



# Growing Future Forests

Scaling Canada's Native Seed Supply Chain

# Overview

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# Introduction



# Growing Future Forests: Scaling Canada's Native Seed Supply Chain

With a global biodiversity crisis and push towards net zero targets, there is an increased demand for collection, propagation and production of native seeds as a means to grow future forests and deliver nature-based solutions. However, many tree planting projects still find it difficult to find a diversity of species from the right seed sources.<sup>1</sup> To address these shortages and scale up forest landscape restoration (FLR) effectively, it is critical to identify the bottlenecks and solutions across the supply chain.<sup>2</sup> In response to increasing landscape degradation, the concept of forest (and) landscape restoration (FLR), defined as a “[planned] process to regain ecological integrity and enhance human well-being in deforested or degraded landscapes” is receiving global attention in attempts to manage, conserve, and restore degraded ecosystems in recent years.<sup>3</sup>

This study aimed to answer the overriding question of: “Where will all the seeds needed for sustainable forestry, restoration and reclamation in Canada come from and who will supply them?”. In our research, we aimed to be as inclusive as possible, as the common concern over the sustainable use of forest genetic resources is shared by many in and outside these three major economic sectors.

In creating this report, we recognize that the tree species, seed sourcing policies and stock types optimized for provincially legislated reforestation efforts differ, in some cases substantially, from those needed for successful afforestation, reclamation, restoration, urban forestry, and agroforestry sectors.<sup>4</sup> But, we believe that the degree to which these sectors share values, resources, knowledge, and most critically, supply chains, is worthy of exploration. Except for federal Species at Risk Act (2002), reforestation remains a provincial responsibility and despite unique provincial systems, no national strategy aimed at delivering stronger outcomes exists.<sup>5</sup>







# Important Definitions

Because this report has been produced as an overarching introduction to those new to the space, we are including some key definitions to help bring clarity to the conversation.

**Reclamation:** Land reclamation is the process of turning disturbed land into its former or other desired state. In Canada, land reclamation efforts are most often directed at land disturbed during natural resource development, including mining and oil and gas operations. Because this development often takes place in forested areas, re-establishing healthy, resilient forest ecosystems is an important part of land reclamation and landscape restoration.

**Sites:** Well sites, industrial pipelines or batteries; Oil production sites; Municipal pipelines; Telecommunication systems; Transmission lines; Coal mines; Oil sands mines; Pits (sand, gravel, clay or marl); Quarries; Peat operations; Roadways; Exploration operations (coal and oil sands); Railways; Industrial plant sites; Renewable energy operations

**Afforestation:** The establishment of a tree crop on an area from which it has always, or for very long, been absent. Where such establishment fails and is repeated, the latter may properly be termed reforestation.

**Reforestation:** Successful renewal of a forest crop by planting or direct seeding.

**Restoration:** The US National Seed Strategy for Rehabilitation and Restoration defines restoration as: “the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed”<sup>B</sup>

**Sites:** Urban naturalization; Urban forestry; Seismic lines; Forest cutblock revegetation; Revegetation of wildfire-damaged sites; Revegetation of insect- and pest-damaged sites; Habitat enhancement (terrestrial, wetland or aquatic); Wetland mitigation; Carbon offset planting



# Key Considerations

For over 100 years, Canada's forest sector has developed robust tree improvement and genetic conservation programs to grow tree seed supply (see Figure 1, and read Canada's second report for the State of the World's Forest Genetic Resources)<sup>c</sup>. Scientists and Registered Professional Foresters understand and encourage the most appropriate tree species and specific seed sources to replant after harvest or natural disturbances. Tree breeding, provenance testing and seed orchards are continually improving the volume and value of genetically improved seed. Policymakers at all levels of government are also considering assisted migration to sustain tree growth and resiliency under a changing climate.

Public seed stewardship (including registration, processing, testing and banking) is also an important insurance policy to help land managers and nurseries plan their long-term activities. Non-governmental organizations are also becoming more involved in seed stewardship and storage in some jurisdictions. Every seed banking organization can have single or multiple missions on a for or not-for-profit basis: operational services, long-term conservation, research and recovery programs.

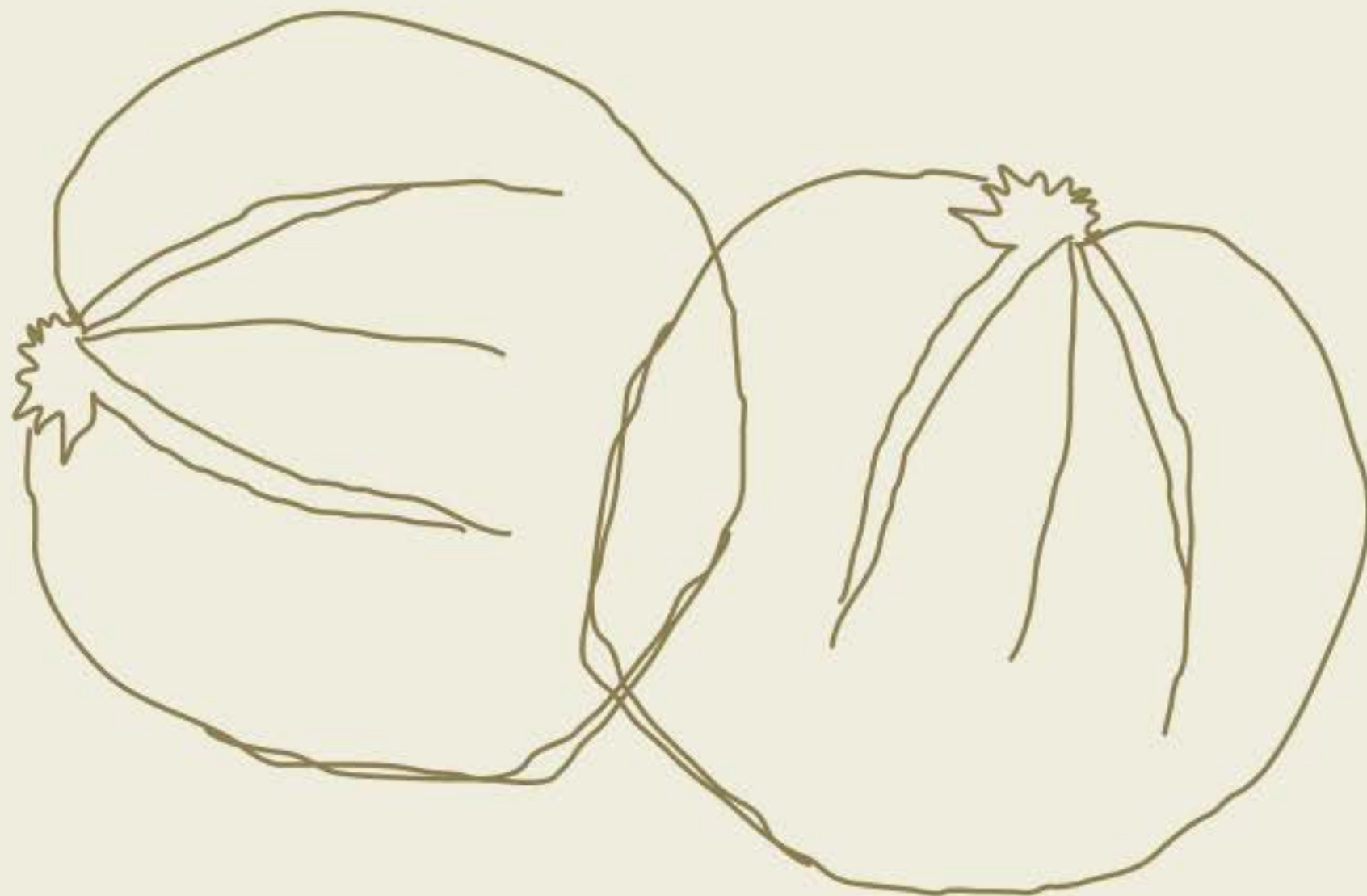




# Objective & Approach

**This research project aims to assess the current tree seed market in Canada, including seed supply, existing capacity, bottlenecks and opportunities to meet emerging forest landscape restoration demand by 2030 and beyond.** In Spring 2022, the National Tree Seed Centre, Wilder Climate Solutions and Accenture collaborated to conduct five national, bilingual surveys<sup>5</sup> followed by 21 qualitative interviews with multidisciplinary experts across Canada. Respondents were asked questions regarding trends in seed and stock supply relative to current demand in their sector and capacity to adapt within the next 10 years, in addition to considering the potential impact of the 2 Billion Tree Program. The survey recognizes that healthy forests are made up of more than trees, but focused mainly on native tree species as critical components of biodiversity and carbon sequestration objectives. It also looked at genetic traceability systems already in use to optimize long-term growth and survival.<sup>6</sup>

Any respondent with the capacity to inform or support professional seed-based forest landscape restoration activities are hereafter considered "the industry" and are considered crucial players in Canada's native seed supply chain.









