REPORT SUMMARY — JANUARY 2025

Building Capacity in the Canadian Tree Seed Supply Chain

Forests Canada

Natural Resources Canada | Ressources naturelles Canada

Canada

Forest Gene Conservation Association

LAND ACKNOWLEDGEMENT

We acknowledge that we conduct our work activities on the treaty lands and territory of numerous and diverse Indigenous Nations and pay tribute to their heritage and legacy.

We aim to walk lightly, harvest with respect, and learn from local knowledge-keepers of every Nation.

AUTHORSHIP

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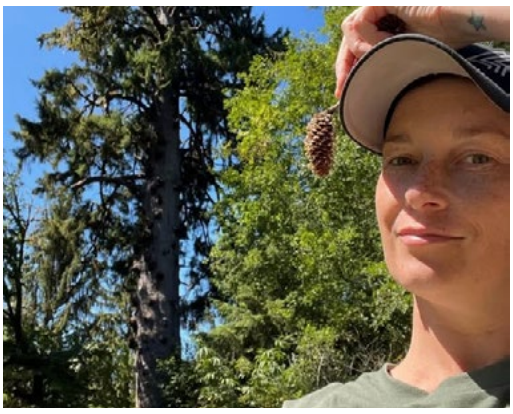
RESEARCH BACKGROUND

Building Capacity in the Tree Seed Supply Chain in Canada is a report summarizing the national seed capacity study carried out by Forests Canada (FC) and the Forest Gene Conservation Association (FGCA) with funding by the 2 Billion Trees (2BT) program in collaboration with the National Tree Seed Centre (NTSC). The study entailed carrying out an investigation into the tree seed supply chain, assessing jurisdictional capacity, developing tools to assist NRCan in assessing 2BT mass planting applications, and providing and promoting resources and tools that support seed acquisition. Data from the NTSC survey, *Sizing Canada's National Seed Supply Chain* (Spearing et. al., 2023), was a key reference for this report.

To highlight the challenges and opportunities with seed across Canada, the findings outlined in this report leveraged previous data from the NTSC survey, interviews with stakeholders across the country, and surveys with tree nurseries to develop key solutions to mitigate the barriers of the seed supply chain.

Melissa Spearing Tribute



We would like to acknowledge the contributions of Melissa Spearing to the critical work of seed across Canada. Melissa's work was instrumental in shaping this study, building off the recent research she led: *Sizing Canada's National Seed Supply Chain* (Spearing et. al., 2023). Melissa was known for her passion for seed, passion for people, and passion for wanting to ensure that we were making the right decisions for the health of our forests in the future uncertainties of climate change. Her impact on our forests will be felt for generations.

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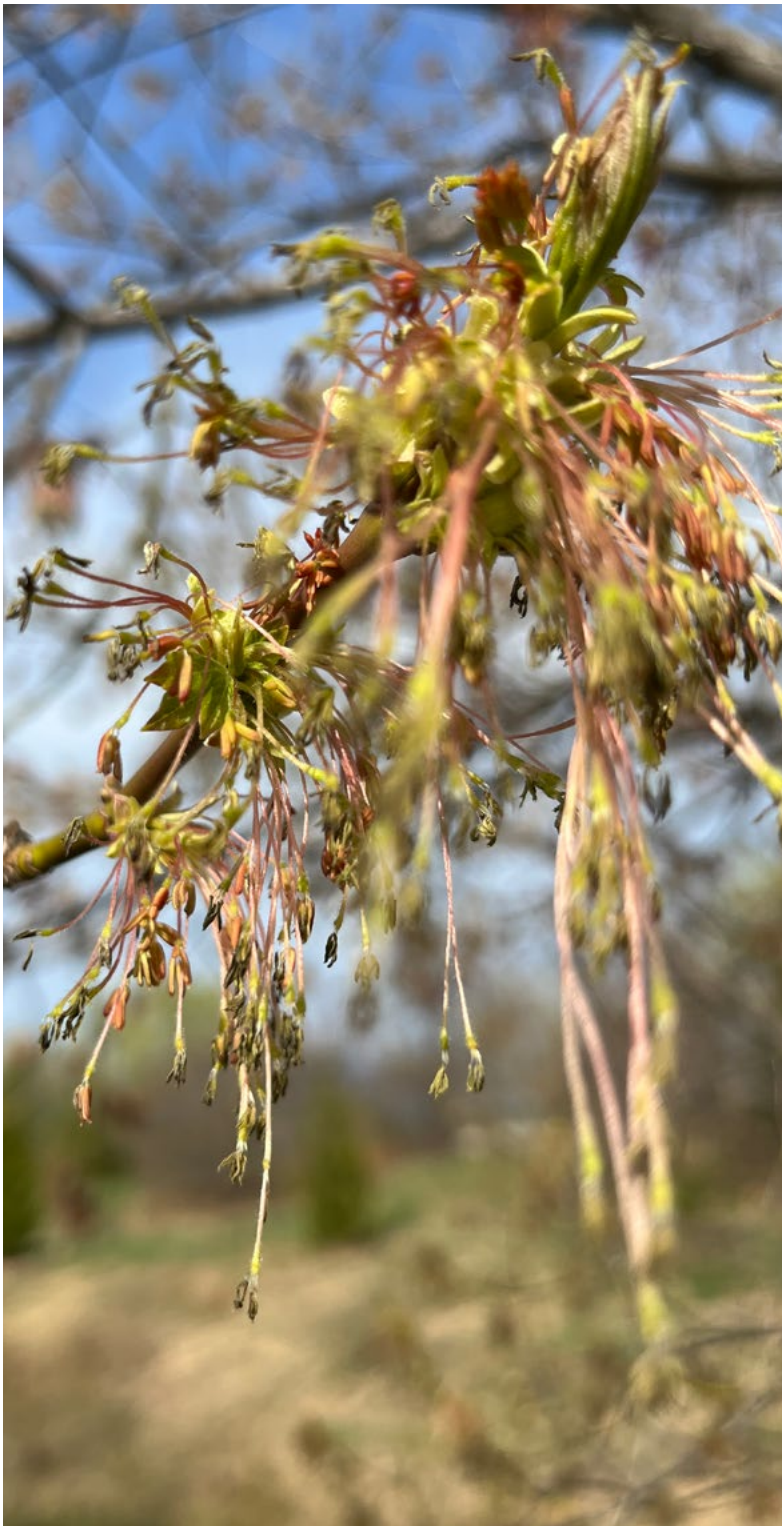
Introduction

The 2 Billion Trees (2BT) Program, launched in 2021 and led by Natural Resources Canada (NRCan), supports scaling nationwide reforestation and forest restoration efforts. The goal is to plant 2 billion additional trees by 2031 across urban, rural, Indigenous, and provincial/territory landscapes.

The complexities of a nationwide tree planting program are numerous, most notably the limited amount of appropriate tree seed or the planning required to support growing this supply to match the increased scale of tree planting projected as a result of the 2BT program. Prior to the launch of the 2BT program, there was a recognition by industry and government stakeholders of growing challenges in the Canadian tree seed supply chain. Additionally, results from surveys and interviews conducted by the National Tree Seed Centre (NTSC) in 2021-2022 (Spearing, et al., 2023), indicated a multitude of gaps likely to impede the first five years of the 2BT program.

