Forest Sector to Take an Innovation System Approach?

The Canadian forest sector is currently implementing a transformative agenda to address today's challenges and better position itself for future opportunities. Taking an innovation system approach is an integral part of this process because it provides the basis for increasing the institutional alignment

and fostering synergy among key actors. The system's overall purpose is to accelerate the time from the idea for an innovation to its implementation. An innovation system approach can be very powerful by providing benefits to every actor in the system, including the firms. These benefits include

- increased alignment of the actors, and allowing the sector, through FPInnovations Board of Directors, to set strategic objectives and speak with one voice, defining national innovation priorities;
- fostering synergies between actors and improving the knowledge transfer process (i.e., by allowing actors quick access to needed information);
- focusing on the customer, whether it be academia, government, or industry, tailoring products to customer needs; and
- supporting the ability of the CFS to optimize policies, regulations, programs, and innovation activities to enhance the forest sector's performance through performance measurement and related evidence-based recommendations.

Conclusion

Innovation is a dynamic process and therefore it is important that the sector continue to look for new opportunities and anticipate potential problems. The key actors in the Canadian forest sector innovation system are in place and strategic R&D investments are being pursued.

The ongoing forest sector transformation will impact the dynamics of the innovation system, and the challenge is to ensure high performance and continued evolution of the system that answers forest sector needs. Because the forest sector innovation system is constantly evolving, it is also important to pursue innovation research into how best to measure its performance, both for individual actors and for the entire system. This focus on measurement could lead to valuable recommendations on how to increase the effectiveness of the system. Measuring innovation will be explored in future Notes in this series.

References

Allman, K.; Edler, J.; Georghiou, L.; Jones, B.; Miles, I.; Omidvar, O.; Ramlogan R.; Rigby, J. 2011. Measuring wider framework conditions for successful innovation: a system's review of UK and international innovation data. NESTA index report: January 2011. Nesta, London. 76 p. http://www.nesta.org.uk/library/documents/Measuring_Framework_web_v2.pdf [Accessed November 2012.]

[CFS] Canadian Forest Service, Natural Resources Canada. 2013. Focus on Innovation: Information Note 2. Historical perspective on forest sector science and technology alignment: the foundation for forest sector transformation. Natural Resources Canada, Canadian Forest Service, Science Program Branch. Ottawa, ON. 7 p.

Fagerberg, J.; Sapprasert, K. 2011. National innovation systems: the emergence of a new approach. Science and Public Policy 38(9):669–679.

Gault, F. 2010. Innovation strategies for a global economy: development, implementation, measurement and management. International Development Research Centre, Ottawa, ON, and Edward Elgar Publishing Inc., Northampton, MA. 256 p.

Lonmo, C.; Schaan, S. 2005. Innovation in selected industries serving the mining and forestry sectors: results from the Survey of Innovation 2003, 2001–2003. [Accessed online.] Statistics Canada. Science, Innovation and Electronic Information Division Working Papers. No.015.58p. http://www.statcan.gc.ca/pub/88f0006x/88f0006x2005015-eng.pdf [Accessed November 2012.]

[NRC] National Research Council of Canada. 2009. Technology clusters—building an innovation advantage for Canada. Dimensions, Issue 1. http://www.nrc-cnrc.gc.ca/eng/dimensions/issue1/clusteroverview.html [Accessed November 2012.]

[OECD] Organisation for Economic Cooperation and Development. 2011. Mobilising private funding. Chapter 3, 3.2 *in* Measuring innovation: a new perspective—online version. www.oecd.org/innovation/strategy/measuring [Accessed November 2012.]

For more information
nrcan.gc.ca/forests/innovation/13329

Cat. no. Fo3-3/3-2014E-PDF
ISBN 978-1-100-21785-7