# Industry Overview and Context



# Climate Change



# Climate change

We are living in a time of intense ecological upheaval. Not only are climatic conditions shifting, producing wetter, hotter, colder, and drier situations, but increased risks of pests and fires are threatening forests everywhere. At the same time, we understand and appreciate the critical role that forests play in sequestering carbon and helping us to achieve net zero targets.

The 2020 State of Canada's Forest Report stated that the rate of projected climate change is expected to be 10 to 100 times faster than the ability of forests to adapt naturally. In response, the scientific community is stepping up to drive tree breeding programs that select superior parent trees with greater survival rates in relation to drought, insect infestations, and extreme weather tolerance. Furthermore, they are isolating genetic markers for nutrient use efficiency, productivity, and wood quality.<sup>7</sup> Tree genomics are helping to enable industry preparation for new and uncharted environments.





A misty forest scene with tall, thin trees. Sunlight filters through the canopy, creating a warm, golden glow. The ground is covered in mist or low-lying vegetation.

“

With global warming, white pine [cones] are opening up on the trees earlier, the squirrels aren't cutting them. Seeds are falling out. It's becoming more difficult to locate caches that used to be easy to find. If someone tells me: Go get us a hectoliter of red pine, I can tell you, not a chance.



Forest managers are selecting thriving seeds and seedlings from southern portions of their projects and strategically planting them in northern portions in an effort to meet changing conditions. This approach, known as Seed Transfer (a type of which is called Assisted Migration), is helping to ensure that today's plantings are positioned for success in the future.<sup>8</sup>

64% of all respondents say they currently use ecological districts/units for seed planning, but only 14% of planting agencies say they follow climate-based seed transfer policies.<sup>9</sup> Programs like the 2 Billion Tree Program (Canada), the Inflation Reduction Act (US) and others are reinforcing the role that diverse forests can and should play in mitigating climate change and delivering co-benefits.

## Selecting and planting seedlings for changing conditions

With rapidly changing climate, local populations of trees may not be able to adapt quickly enough to remain healthy. Forest managers can help by strategically selecting the seedlings from one part of a tree species' range and planting them where they will be better adapted to new environmental conditions.

Cool

Warm



\*This is illustrative only, visit <https://cfs.cloud.nrcan.gc.ca/seedwhere/> for climate data



# Current State Supply Chain: Forest Landscape Restoration and Reclamation



## Current Supply Chain



# Current State Supply Chain

The current supply chain operates in a classical linear flow model. It has met the traditional needs of the sector, when it historically experienced stable demand. Seed collectors, producers (i.e. orchard managers) and growers have produced the same goods, repeatedly with limited fluctuation. Its a traditional model that has served the industry well in the era before significant climate impact.

However, as you'll see in the following pages, with increases in demand due to net zero-related policy and shifting ecological factors, there are a number of inadequacies emerging that can no longer be ignored.



## Current Supply Chain



# Key Issues

**Since 2008, rapid succession and consolidation of seed service providers (since 2008):**

Growing reliance on a few long-standing, well resourced private sector players in North America

**Limited visibility of future demand:**

Inability to match species in need and growing infrastructure needed to meet fluctuating future demand

**Few long term contracts:**

A just-in-time, ad hoc approach limits ability to plan, scale, and optimize resources



## Current Supply Chain



# Pervasive Challenges Across the Supply Chain

Underlying the restoration and reclamation supply chain is the fact that tree seed and seedlings are often assumed to be cheap, readily available and broadly adaptable. Value propositions in this sector need to be aligned with the challenges ahead, not models of the past.

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## Lack of Communication

Insufficient communication and planning that leads to “substitute or nothing” decisions that undermine ecological objectives or fail to report successful experiments.

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## Limited Visibility of Future Demand

Inability to provide meaningful forecasting at most stages resulting in production that is mismatched from demand.

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## Fractured Policy

Different policies for different sectors in each province and limited national guidance on seed quality.

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## Research & Development, Education and Mobilization

Lack of education and utilization of proven seed science technology. Leads to seed waste and reinventing the wheel.

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# Ideal State of Supply Chain



# Ideal State Supply Chain

Given the current external impacts on the industry and the additional challenges that are emerging, we must reassess the way the supply chain operates. Instead of continuing with the fractured, linear model, the ideal state supply chain operates in a cyclical fashion, with a reinforcing loop reflecting the inclusion of critical planning and forecasting processes. This circular model ensures that real time data, intelligence and emerging science are efficiently fed back into the system at all stages, driving responsiveness, accuracy and, ultimately, success rates.

By reimagining the supply chain as circular, we can increase the appreciation of interconnectivity between all groups and stages, and codify the importance of information gathering and sharing that ultimately drives holistic industry evolution.





# Indicators of a Healthy Supply Chain



## Planning

An interconnected supply chain allows for better planning among all stakeholders.

## Strong and Coordinated Policy

Views the supply chain holistically, valuing improved integration and providing structure, focus and stimulus to drive value. Key areas of improvement required for meaningful data collection and analysis;

## Integrated Data and Research

Interconnectivity of data, especially for inventory management allows for better understanding of demand. Accessibility of research and climate modelling drives improvements in survivability;

## Long-Term Contracts

Coordinated and consolidated data empowers improved decision making, streamlined procurement, and enables the industry to appropriately and accurately scale to meet needs.



# Key Players



# Survey Respondents

In Canada, the majority of operational tree planting, reclamation and restoration activities are facilitated by small organizations of less than 50 people. One in three claim to work for a private business, however federal agencies, non-governmental organizations and provincial departments also play critical roles. Only 4% of respondents were from Indigenous organizations, but interviews suggested far more partnerships are emerging that aim to enable Indigenous-led businesses. 85% of respondents expect to participate in and benefit from the 2 Billion Tree Program (2BT).<sup>10</sup>





# Q: What role(s) do you fill in the seed supply chain?

Supply Chain Roles*	%	# of Respondents
Collecting seed from wild, unmanaged populations	59%	68
Planting/restoring sites	54%	62
Distributing seed or seedlings	45%	52
Processing seed	43%	50
Growing seedlings	43%	49
Storing seed	42%	48

Supply Chain Roles*	%	# of Respondents
Planning and procurement	39%	44
Carrying out seed-based research or education	30%	35
Producing seed from an orchard or managed production area	27%	31
Forest inventory and botanical surveys that identify viable populations	19%	22
Developing seed policies or certification (voluntary or regulated)	9%	10

\*The majority of respondents fulfill 4 or more roles in the seed supply chain.

Total Participants: 115 with at least 1 role  
(NTSC Base Survey + Interviewees, see Methodology)



# The Human Experience





# Collectors

Wild seed collecting is a skilled though highly unpredictable, highly seasonal and often unprofitable activity. Collectors require the knowledge to accurately identify, monitor, forecast and schedule collection efforts across a variety of species and locations. It is physical and time consuming work. However, the majority report making less than \$10,000/year. As a result, small businesses and contractors are not incentivized to travel far or invest in expensive tools. The most frequently used tools are smart phones, coolers/refrigerators, pole pruners and temporary cone sheds. Despite the many difficulties in their profession, seed collectors say the ability to be outside, connect with nature and the knowledge that they are contributing to a healthier environment motivates them to continue.<sup>11</sup>

Photo by Melissa Spearing, 2012

**“At some point [the forestry companies] will want more seed collected and then there will be nobody there to do it. The older collectors are still quite capable, but getting a newer generation is going to be important in the long run.”<sup>12</sup>**

## Challenges

Low compensation | Limited guaranteed contracts | Lack of experienced labor or training next generation | No clear market demand signals | Seed preservation | Seasonality of work | Safety concerns (weather, bugs, thorns)

## Additional Insights<sup>11</sup>

- 58% are age 45 or older. There is a shortage of young workers to take over the industry in the coming decade.
- 57% of part-time or contracted collectors reported making less than \$10,000 per year collecting seed before taxes and expenses.
- Seed collectors typically work 30 days or less per year with a median hourly pay of \$27.
- 74% learned the craft on the job or from existing resources.
- 76% of seed collectors do so for forestry nurseries and nursery producers.<sup>13</sup>





# Growers

Majority (75%) of growers work for organizations of less than 50 employees. Many nurseries are family run businesses that operate in a low-tech, handshake-deal environment. 66% of growers report producing seed on site, with only 23% sourcing from farther than 500km or the United States. Most growers (53%) report it is not difficult to maintain seed source or genetic identity through their internal production processes. Growers want the right plant in the right place.

Photo by Jason van Bruggen for Wilder, 2021.

**“It is a considerable risk and financial burden to start growing a crop which might not be sold for up to ten years or more.”**

**“We want to expand but we have no growing contracts.”<sup>14</sup>**

## Challenges

Infrastructure and labour | Seed availability | Market demand | Lack of long-term contracts | Limited connection to extension/research agents | Regulation slows the ability to respond to demand | Invasive pest management.