Identifying and addressing the barriers and challenges different sectors face around tree seed procurement and access are important if agreement holders are to fulfil their 2BT program commitments. Investing in solutions to overcome some of these barriers is required to increase supply of high-quality, source-identified and climate-ready material that is suitable for projects and programs on private, public and Indigenous lands.

The 2BT program has allocated funds across several different streams to support a diversity of planting projects and partners. The 2BT program is focused on funding four streams: (1) Bilateral Agreements (Provinces and Territories); (2) Tree Planting Stream (Mass Plantings); (3) Indigenous Funding Stream; and (4) Urban Plantings. While seed



Silver maple flowering

supply challenges exist across all streams as the program scales up existing planting efforts, this report focuses on the challenges associated with both the bilateral agreements and the tree planting stream.

Currently, the 2BT program supports treeplanting operations with a range of stakeholders, including those operating on private, public and Indigenous lands. Funding agreements to support tree planting are made directly with NRCan through mass planting agreements, through aggregator organizations (including FC), or indirectly through bilateral agreements with provinces and territories. It takes approximately 1.5 to 5 seeds to produce one ship tree and depending on seed quality can be even higher. This means that ~3 billion seeds are required to fulfil these existing agreements. This scale of increase requires significant investment across the supply chain — from collection to processing and storage — in addition to knowledge mobilization and training to ensure that high-quality and appropriate tree seed is being sourced.

Douglas fir cone and old male pollen cones

Tree Planting Sectors

To achieve the 2BT targets, numerous types of participants will be needed across sectors, including those operating on private, public and Indigenous lands. For the purposes of this study, four primary restoration sectors and end users of tree seed were identified across the country: (1) Non-governmental Organizations (NGOs); (2) Restoration and Reclamation Industries (R&R); (3) Forest Industry (FI); and (4) Indigenous Communities and Organizations (ICOs)*.

NGOs, which include environmental organizations, conservation authorities/ watershed districts and charities, carry out reforestation and restoration projects on private, municipal and public land. Many NGOs have either direct 2BT agreements with NRCan, access funding through aggregators, and/or are planting trees through provincial bilateral agreements. The funding for these projects is supported through the government, foundations, donations, and the private sector.

Left: Red Oak one-year seedbeds

Right Top: Red Oak cut test sample

Right Bottom: Red Oak acorns before floating

*A growing number of Indigenous communities are entering the R&R sector. Aski Reclamation Ltd., owned and operated by the Saulteau First Nations, located in Traditional Treaty 8 Territory, is one such example. These community-owned companies integrate their traditional knowledge into restoration practices. Additionally, planting can be driven by community interests in restoring access to plants for traditional foods, medicines and ceremony.

Red Oak Crop Intensity

NGOs are putting an increased demand on seed supply as they are key drivers in restoration projects and operate across landscapes. Restoration projects driven by NGOs are often complex and require planting strategies with a broader range of tree and shrub species and can operate across multiple seed zones. Hardwood stock is often grown by third-party nurseries where the seed is supplied by the grower, but often, seed provenance is unknown. Conversely, many conifer seedlings grown under contract are sourced from provincial or forest industry nurseries and are generally available from appropriate seed sources.

NGOs often purchase planting stock on speculation or are forced to purchase whatever surplus material is available in the tree supply system. This uncertainty can limit seedlings from appropriate sources and potentially restrict species available and appropriate for specific site conditions. It often comes down to choosing between planting a species, seed source, or stock type that is not ideally suited to a site or having to pass on the project. Completing the project most often wins out.

Sourcing hardwood tree seedlings is a challenge at industrial levels, and some organizations are developing relationships with nurseries to grow the required stock. Some NGOs are directly involved with collecting seed and supplying it to local growers or growing the stock themselves. These strategies significantly increase the data on seed provenance and can increase the variety of plants and trees available for restoration projects.

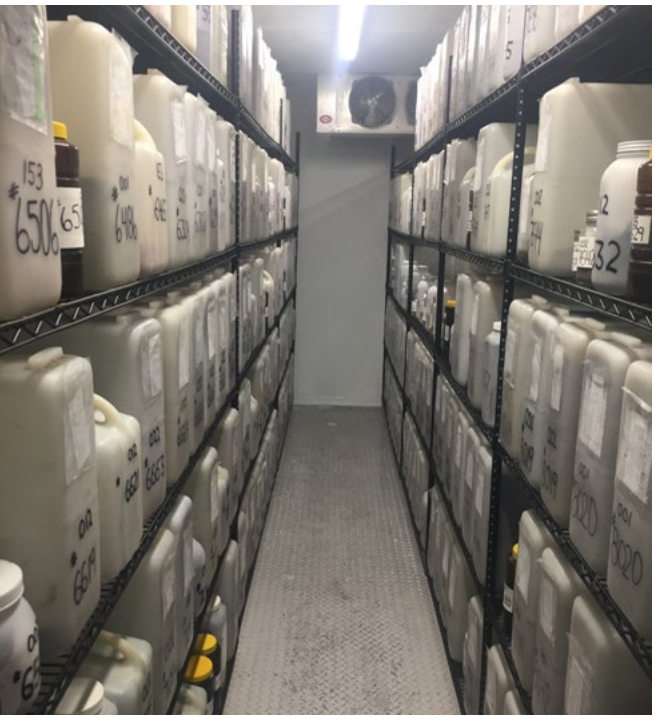
The R&R sector carries out projects on private and public land. Undertakings for this sector evolve from deforestation due to industrial activity (e.g. oil, gas and mining), degradation through past development (e.g. urban and municipal development and agriculture) and natural disturbances (e.g. fire). Reclamation practices are often complex, and the

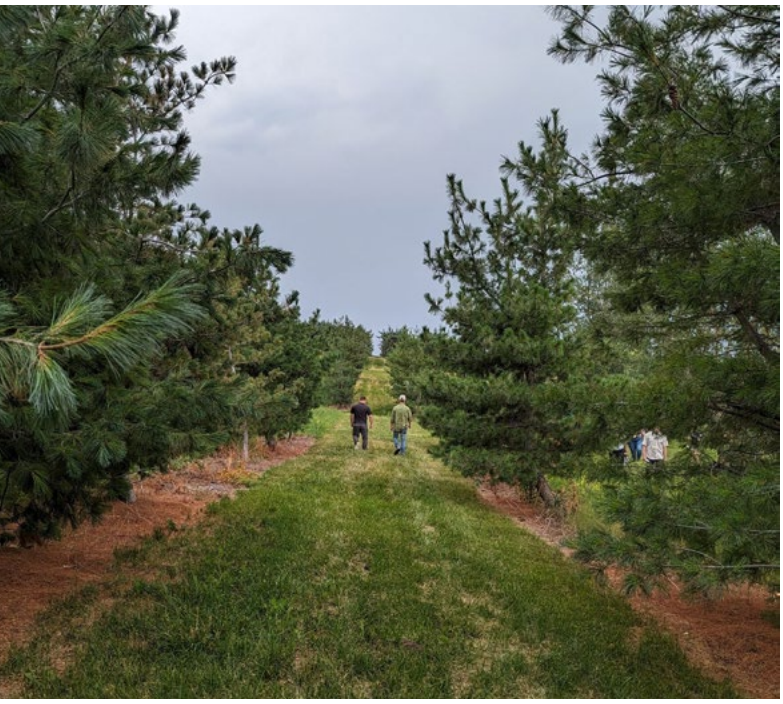
strategies require a broad range of tree and shrub species. The projects are funded by government, industry, and private resources.