## Additional Insights<sup>14</sup>

- 78% of growers reported using Canadian seed sources for more than half of their 2019 production and 55% source seed and growing materials in Canada alone.
- 66% of growers report producing native seed on site.
- 46% say seed source requirements have increased, with 45% describing their clients as stringent in verifying seed source.
- 79% say awareness and understanding of source-identified native seed and stock has increased over the last 5 year.
- 2019 native tree production units were 92% coniferous and 8% deciduous species.





# Planters

Tree planting activities are generally facilitated by small private businesses or organizations funded by NGOs or the Federal Government, we call these respondents, 'planters'. Among planter survey respondents, most claim to be planting less than 100 acres, with a median lot size of 55 acres. When selecting planting species, matching the target ecosystem and functional characteristics are the most important factors. Restoration projects are most frequently undertaken to restore wildlife habitats, to conserve native tree species and for ecosystem services. Planters are interested in species survival data 2-10 years after planting.<sup>16</sup>

**"I would like to have everyone in the room from practitioners/managers, contractors, suppliers, growers/harvesters to discuss the local seed chain so we all have a better idea of the process and how to make it better."<sup>15</sup>**

## Challenges

Lack of seed availability and limited ability to procure nearby | Insufficient funding relative to restoration costs | Difficulty in forecasting planting needs to inform growers on time | Lack of knowledge to produce seed for their own needs | Many species difficult to procure from the open market.

## Additional Insights <sup>15</sup>

- Half of planters (49%) include a native species definition in their procurement contracts, referring to a plant that is native to the region it is being planted in.
- 56% say their organization would pay 25% higher fees for genetically appropriate plants and seeds.
- Only half say they have purchased/utilized certified Native Stock from Canada.





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If you dream of doing  
your part for the planet,  
and do not mind getting  
your hands dirty, then  
this job is for you.



# Key Issues Affecting the Industry



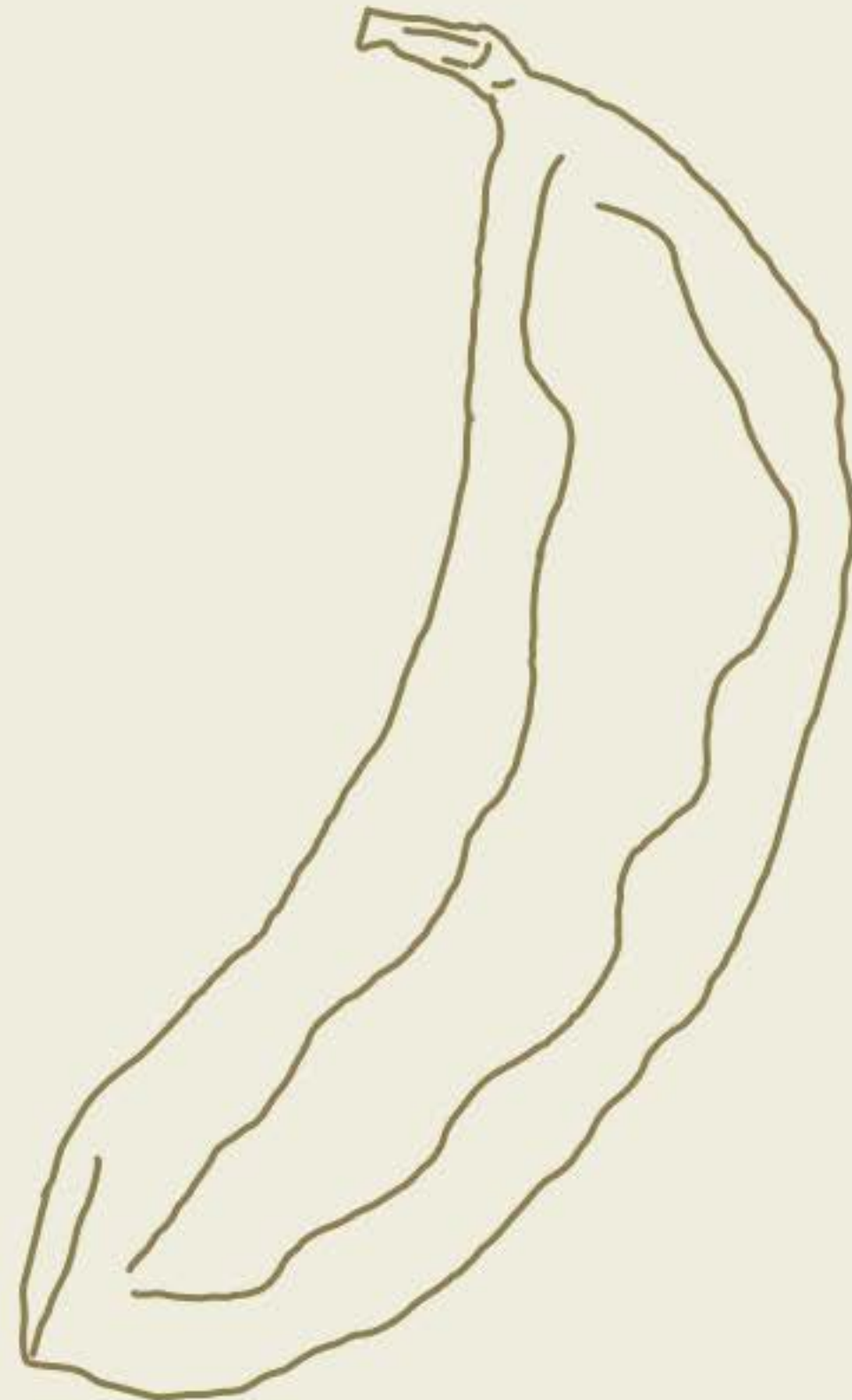
# Biotic/Abiotic factors in Seed Production and Storage



# Biotic/Abiotic factors in seed production & storage

The capacity to gather and produce enough native seed and/or stock at the right time is hampered by a number of biological barriers that vary by year, species, region and degree of technical expertise within each organization.

Seed quality and quantity can decline rapidly due to habitat loss, pests, disease and for some species, a lack of pollinators and the duration of biologically possible storage varies by species. Orthodox seeds can be stored for decades when dried and frozen, but other seeds are recalcitrant or short-lived, meaning that they have to be recollected each year or stored under very specific temperature and moisture conditions impractical to most practitioners. In the case of wild collection, viable populations for local restoration projects may be strictly controlled or inaccessible based on land ownership, permitting and/or protection policies.