The R&R industry *currently* places a relatively small demand on tree seed supply in terms of gross numbers, but with increased areas affected by natural disturbance, this demand will likely increase significantly. Also, due to the complexity of planting sites, most areas require a wider range of tree and shrub species that often operate over multiple seed zones. Most R&R organizations can access conifer seedlings from nurseries growing for the forest industry (if planting on public land, regulations often dictate they must use tree seed from government sources). Still, there are issues sourcing hardwood tree and shrub species. Because of their diverse planting needs, most companies in the R&R sector have developed relationships with specific nurseries, created their own seed banks and are growing their own planting stock or contracting private nurseries.

Left: Cones drying on cone trays

Below: Seed storage in -20 Celsius freezer





View of white pine seed orchard

1/2 cut test on squirrel cached white pine cones

FI plays a significant role in reforestation efforts across Canada. The FI sector is regulated under provincial policy, and harvested areas must be regenerated through tree planting efforts or suitable natural regeneration. These types of legally required reforestation projects are not eligible for 2BT program funding. However, public forest areas impacted by natural disturbances (e.g. fire, pest and disease) may be eligible for 2BT funding, and the demand for this is likely to increase with greater disturbances driven by climate change. FI does not typically have 2BT mass planting agreements directly with NRCan, but the forest sector will be critical to delivering on the ground results for the bilateral agreements with provinces and territories. FI will also be a vital contributor supporting the scaling up of existing tree seed services to support projects funded by the 2BT program (e.g. access to tree seed, services and knowledge).

In many jurisdictions, the FI has invested in tree improvement programs such as tree seed facilities, seed orchards and human resources to provide a sustained supply of tree seed (Thomas, Stoehr, et al., 2024). In British Columbia, Alberta, Ontario and Quebec, specific government regulations control various aspects of tree seed registration, collection, storage and deployment on public forest land. In provinces without regulation, FI has business-to-business relationships with the government that controls the supply of most tree seed. Investments in tree improvement programs have been made by all provinces (Thomas, Barb R., et al., 2024), however, some are no longer supported appropriately. These incentives and programs support the development of tree breeding initiatives, seed orchards, growth and yield programs and track genetic gains from improved stock. The status of improved stock deployment varies by province, with no programs existing in the Northern Territories (Yukon, Northwest Territories and Nunavut).

ICOs are becoming increasingly interested in getting involved in the 2BT program. ICOs have unique and important interests in restoration as planting is often done to address concerns for food security, medicines and the loss of plants with cultural significance, in addition to supporting community well-being and local economies. Typically, projects are conducted on community land and adjacent land bases. The land bases are often under self-governance or are Treaty Lands and are typically funded partially by 2BT or provincial bilateral agreements.

ICOs place a smaller demand on the seed supply in terms of tree seed volume, but they have a more holistic view of all the plants and animals that need to be conserved and restored. For those engaged in seed saving, collections are generally smaller and are often more challenging to obtain, process and store. Provenance is of great importance to community members, and there is an emphasis on using local seed sources. ICOs' capacity to collect, process and store seed varies significantly: it is high where economic opportunities for regular restoration projects are demanded, but low where communities are developing interest.

There is a strong community interest in growing native plants to restore local landscapes, but finding and retaining skilled knowledge-holders, like in other sectors, is a chronic challenge. Tree and shrub seed storage facilities are typically in communities where commercial opportunities exist (i.e., via R&R contracts and nurseries) and there are limited options* outside communities.

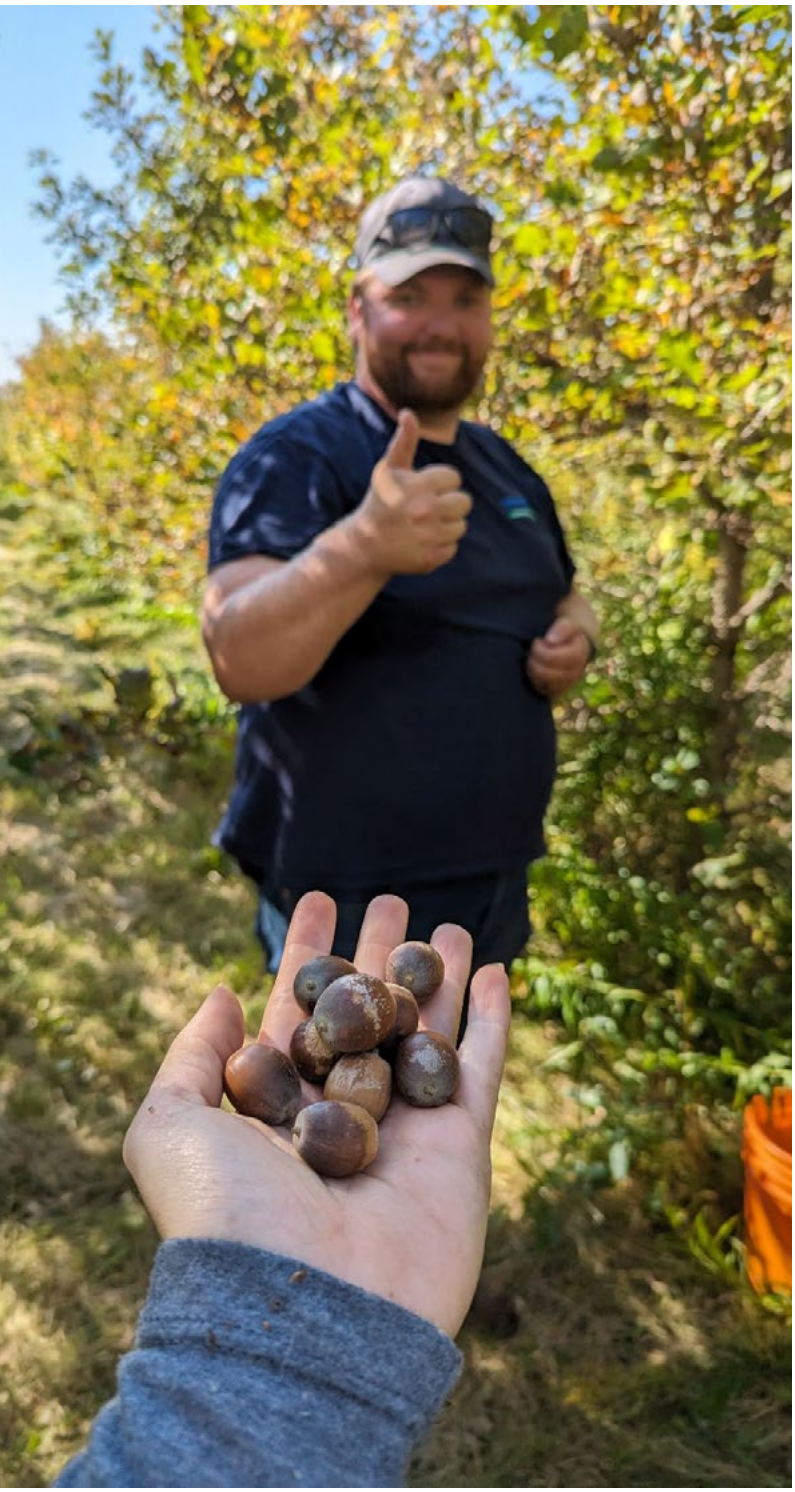
*An option for some communities is the Indigenous Seed Collection Program (ISCP). As of May 2024, five Indigenous communities have signed Memorandums of Understanding with NRCan's ISCP. The agreements ensure security of intellectual property rights and access to training in seed extraction, testing and long-term seed storage.