# Sourcing and Deploying Native Seed





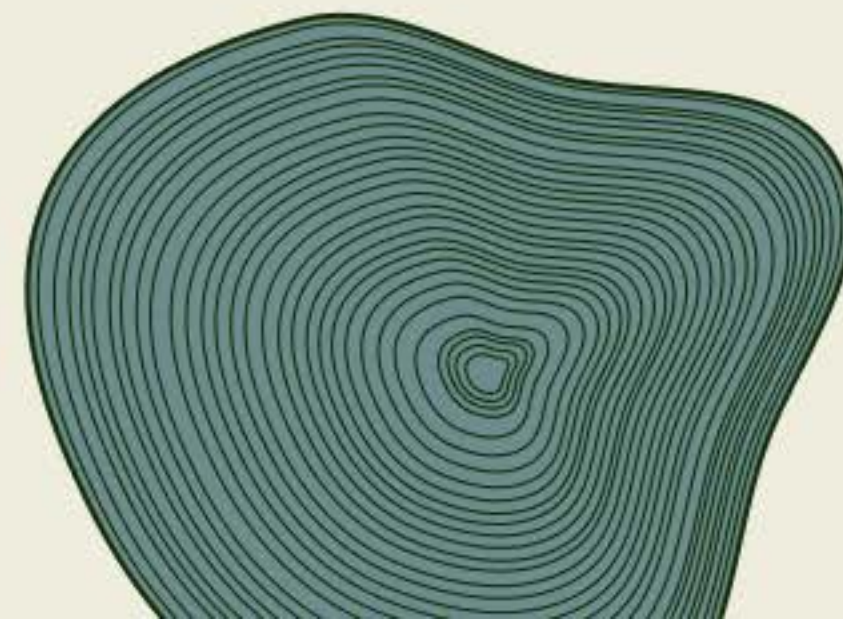
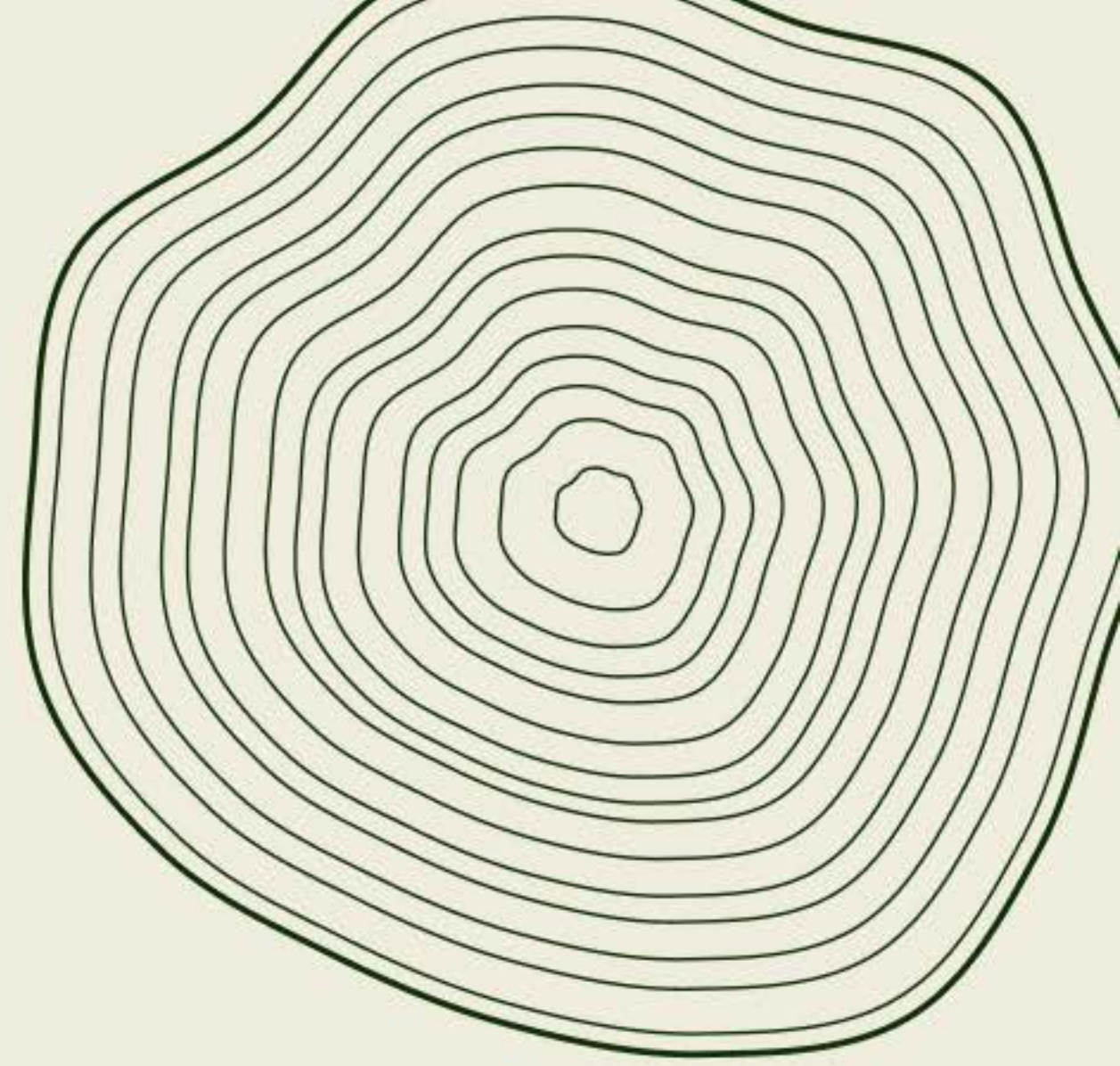
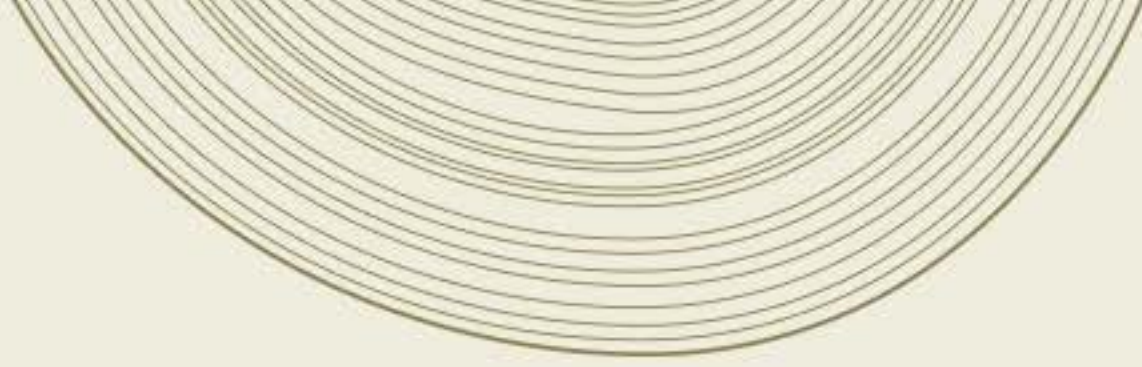
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The drive to preserve biological diversity to tackle climate change issues has brought awareness to locally sourced seed.



# Sourcing and Deploying Native Seed

Many organizations reported deploying native seed and stock to multiple jurisdictions across Canada.<sup>21</sup> Some planting organizations collect local seed to be contract grown at a nursery in a neighbouring jurisdiction (outside of its natural ecozone), and then have the stock shipped back to them. There is a large amount of shipping involved in this, which is not only costly, but also risks the success of plant materials based on climatic conditions. Outside of provincial reforestation regulations and specific procurement policies, seed collectors and nurseries in many provinces are free to sell native species to wherever there is a willing buyer. This can result in limited ability to deploy seed strategically. It also creates an unstandardized approach to storing and processing seed.





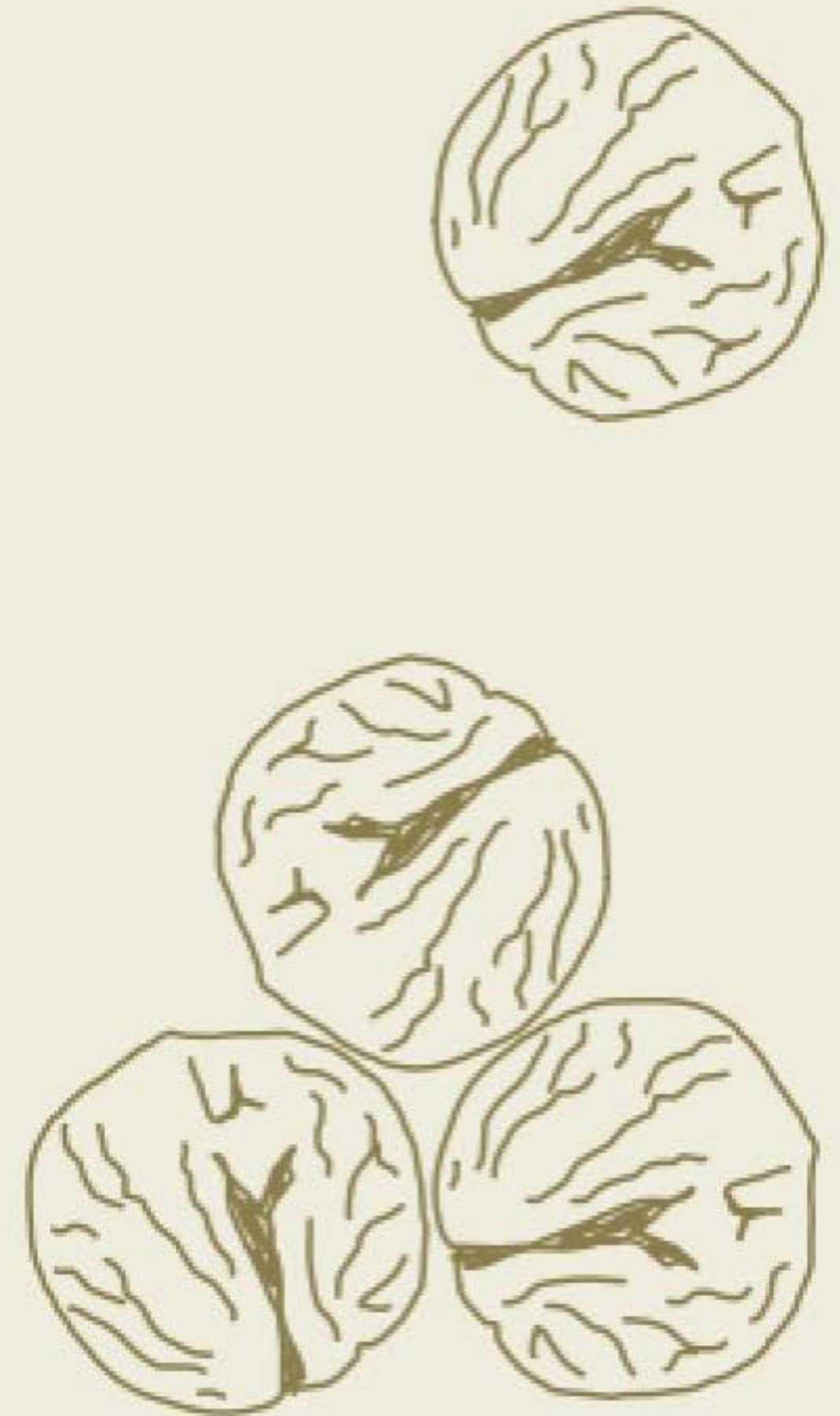
# Current Seed Supply



# Current Seed Supply

In 2012, Canada had 330,000 kgs of stored seed for existing reforestation programs and it was deemed sufficient, but there were early signals of capacity issues.<sup>4</sup>

Today only 18% of respondents said they likely/very likely have sufficient seed in storage to meet additional demand above their current reforestation commitments. 54% say it's likely that there are underutilized orchards and seed production areas nearby they could procure from. Provincial governments are more likely to have excess seed in storage compared to other organizations, however inventories are often not readily accessible to individuals and companies outside of the reforestation industry.<sup>20</sup>







“  
Pas de semences,  
pas de plants!  
No seeds,  
no plants!

Quebec Ministère des Forêts, de la Faune et des Parcs forestry production brochure ([see link](#))

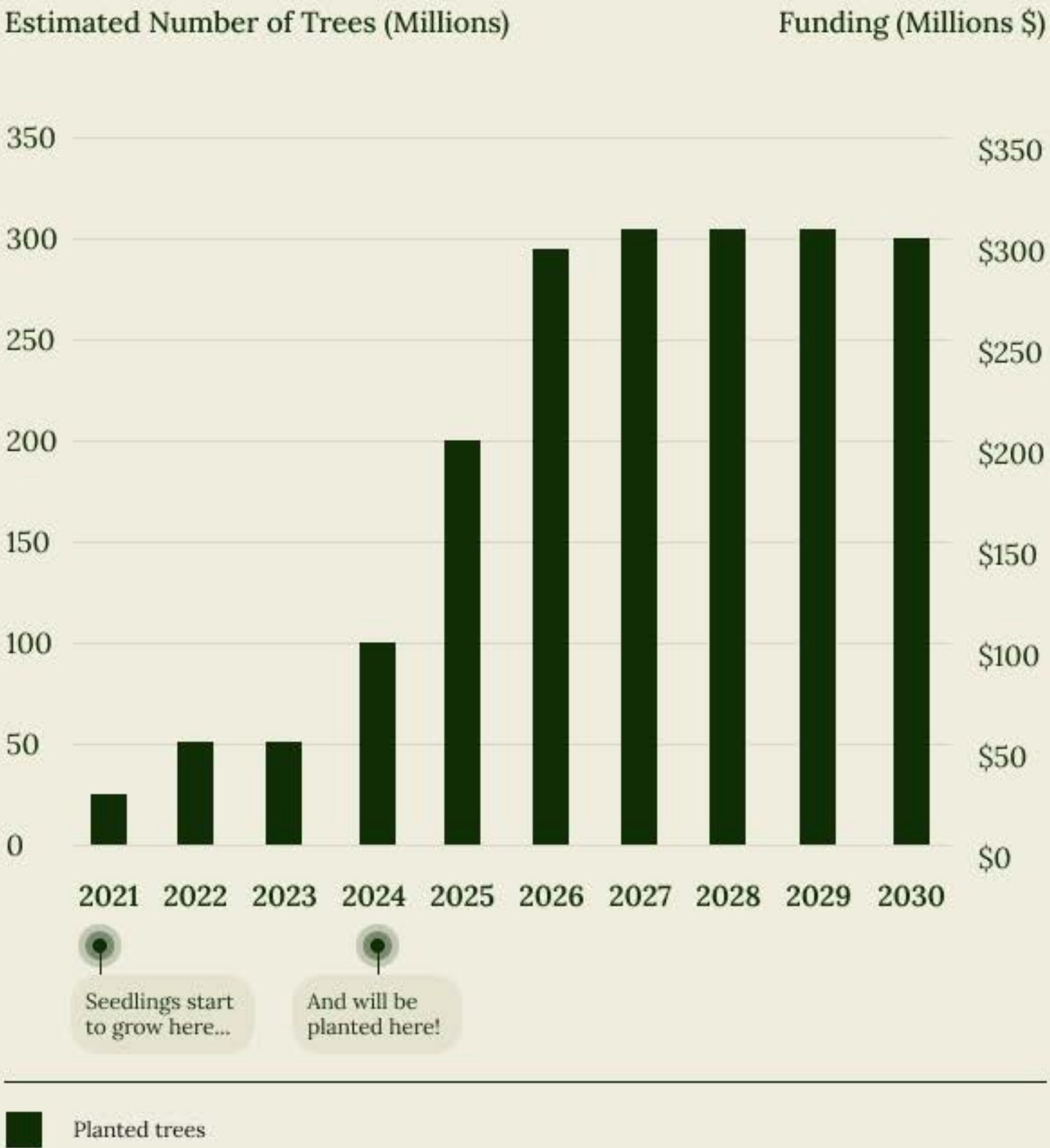


# 2 Billion Trees Action Plan

The launch of Canada’s 2 Billion Tree (2BT) program in early 2021 signalled that the time had come to scale production capacity by 40%.<sup>16</sup> At the same time, NTSC has suggested that successfully planting 2 billion trees could require up to 11 billion seeds.<sup>17</sup>

While 2BT makes it clear that there is a critical need to increase supply and propagation of seeds, expand greenhouse growing space, and identify land to facilitate tree planting, at this point, the 2BT program is not responsible for seed security or planning, and those wishing to participate in funding are responsible for securing seed and seedlings. This inevitably places responsibility with the specialized organizations we surveyed.

It is also noteworthy that there is an obvious lag between when seeds are collected and when seedlings are ready to be planted out; a gap that poses a risk in accomplishing these goals.



If you would like to view the current status of 2BT funding you can visit: [\(see link\)](#)



# Amplifying Supply to Meet Demand

A circular supply chain in restoration planning and forecasting can help determine where the greatest planting opportunities are, and what species and seed sources are required for success.

Nurseries that grow trees source seed from a variety of providers; seed collection contractors, commercial seed warehouses (who offer catalogues from wild stands), specialized seed orchards and seed production areas (SPAs). Orchards and SPAs can produce more consistent quantities of seed with improved genetic traits and predicted performance, but can then be prohibitively expensive or restricted to timber production.

For many native species needed for diverse restoration outcomes, there are simply not large regional production pipelines ready to turn on. In spite of improved seed orchard availability in the reforestation sector in recent decades,<sup>18</sup> restoration and reclamation practitioners reported having to make deals to access reforestation surplus, or become self-sufficient from wild sources.<sup>19</sup>

Restoration efforts will be required long after 2030 and the industry needs to remain sustainable.<sup>20</sup> In the next five years, organizations expect the greatest restoration and reclamation opportunities to be (n=105):

- Specialized habitat enhancement and species recovery programs (40%)
- Naturalizing agricultural fields, windrows and pollinator strips (35%)
- Carbon offset plantings (25%)
- Urban and community forestry (24%)
- Revegetation of wildfire-damaged sites (19%) and insect and pest-damaged sites (19%)



# A limited long-term portfolio

The majority of growers surveyed claimed that they do not currently have any tree seed in storage. However, 22% of growers have four or more years of conifer seed in storage based on current production needs. Due to complex biology and preference for fresh seed (with better viability), seed of hardwood trees, shrubs, native grasses and herbaceous plants are stored for shorter periods of time and only by a few growers.<sup>21</sup>