Summary

Overall, significant differences exist in the needs and access to seed across restoration sectors. Collectively, these stakeholders will play a critical role in delivering the tree targets set forth by NRCan's 2 Billion Trees Program through mass planting and provincial bilateral agreements. The current 2BT agreements estimate that an additional 150-200 million trees need to be planted annually to reach the program goals. Over the past decade, 500 to 600 million trees have been planted annually by the forest industry for the reforestation of harvested areas (Canadian Council of Forest Ministers, 2024). These reforestation targets and mandates delivered by the FI are expected to continue. In contrast, the reported 2016-2022 average of non-reforestation Canadian nursery production of woody plants was approximately 41.3 million per year (Statistics Canada, 2024).

The current seed and tree supply system is based on fulfilling current reforestation efforts. Historically, most provinces have been directly involved with the seed supply chain. However, with redirected commitment and funding, many provinces are backing away from funding direct seed acquisition and taking on more of a policy and regulatory role. Therefore, in addition to variability across sectors, issues associated with the tree seed supply chain tend to be provincial or regional in nature.

Barriers in Tree Seed Supply Chain

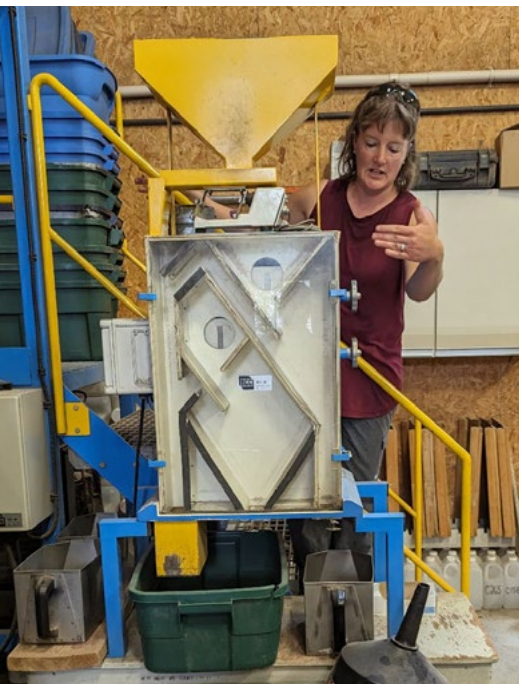


Bur oak acorns from assisted migration trial area

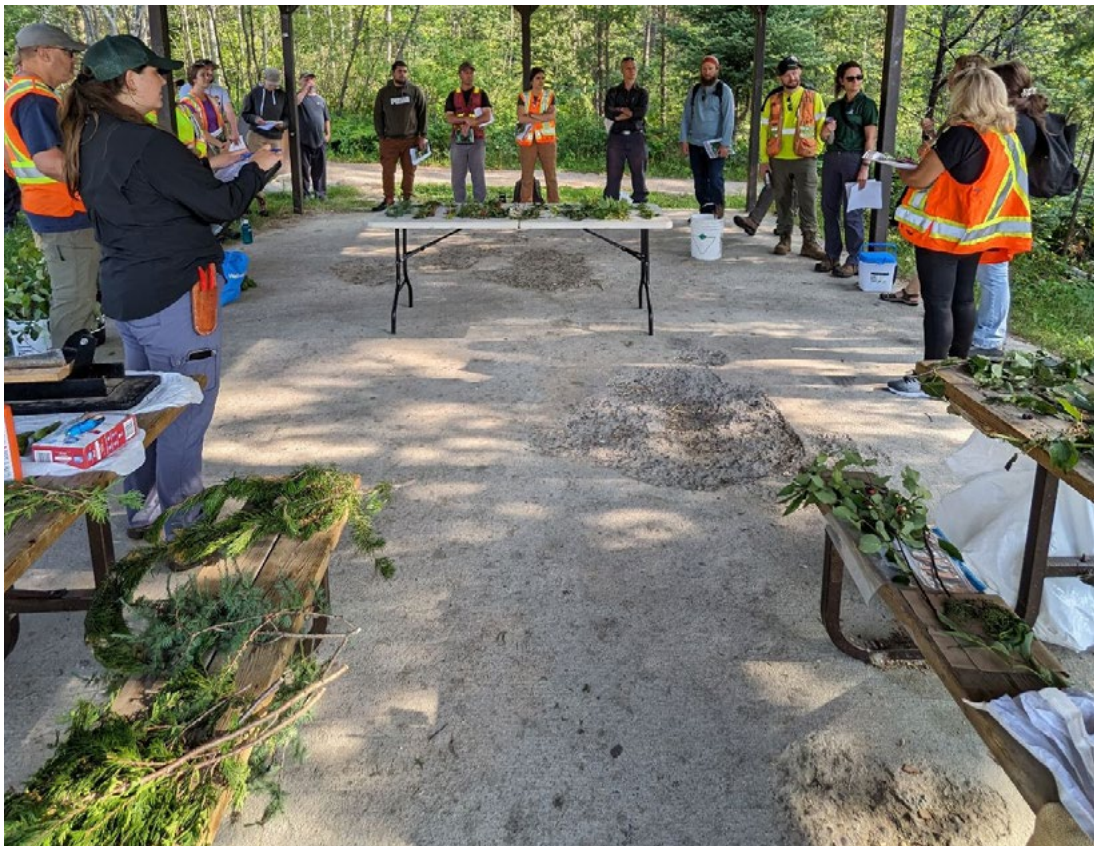
The tree seed supply chain is complex and varies nationally, regionally and by sector. One of the main limitations stakeholders identified was access to good quality, sustainable seed supply — more specifically, access to climate-ready seed, locally-diverse seed, or hardwood seed.

Barriers identified (Table 1) as part of this study include:

- **Climate-ready seed supply:** There is an apparent lack of climate-ready tree seed, which may include local and non-local sources. Climate-Based Seed Transfer (CBST) is increasingly being used to address the changing climate. This requires seed to be collected from locations outside of traditional operating areas, and many jurisdictions lack the systems to support the level of coordination and oversight required.
- **Hardwood seed supply:** There is limited access to a steady and reliable supply of high-quality hardwood tree seed. This issue is exacerbated by the fact that many hardwood species cannot be stored long-term and/or research may be limited on the storage protocols for these species.
- **Limited diversity of local tree and shrub seed supply:** There is a limited supply of a diversity of species and limited genetic diversity within collections. In some jurisdictions, collections may not include regional representation and are focused on collection convenience, just meeting demand and targets.
- **Human capacity:** Challenges in recruiting and retaining individuals persist. In many instances, current compensation does not reflect the level of effort and expertise required for acquisition.