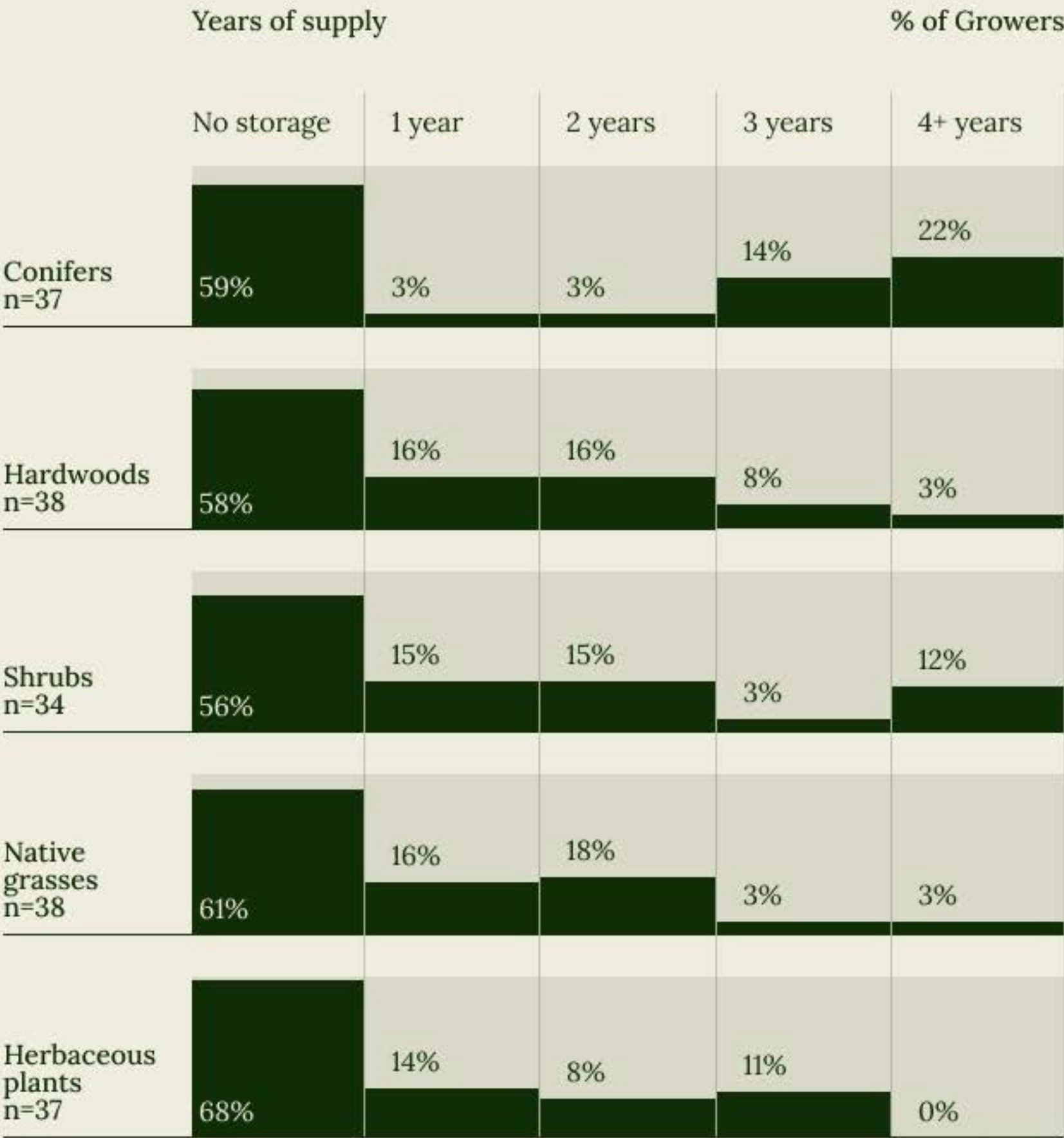




# The majority of surveyed growers do not bank seeds

25

\*It is important to note this data is influenced by jurisdictional policies; several provinces require tree seed deployed to public lands to be registered and stored at their facility (i.e. British Columbia, Alberta, Quebec). Interviewees clarified that only growers serving clients outside these policies or outside their jurisdiction could choose to store their own seed.





# Challenging species to source

Growers and planters listed a wide range of species for which they have had difficulty sourcing high quality seed and stock.<sup>22</sup> Some of these species do not have seed orchards and/or have proven more challenging to gather in quantities that would allow for the banking of any significant volume. Additionally, there is limited visibility to in-demand species, leaving collectors with little direction on what to focus collection efforts.





**Acer**  
(Maple)

**Carya**  
(Hickory)

**Pinus**  
(Pine)

**Fraxinus**  
(Ash)

**Salix**  
(Willow)

**Juglans**  
(Walnut)

**Populus**  
(Poplar)

**Picea**  
(Spruce)

**Quercus**  
(Oak)

**Larch**  
(Larches)

**Difficult to  
Source Seed  
and Stock**

Seed size proportionate to top 10 responses by Planters and Growers<sup>22</sup>



# Certification and Quality Assurances



# Certification & Quality Assurances

48% percent of planting agencies say they have purchased certified native seed and stock from within Canada. However, there were few mandatory and many voluntary certification programs noted. For example, only six native grasses can be certified by the federal *Seeds Act*, whereas no national forest seed scheme has been adopted between jurisdictions or sectors.<sup>23</sup> Nevertheless, 56% say their organization would pay 25% more for genetically appropriate plants and seeds.<sup>24</sup>

46% of planters claim to be professionally certified; however these certifications are varied, indicating a potential lack of standardization and oversight between sectors and jurisdictions.

Frequently noted certifications and professional development programs included:<sup>24</sup>

- Forest Gene Conservation Association Certified Seed Collector (CSC)
- Society of Ecological Restoration Certified Ecological Restoration Practitioner (CERP)
- Alberta Society of Professional Biologists (P. Biol)
- BC College of Applied Biology (CAB)
- Canadian Society of Landscape Architects (CSLA)
- International Society of Arboriculture (Certified Arborist)







# Knowledge Transfer

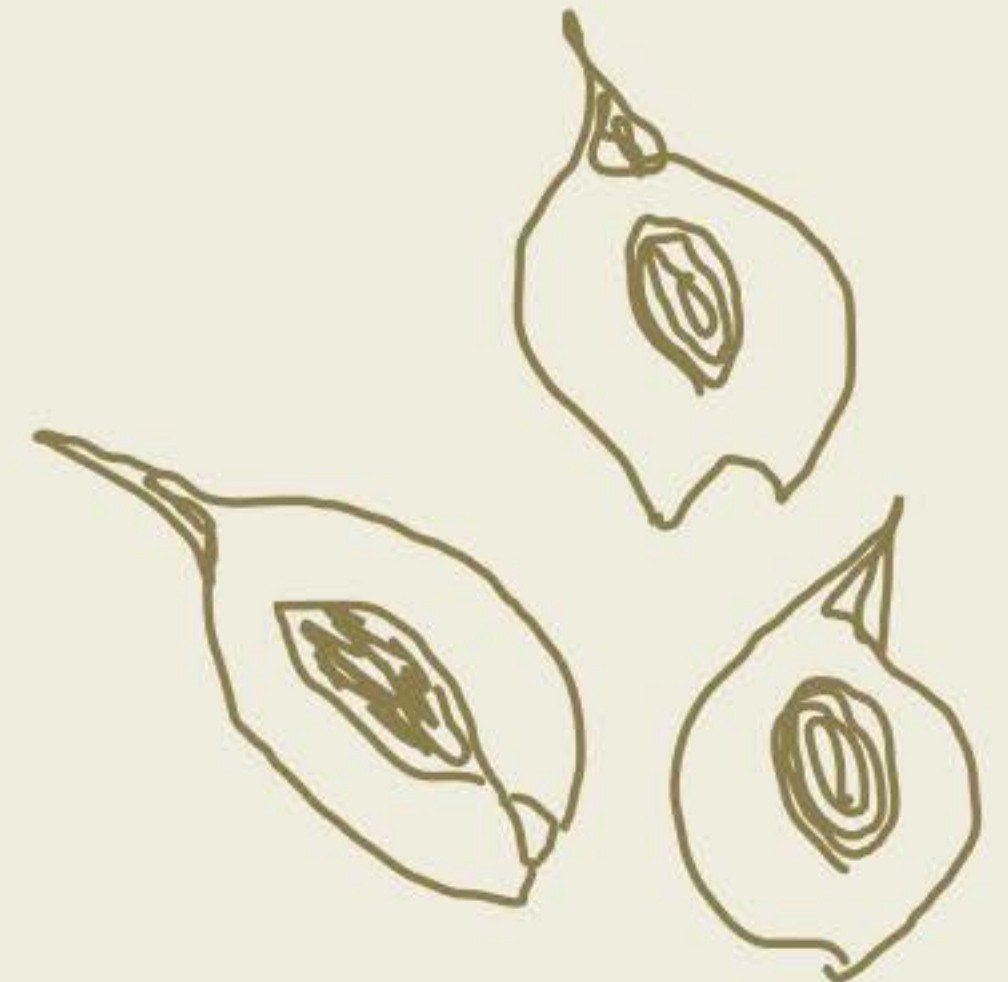


# Knowledge transfer

The research reveals a strained flow of information between public research and workforce development programs, as well as between individuals and companies in the field making practical, on-the-ground knowledge and best practices largely opaque, especially for newcomers to the industry.

Where public seed services and research gaps exist, many organizations develop proprietary knowledge to improve productivity and profitability, which is only passed on through trusted relationships. Tensions between public stewardship, for-profit and not-for-profit entities further limit sharing. Knowledge exchange silos can deter innovation, new entrants and awareness of emerging issues. Simple knowledge of demand data to help inform planning/forecasting would make a huge difference to collectors who otherwise have a limited sense of market requirements.

When asked about what knowledge transfer methodologies they were implementing, several respondents mentioned the importance of informally learning from other sites (ie, touring other facilities for seed extraction) and applying parts of the process back to their own operations with the objectives of enabling workflow and increasing yield.<sup>25</sup>





A high-angle photograph of two people kneeling on a grassy field. The person on the left is wearing a light blue long-sleeved shirt, dark pants, and a dark cowboy hat. The person on the right is wearing a green hoodie and dark pants. They are both looking down at a clipboard held by the person in the cowboy hat. The background is a grassy field with some blue equipment visible in the distance.

“

Some advancements are not shared, they're considered proprietary or have a competitive advantage. I think we need practical public research and the low tech activities are still very important and needed. We're losing a lot of this institutional knowledge.

Kolotelo, D. Deployment Bottlenecks: Cone and Seed Processing, Storage and Inventory Management.

© His Majesty the King in Right of Canada, as represented by the Minister of Natural Resources, 2022.



# Technology and Innovation



# Technology & Innovation

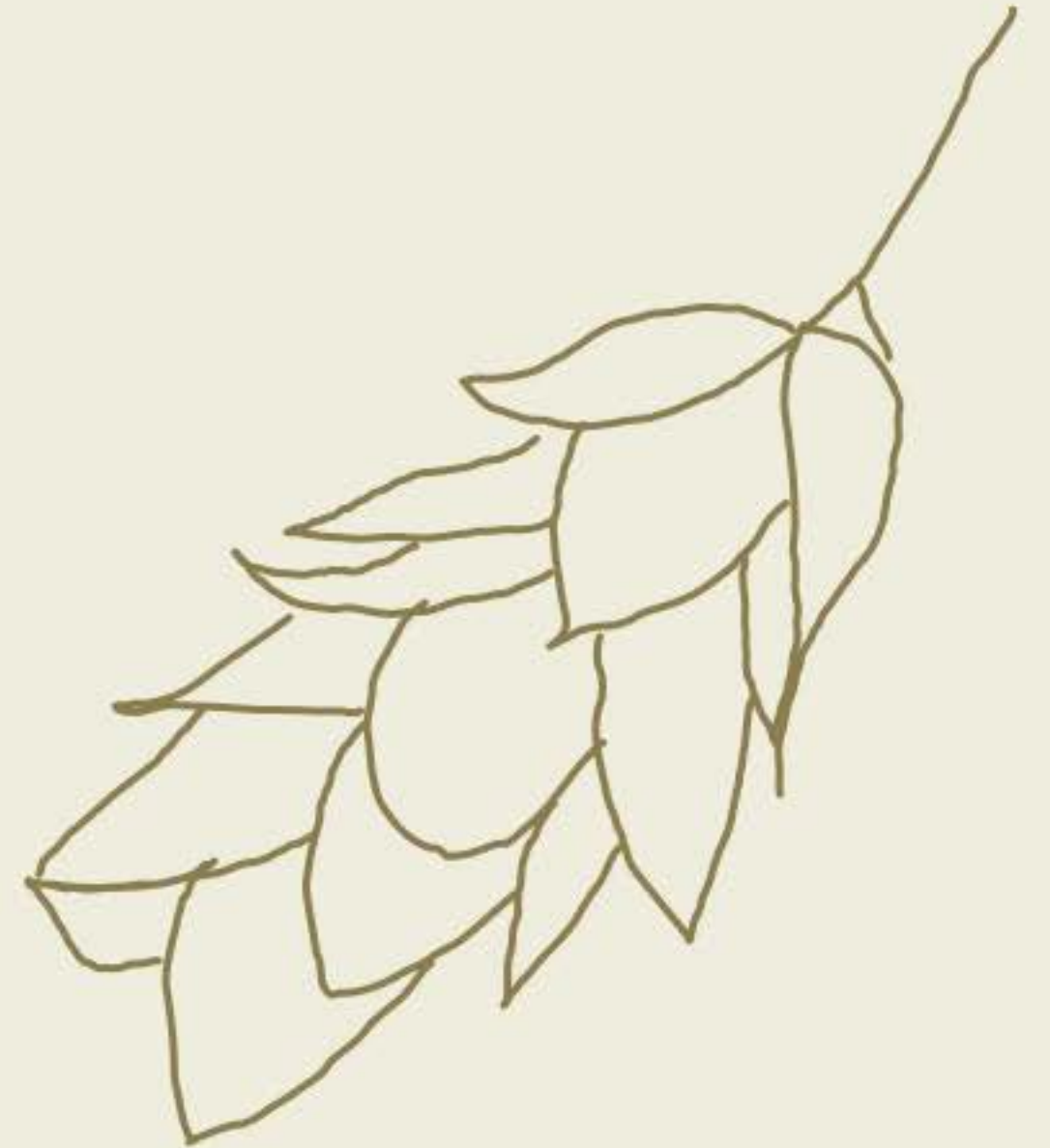
When it comes to collecting, cataloguing and inventory management, the majority of our survey respondents and interviewees outside legislated reforestation requirements use 'low-tech' or analog solutions for record keeping. Some have evolved to adopt simple technology like locally stored Excel spreadsheets, Google Maps, text/picture messaging, and general smartphone technology.<sup>26</sup> However, data tends to be siloed, manually updated and treated as internal. This means that there is limited availability of useful industry data between players or the industry writ large.





A few larger organizations interviewed use high-tech solutions including forest inventory using LiDAR technology, GIS systems to map collection sites, relational databases, custom software builds, and ecommerce marketplaces for sales. However, these technologies take time and money to acquire, onboard, and implement, so a wide delta for technology across the industry remains.

Most respondents felt that the cost of modernization was far too high and that a large amount of knowledge is considered 'proprietary' (ie. details of implementing barcode technology, specifications for building customized databases or specialized seed storage technology).







“

We have a Seed Planning and Registry system in place. We've almost had that for about 30 years now. It provides up to the minute seed inventories and it is an open source. You know, that isn't the case with other jurisdictions and I think it is important. It encourages trade. It encourages use of the best seed on the landscape. There's no reason that should be a proprietary piece of information.



# Profitability and Secure Long-Term Contracts



# Profitability & Secure Long-Term Contracts

Many experts agree that seed has long been an undervalued afterthought by decision-makers and planting organizations. Most of the collectors surveyed were based in Eastern Canada and we heard that they were losing staff and collectors who were going out west for work. 57% of part-time or contract seed collectors reported making less than \$10,000 per year, before taxes and expenses, though 21% make over \$50,000 annually. The median rate is \$27 per hour. 59% don't believe seed collection is profitable.<sup>26</sup>







“

Pricing seed can be tricky,  
sometimes it costs more to  
collect the seed than it can  
be sold for.



## Key Issues Affecting the Industry

Approximately one third (35%) of planters said that they couldn't forecast beyond 1 year when determining what plant material will be needed. Only 8% could forecast out 3 years or longer.<sup>27</sup> When seed is not banked ahead, failure to account for seed procurement timelines causes chronic and significant cascading bottlenecks, which may end in “substitute or nothing” decisions.





A photograph of four people in a forest setting. On the left, a man with a beard and curly hair, wearing an orange safety vest over a blue long-sleeved shirt, is smiling and looking down. Next to him is a woman wearing a black baseball cap, a yellow shirt, and an orange safety vest, also smiling. In the center is a woman wearing a blue baseball cap with sunglasses on top, a blue jacket, and a colorful beaded necklace. To her right is another woman wearing a black baseball cap, a blue and white striped shirt, and an orange safety vest. On the far right is a woman wearing a red and white baseball cap, a grey t-shirt with a red 'Levi's' logo, and grey pants. They are all looking down at something in their hands. The background is a dense forest with many thin trees and green foliage.

“

A substantial client-facing challenge is communication and the understanding of timelines. For the sustainable future of the native seeds supply chain, end-users and collectors need to speak the same language.

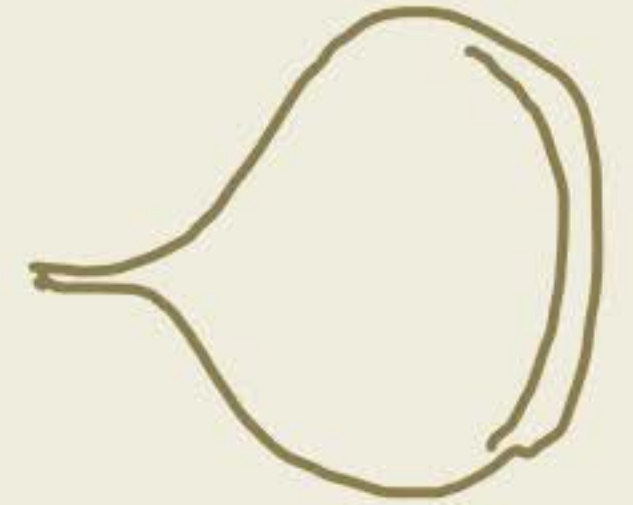


# Infrastructure: Tools, Equipment, Facilities, Logistics and Networks



# Infrastructure

Growers report that infrastructure is a limiting factor. The ability to properly clean, process and store seed requires equipment and facilities that ensure seed viability is maintained for years or decades. Less than half of all respondents have specialized equipment such as seed coolers (46%), seed processing equipment (44%) and seed freezers (36%), which are necessary to improve seed storage capacity.<sup>29</sup> Industrial seed extraction equipment is prohibitively expensive for all but the largest organizations. Additionally, the cost of growing specialized seed and nursery infrastructure to enable increased production has not been specifically addressed through government grants or incentive programs. Most small and medium-sized organizations are left to take on the risk of scaling their operations, but are not often granted long term contracts that empower these critical decisions.<sup>30</sup>





A photograph of industrial machinery, specifically three large yellow conical processing units mounted on a blue metal frame. Each unit has a transparent safety enclosure at the base. The background shows a factory setting with various pipes and structural elements.