Above: Demonstration of gravity separator at Millson Forestry Service



Left: Certified Seed Collector field day by FGCA

- **Tree seed training:** There are challenges in accessing seed-related training on collection, handling, processing, testing, storage, inventory, etc.
- **Networks and knowledge mobilization:** There are limited networks to share knowledge, experiences, and information. Additionally, there is an absence of networks to support cross-jurisdictional seed procurement.
- **Access to tree seed services:** There are limited or fragmented infrastructure and services required to meet the seed purchasing, processing, storing, data capture and upgrading needs. This varies by jurisdiction and sector.
- **Declining investment in tree improvement programs:** In parts of the country, tree seed orchards and tree improvement programs have seen disinvestment over the last decade. Despite this, these facilities and installations have the potential to supply large quantities of climate-ready seed and have improved performance and fitness compared to most wild seed collections.
- **Variability of wild tree seed crops:** Natural periodicity/masting and the observed increase in time between viable seed crops due to climate changes and extreme weather events are highly variable. The original parentage of plantation sites is often unknown.

Overall, there is a clear decline and lack of investment in seed and seed quality across jurisdictions. This is the result of the variability in funding programs and changes in the political environment. Table 1 further outlines these barriers in the seed supply chain and breaks it down further into which sectors are experiencing these barriers and at what significance.

Table 1. Identified barriers in the tree seed supply chain by stakeholder group.

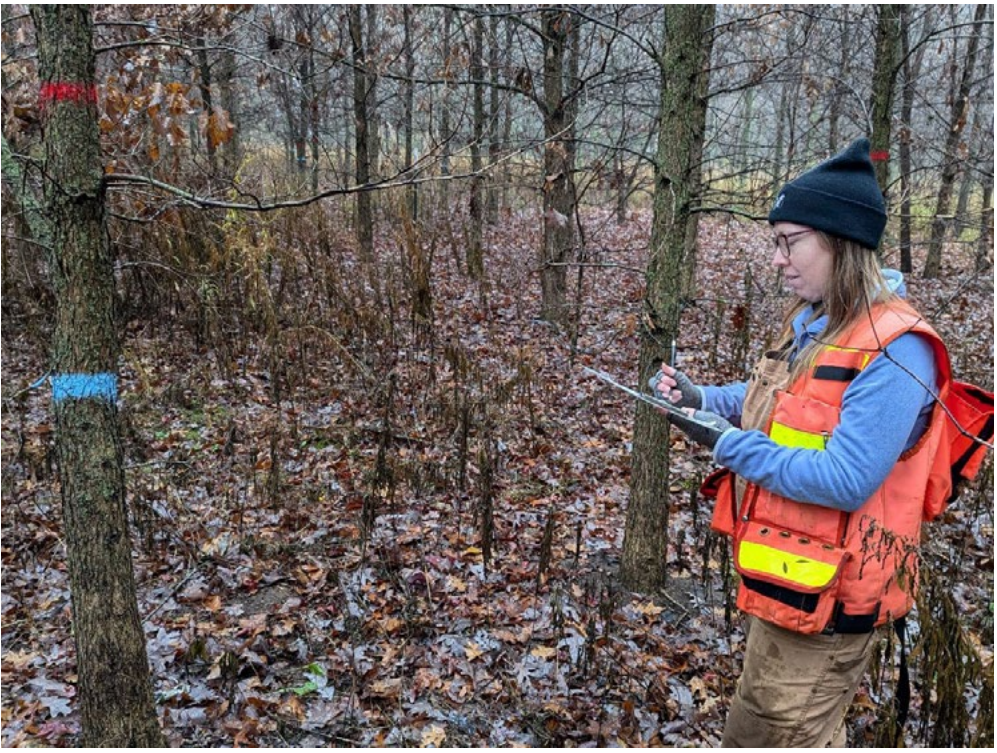
Significant Barriers | Moderate Barriers | Low Barriers | Barriers have not been identified

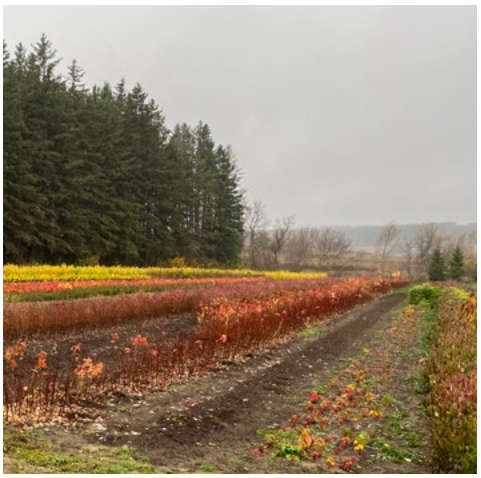
BARRIERS	NON-GOVERN-MENTAL ORGANIZA-TIONS	RESTORATION AND RECLAMATION	FOREST INDUSTRY (NGO, R&R, FI, ICO)	INDIGENOUS COMMUNITIES AND ORGANIZA-TIONS
Climate-ready seed supply	Significant	Moderate	Low	Significant
Hardwood seed supply	Significant	Moderate	Low	Significant
Limited diversity of local tree and shrub seed supply	Moderate	Not identified	Not identified	Significant
Human capacity	Significant	Significant	Significant	Significant
Tree seed training	Significant	Moderate	Moderate	Significant
Networks and knowledge mobilization	Moderate	Not identified	Not identified	Moderate
Access to tree seed services	Significant	Not identified	Not identified	Significant
Declining investment in tree improvement programs	Not identified	Not identified	Moderate	Not identified
Variability of wild tree seed crops	Moderate	Moderate	Moderate	Moderate

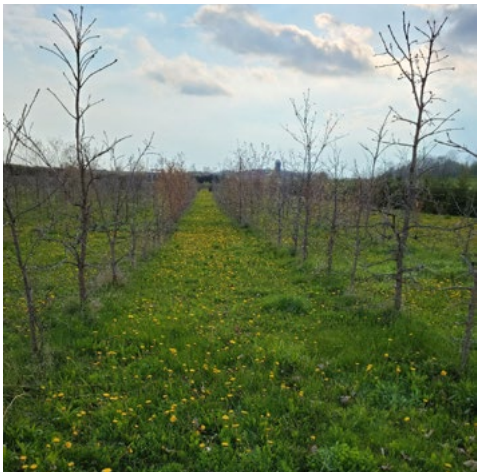
Recommendations for Increasing Seed Capacity

Increasing seed capacity will require investment in organizations that can support removing or working around barriers outlined in this report. These recommendations should be implemented over the next several years to fill some of the seed supply gaps across the restoration and reclamation initiatives and to meet the growing needs of the 2BT program.

Table 2 lists the recommendations that will enhance current and future 2BT program agreement holders' ability to meet their projected targets. The *Strategies* column lists several recommended categories of funding priorities that could support applicants and NRCan in prioritizing and reviewing applications. Within those suggested strategies are included *recommendations* that could be proposed, as well as the intended *outcomes* of the funding investment. The caveat is that the recommendations will require sustained commitment and investment to have any impact.







Above: Evaluation of hardwood Assisted Migration Trials

Right Top: Hardwood seed beds at Pineneedle Farms

Right Bottom: Layout of a hardwood Assisted Migration Trial area

Table 2. Recommendations to increase capacity (both tree seed quantity and quality), in the tree seed supply chain, time to impact and level of impact.
Includes a list of strategies (not in order of priority) for capacity building, their associated recommendations and intended outcomes. Timeframe to initial impact, level of impact and scale of investment required are provided for each recommendation.

Higher Priority for 2BT– direct benefit within program timelines

Lower Priority for 2BT – long-term benefit beyond program timelines

STRATEGIES	RECOMMENDATIONS	INTENDED OUTCOMES
1. Partnership and Networks: Support the development and maintenance of seed supply partnerships and networks	**1.1 Partnership and Networks** - Build regional networks and partnerships Timeframe to initial impact: 2027 Level of impact: Moderate Investment: Low	· Increased knowledge exchange, identification of supply gaps and access to tree seed · Efficient mobilization of tree seed collections; scaling-up of seed collections
2. Training, Mentorship & Curriculum: Increase knowledge mobilization efforts to enhance the availability of education and training	**2.1 Training** - Develop and deliver seed curriculum and training (e.g. procurement, collection, processing, storage, etc.) Timeframe to initial impact: 2028 Level of impact: Moderate Investment: Moderate	· Increased capacity to collect, process and store tree seed · Increased volume and quality of tree seed collected and stored
	2.2 Mentorship – Develop and deliver mentorship opportunities through informal and formal programming to improve knowledge-sharing around seed processes Timeframe to initial impact: 2027 Level of impact: Moderate Investment: Low	· Increased recruitment of new and retention of older workers in the sector · Increased capacity in existing workers to effectively collect, process and store tree seed · Increased volume and quality of tree seed collected and stored
	2.3 Post-Secondary Curriculum Integrate seed management and related training within post-secondary natural resource course curriculum Timeframe to initial impact: 2031 Level of impact: Low to Moderate Investment: Low	· Increased recruitment into the sector · Increased knowledge through the supply chain

3. Storage: Increase the availability of new or existing regionalized processing and long-term seed storage facilities through new or existing partnerships	**3.1 New Storage** - Develop regional facilities for seed processing and the long-term storage of tree seed that is connected to the existing network of users Timeframe to initial impact: 2031 Level of impact: Moderate Investment: Moderate to High	• Increased tree seed storage available • Maintained quality of tree seed collections • Increased volume and decreased cost (due to improved germination rates) of appropriate species available for planting for 2BT
	3.2 Existing Storage - Leverage existing seed processing and storage facilities and establish partnerships with existing organizations with a good track record in the business (e.g. agricultural partnerships) Timeframe to initial impact: 2028 Level of impact: Low to Moderate Investment: Low	• Increased stored tree seed available • Increased volume and decreased cost (due to improved germination rates) of appropriate species available for planting for 2BT • New collaboration and funding opportunities
4. Orchard Installations, Support & Production Areas: Install new seed orchards and invest in underutilized seed orchards and production areas; Create seed production areas from existing areas; Diversify installations of softwood, hardwood and non-traditional species	**4.1 Orchard Install** - Support the development, planting and maintenance of new (regional) seed orchards and seed production areas Timeframe to initial impact: >2031 Level of impact: Very High Investment: High	• Increased availability of high-quality tree seed • Control over production of tree seed (forced seed production from year to year) • Increased volume and quality of tree seed collected • Improved seed supply for initiatives beyond the 2BT program
	4.2 Orchard Support - Support for organizations who maintain tree seed orchards and transition under-utilized existing seed orchards and seed production areas into productive seed collection sites Timeframe to initial impact: 2029 Level of impact: High Investment: Moderate to High	• Increased availability of high-quality tree seed • Maintained control over the production of tree seed (forced seed production from year to year) • Increases in volume and quality of tree seed collected from existing orchards • Improved seed supply for initiatives beyond the 2BT program

	4.3 Production Areas - Support the creation of seed production areas from existing mature stands through selection harvesting Timeframe to initial impact: 2029 Level of impact: High Investment: Moderate to High	• Increased availability of quality tree seed • Increases in volume and quality of tree seed collected in a short timeframe • Improved seed supply for initiatives beyond the 2BT program
5. Research: Invest in research and extension that addresses seed issues for species of importance to 2BT proponents	**5.1 Research** - Support for organizations that carry out research and extension activities pertaining to collections, cleaning, and storage protocols for non-traditional and new species (not currently prioritized by FI). For example, long-term storage techniques for recalcitrant seed, breaking dormancy for challenging species and methods for upgrading seed collections. Timeframe to initial impact: >2031 Level of impact: Low to Moderate Investment: Moderate	• Increased availability of high-quality tree seed from non-traditional species, unique populations, challenging sites and species at risk • Extension is provided to ensure implementation of research
6. Seed Services: Invest directly in seed through 2BT planting agreement holders	**6.1 Seed Services** - Directly support seed collection, processing and storage through stipends and other financial instruments Timeframe to initial impact: 2027 Level of impact: High Investment: Moderate	• Increased resources in the seed supply chain to collect, process and store • Increased volume and quality of tree seed • Leveraging of existing successful seed programs that have a proven track record for collecting consistent volumes of tree seed • Fair compensation for service providers, including collectors • Greater access to harder-to-obtain species

7. Strategic Collections: Funding to support strategic seed collections	**7.1 Strategic Collections** – Approve projects that help develop strategic plans to support increased seed inventories. For example, seed procurement funds are made available to 2BT agreement holders to support opportunistic collections during significant crop years, purchase of surplus orchard seed or other opportunistic seed purchases related to planting proposals. Timeframe to initial impact: 2027 Level of impact: Moderate Investment: Moderate	• Increased volume and quality of climate-ready tree seed from traditional and non-traditional species • Greater stakeholder access to better quality seed (genetic and physiological quality) • Budget and human resource efficiencies realized
8. Climate-Ready Seed: Scaling-up of seed banking to respond to operational needs of reforestation efforts of large areas impacted by climate change (e.g. pest or fire damage)	**8.1 Climate-Ready Seed** – Supporting the collection of large volumes of seed that supports reforestation efforts from regionally appropriate seed sources. Additionally, advocating and informing larger seed banking efforts Timeframe to initial impact: 2030 Level of impact: High Investment: High	• Increased volume and quality of climate-appropriate tree seed • Banked seed to address climate-related planting needs • Increased awareness of the need for large-scale banking efforts

Table 3. Recommendations to address barriers in the tree seed supply chain — Identifies how key investments (horizontal axis) would help to reduce barriers (vertical axis) in the seed supply chain.

	1. PARTNERSHIPS AND NETWORKS	2.1 TRAINING	2.2 MENTORSHIP	2.3 PS CURRICULUM	3.1 NEW STORAGE	3.2 EXISTING STORAGE	4.1 ORCHARD INSTALLATION	4.2 ORCHARD SUPPORT	4.3 PRODUCTION AREAS	5. RESEARCH	6. SEED SERVICES	7. STRATEGIC COLLECTIONS	8. CLIMATE READY SEED
Climate-ready seed supply	⊙			⊙	⊙		⊙	⊙	⊙	⊙	⊙	⊙	⊙
Hardwood seed supply	⊙	⊙	⊙		⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
Limited diversity of local tree and shrub seed supply				⊙	⊙		⊙	⊙	⊙			⊙	⊙
Human capacity		⊙	⊙	⊙		⊙					⊙		
Tree seed training		⊙	⊙		⊙								
Networks and knowledge mobilization	⊙	⊙	⊙	⊙	⊙	⊙							
Access to tree seed services	⊙	⊙			⊙						⊙		
Declining investment in tree improvement programs							⊙	⊙	⊙	⊙		⊙	⊙
Variability of wild tree seed crops	⊙				⊙	⊙	⊙	⊙	⊙	⊙		⊙	

Tree seed supply challenges vary by jurisdiction across the country and by sector. Table 4 links the recommendations to sectors by jurisdiction and specifically separates the forest industry. Historically, FI has had policy and/or government support for reforestation and associated seed supply systems, versus others without the same level of support, leading to a lack of infrastructure and appropriate supply.

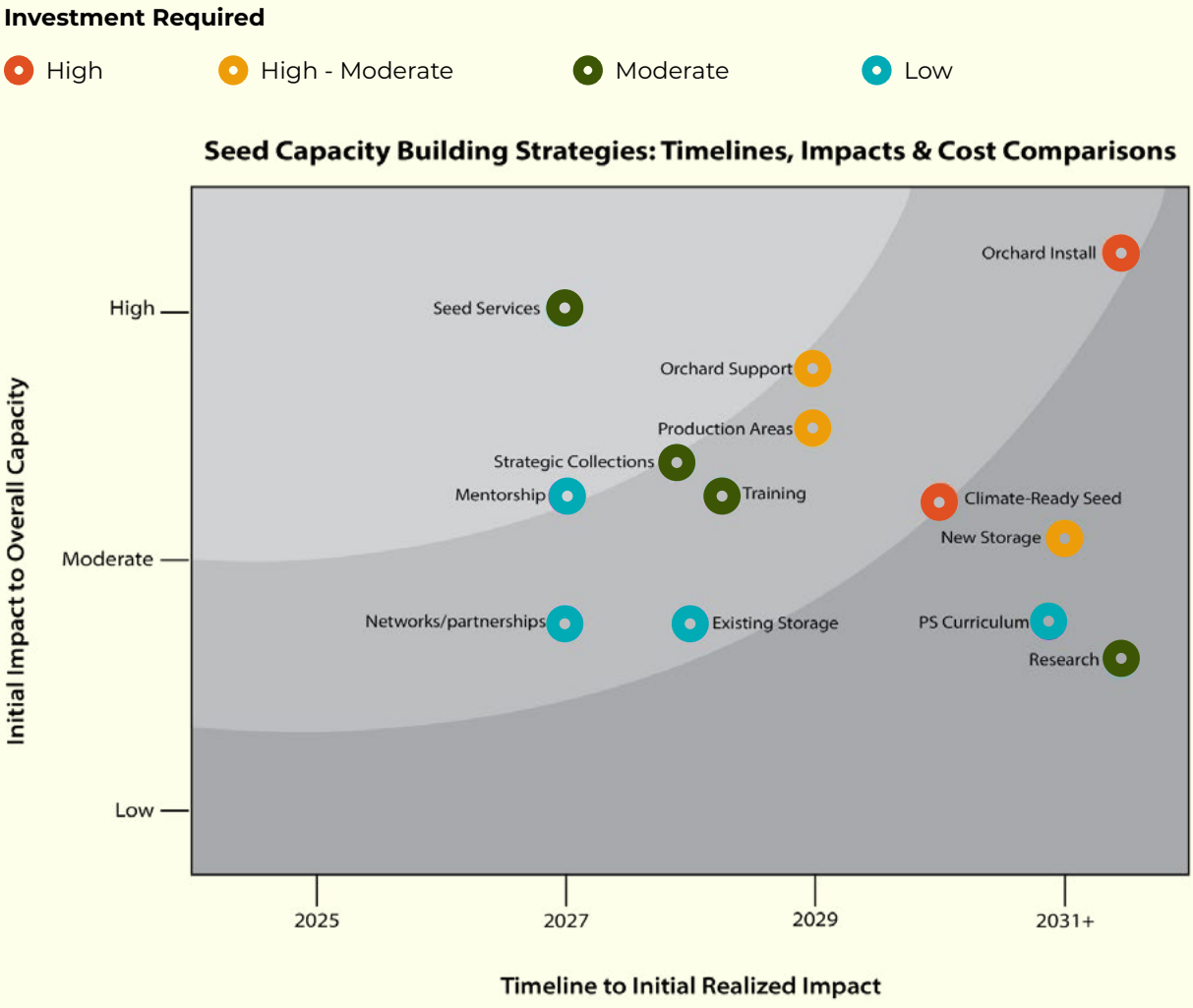
Table 4. Recommendations by Jurisdiction and Stakeholder —
Strategies (and associated recommendations, see Table 2) to support the seed supply system by jurisdiction, demonstrating the differences in capacity needs between the Forest Industry (FI) or Other (R&R, NGO, ICO) sectors. Strategies are not in order of priority.

Significant Support Needed · Moderate Support Needed · Low Support Needed · Existing systems in place

STRATEGIES	BC/AB		SK/MN		ON		QC		NS/NB/ PEI		N.L.		TERRITO-RIES	
	FI	OTHER	FI	OTHER	FI	OTHER	FI	OTHER	FI	OTHER	FI	OTHER	FI	OTHER
1. Partnership and Networks	○	●	○	○	●	●	○	●	○	●	○	●	○	●
2. Training, Mentorship & Curriculum	○	●	○	●	◐	◐	○	●	○	●	○	●	○	●
3. Storage	○	●	○	○	○	●	○	●	○	●	○	●	○	●
4. Orchard Install, Support & Production Areas	○	◐	◐	◐	●	●	○	◐	○	◐	○	◐	●	●
5. Research	●	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
6. Seed Services	○	●	○	●	●	●	○	●	○	●	○	●	○	●
7. Strategic Collections	○	●	●	●	◐	◐	○	●	○	●	◐	●	●	●
8. Climate-Ready Seed	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐

None of the recommendations will have an immediate impact or will solve all the barriers identified in this report. The recommendations were reviewed and rated based on their expected impact and when they will likely positively influence the supply chain (if funding is implemented in 2024).

Figure 1. Estimated timeline and investment required compared to initial and level of realized impact of investing in seed capacity building strategies (based on complementation in 2024). The top left indicates a high initial impact in the shortest time to realized impact, while the top right indicates highest impact but the longest time to initial realized impact.

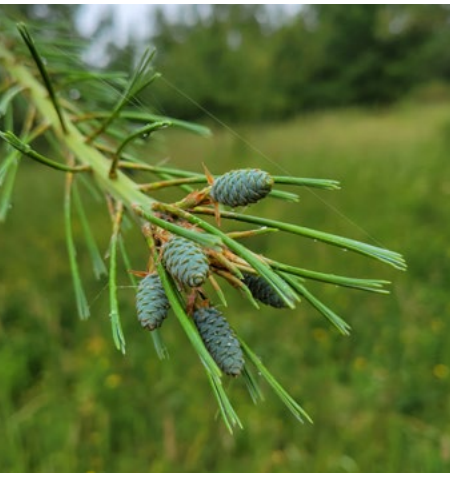


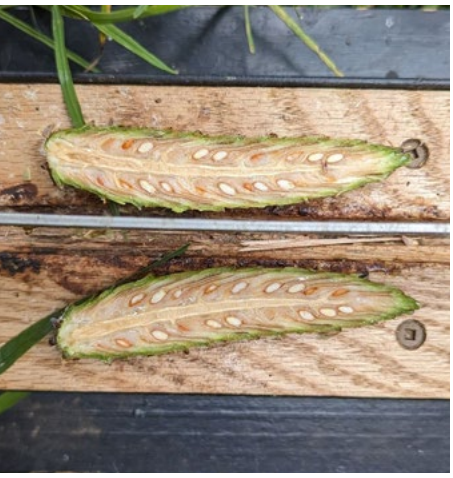
Recommendations for the 2 Billion Tree Program

This report highlights various barriers and recommended strategies to effectively scale up the tree seed supply chain. The goal is not only to match the approved targets under the 2BT program, but also to make positive contributions to the sector for years to come. Many organizations, new or unfamiliar with the restoration community, do not consider the importance, necessity, and availability of seed to grow stock for their commitments. It is often an afterthought, and they struggle to find *any* seed or stock to use without considering factors such as appropriate species, seed quality and climate-ready sources. Many assume that the appropriate planting material will be grown on speculation and be available from a local nursery at any time. Without adequate planning (ordering and arranging for planting stock well ahead of the project being implemented), organizations plant what is available and can be forced to substitute species and sources that are inappropriate for the site characteristics or project objectives.

It is recommended that NRCan use the included tables and figure to help review and identify opportunities for investment to help build seed capacity, acknowledging that without this investment, it is unlikely that the appropriate supply will be developed. The tables and figure assume that funding will be available immediately to have an impact on the seed supply system (and subsequent tree planting initiatives) within the 2BT program timeline.

- **Table 1. Identified barriers in the tree seed supply chain by stakeholder group**
  May be useful when evaluating who is applying for and seeking funding for building seed capacity. As identified in this table, it outlines which barriers impact the sectors outlined.
- **Table 2. Recommendations to increase capacity, both tree seed quantity and quality, in the tree seed supply chain, time to impact, and level of impact**
  This table may be used by organizations wanting to identify and develop opportunities to contribute to overcoming barriers within the tree seed supply chain. Based on the strategies presented, NRCan may choose to fund projects that have an immediate impact or invest in more strategic opportunities. Organizations may include elements of this within their own applications.
- **Table 3. Recommendations to address barriers in the tree seed supply chain**
  May be used in the application process whereby the applicant could identify the tree seed supply recommendation they are implementing and the barrier it addresses. Planting projects may then provide additional value to addressing seed supply issues as well as the 2BT objectives.
- **Table 4. Recommendations by Jurisdiction and Stakeholder**
  May be used by the 2BT approvers and committees to evaluate gaps based on jurisdiction and determine if the proposed strategy would address identified gaps.
- **Figure 1. Seed Capacity Building Strategies: Timelines, Impacts & Cost Comparisons**
  Can be used to evaluate applications based on cost inputs and realized impact and the contribution to overall capacity. Based on recommendations presented, NRCan may choose to fund projects that have an immediate impact or invest in more strategic opportunities.





Above: White Pine cone maturation stages

Left Top: White Pine conelets

Left Bottom: White Pine half cut test to check seed maturity and quality

It is recommended that NRCan carefully review all tree planting and capacity applications and consider not only stock supply but also whether seed capacity has been considered as part of their delivery plan. The following are some key questions for NRCan to consider when evaluating 2BT planting and seed-related proposals.

Questions to ask of tree planting applicants:

- Does the applicant have a good understanding of the tree seed supply chain challenges associated with their agreement proposal?
- Does the planting project applicant have a seed sourcing plan?
- Does the organization have a proven track record and foundational knowledge of the seed and stock supply system to deliver?

Questions to ask of seed capacity applicants:

- Does the proposal help to address one or more of the barriers listed in this report?
- Does the organization have a proven track record and foundational knowledge to deliver effectively on the proposed seed capacity project?
- Is the applicant proposing a solution that might be valuable for other stakeholders?
- Does the proposed region of implementation match the operational gaps outlined in this report?
- Has the applicant considered leveraging existing services and/or programs with a proven track record?

At minimum, organizations applying for 2BT funding should have references about where their seed and stock supply is coming from. It will illustrate they have done their due diligence to ensure an adequate and appropriate supply to meet their current and future planting commitments. This will require applicants to work with their nurseries to plan and source appropriate seed for their projects and allow 2BT to assess the capacity of the organizations to carry out the project successfully.

Finally, to avoid duplication or disruption to current infrastructure as well as investment initiatives to support long-term benefits beyond the 2BT program, it is recommended that NRCan look to organizations like the NTSC, FC and the FGCA for advice and guidance.

Natural white pine regen on forest floor

Conclusions

The 2BT program has supported the scaling up of tree planting efforts across Canada, with numbers exponentially growing over time. While the commitment of agreement holders is impressive and funding appreciated, greater emphasis should be put on ensuring a supply of appropriate tree seed to support the highest quality planting of the right tree, from the right source, in the right place.

To achieve these results, investments are needed across the tree seed supply chain. There has been limited investment in the tree seed supply chain in many jurisdictions (varying by sector) and, more so, limited investment in climate-ready tree seed sources. In the past, there has been more emphasis on the needs of the forest industry and the limited species required to support these undertakings. There has been little to no investment in seed supply systems to support restoration sectors, and the result is limitations for organizations to access appropriate seed sources. The current state of the tree seed supply chain could negatively impact an organization's ability to fulfil commitments with NRCan and 2BT agreements.

Seed is undervalued as a component of tree stock production. Without high quality appropriately sourced seed, seedling quality, including survival and ability to thrive, will be challenged. Outdated compensation models and a lack of consideration of tree seed needs have led to a decline in the capacity in the supply chain for all but a few conifer species. Recruitment and retention of individuals working in the sector is becoming more and more challenging.

Investment at this time is critical: every recommendation in this report will require funding to increase the availability of high-quality, climate-ready tree seed. Strategic investment must be made in human resources, facilities, seed production, training, education and research. The strategies and associated recommendations outlined in this report are designed to leverage existing infrastructure, systems and knowledge bases while considering areas for new investment that can help 2BT effectively meet targets and objectives. Strategies will inevitably vary by jurisdiction, region and sector; however, the core elements of the recommendations are universal.

Without immediate investment and utilization of existing knowledge and networks, it is unlikely the country will have the supply or access to appropriate seed required for reforestation and restoration demand to meet the objectives of the 2BT program.

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Notes