“

Entry level (industrial cone processing) is pretty much gonna be 2 million bucks. That includes a facility to put all the equipment in and then the equipment.



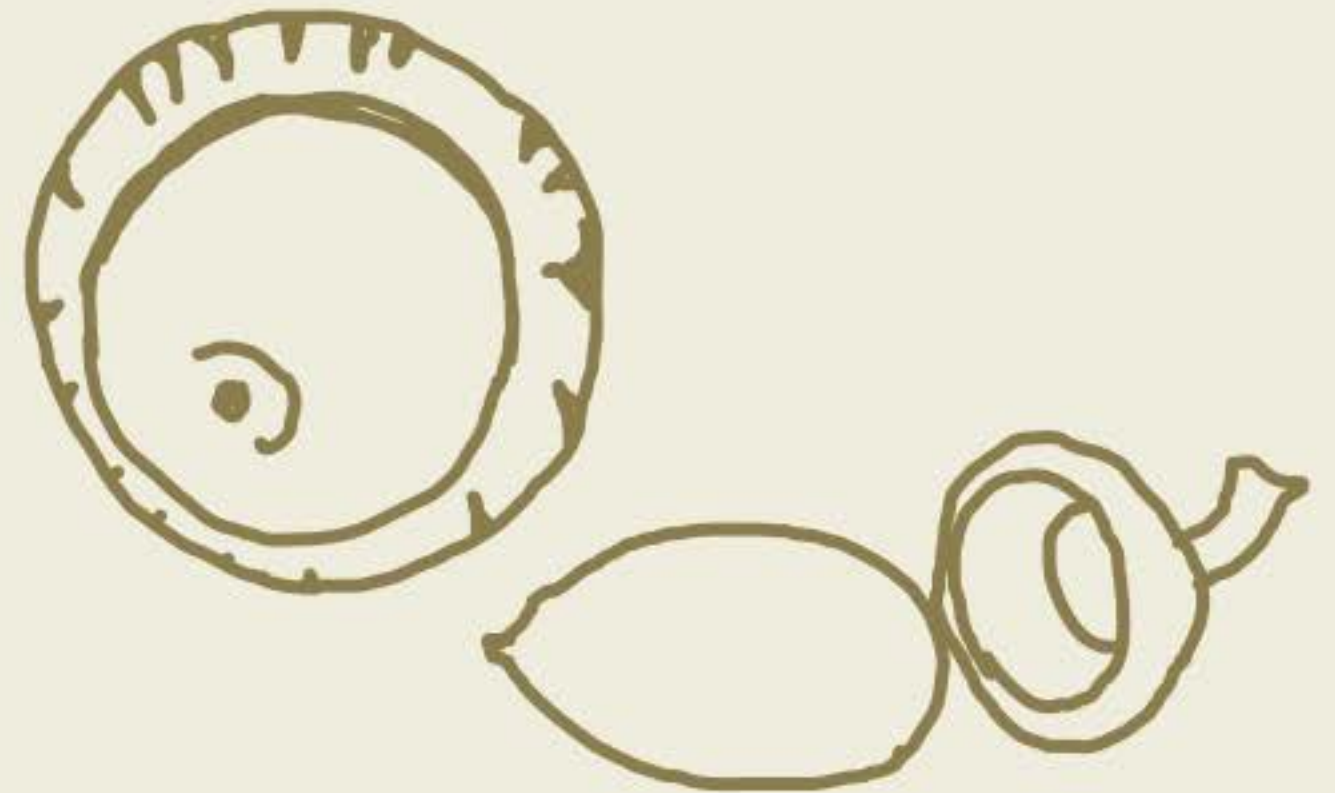
# Labour



# Labour

Labour shortages and a continuing wave of retirements are expected by 2028 and respondents agreed this will cause continued bottlenecks throughout the native seed supply chain.<sup>32</sup> Only 36% of survey respondents say it's likely there is sufficient general labour to meet their region's needs for the next 5 years. Even fewer feel it's likely that there are a sufficient number of trained seed collectors, skilled growers, and capable planters. To develop their current workforce, 72% of respondents said they plan to increase, improve or develop training and knowledge exchange opportunities, with 40% hoping to start this in the next 1-2 years. 58% plan on hiring additional Canadian summer students, while 53% plan on hiring additional Canadian part time workers. Only 11% will hire additional temporary foreign workers.<sup>33</sup>

The industry needs to attract new participants whether it is by encouraging the next generation to become involved or by attracting migrant labour with a strong value proposition: profitability, purpose, training and future career opportunities.







“

We need more  
boots on the  
ground.



Policy has an  
opportunity to support  
the seed market



National and jurisdictional programs can fundamentally shape the Canadian seed market. The most recent example being the launch of The Canadian Net Zero Emissions Accountability Act, part of which is the 2 Billion Tree Program, which is making \$3.19 billion available over the next decade for public, private and nonprofit stakeholders to execute on this ambitious goal. Historically, provincial policy and investment have set the stage for key capacities such as research, seed banking, infrastructure and nursery operations, however when the funding dries up, so too does local capacity.

Policy can also play a critical role in prioritizing native species. Though Canada signed the Convention of Biological Diversity in 1992, mechanisms to ensure sustainable use of wild genetic resources are still filtering down through a multitude of Indigenous, federal, jurisdictional, municipal and private sector partners.<sup>33</sup> While sustainable forest management policies have strong incentives to improve seed supply for future productivity, reforestation, reclamation and restoration practices are evolving at different rates. Western Canadian jurisdictions are leading the way in expanding reforestation programs to non-commercial tree species, but some respondents and Interviewees claimed there was still not enough support for shrubs and other native species required in their plans.

“

"There is a lot of red tape at every level of government that makes it slow and difficult to expand. Demand is changing rapidly, faster than our ability to grow plants and also getting proper permitting in place."<sup>34</sup>





“

The creation  
of a thousand  
forests is in  
one acorn

Ralph Waldo Emerson



# Recommendations



# Summary of recommendations

The tree seed sector is facing increasing pressures that could lead to tremendous growth but inherent in that is also complex long term risk. The biggest opportunities relate to improved market transparency that incentivizes labour and leverages modern technology. In a traditionally analog sector, challenged by the vagaries of nature, finding new ways to connect and streamline efforts and data will be hugely beneficial not only for the growth of the sector, but for the future of healthy forests.

As such, Wilder Climate Solutions has identified six key recommendations:

- Focus on Forests and Biodiversity
- Inclusion of Indigenous Knowledge and Leadership
- Development of Public Support
- Funding for Enhanced Infrastructure and Longterm Contracts
- Incentivization of Labour and Pricing
- Standardization of Tech and Knowledge Sharing



# A Focus on Forests and Biodiversity

Investments and actions must look beyond trees alone, and focus on strengthening future forests, the habitat that they provide and the biodiversity that they represent.

The WWF Living Planet report reveals that we've lost nearly 70% of our species on the planet since 1970. Conserving, strengthening and building healthy forests will help us turn the tide: protecting species from extinction and building stronger, more resilient ecosystems. We recommend measuring forest health over tree volume, limiting monocultures, and planting with complimentary species to return forested lands to what they once were and restoring all of the benefit that they can provide.





# Indigenous Knowledge and Leadership

Not only do Indigenous worldviews hold critical wisdom to guide and reinforce regenerative practices, they are inherently regenerative. The keepers of this knowledge should be included in and leading efforts applied to improving and evolving the seed supply chain.

Furthermore, as included in the 94 Calls to Action from the Truth and Reconciliation Commission of Canada and the United Nations Declaration on the Rights of Indigenous People, we recommend that efforts applied to ameliorate the supply chain include and involve Indigenous peoples through consultation, the building of respectful relationships and the obtaining of free, prior and informed consent of Indigenous peoples. We also urge corporate entities working in this space to ensure that Aboriginal peoples have equitable access to jobs, training, and education opportunities and that Aboriginal communities are able to gain long-term sustainable benefits from economic development projects. There is an immense opportunity to benefit from intercultural exchange in the ecological sector and it should be seen as core to moving this industry forward.



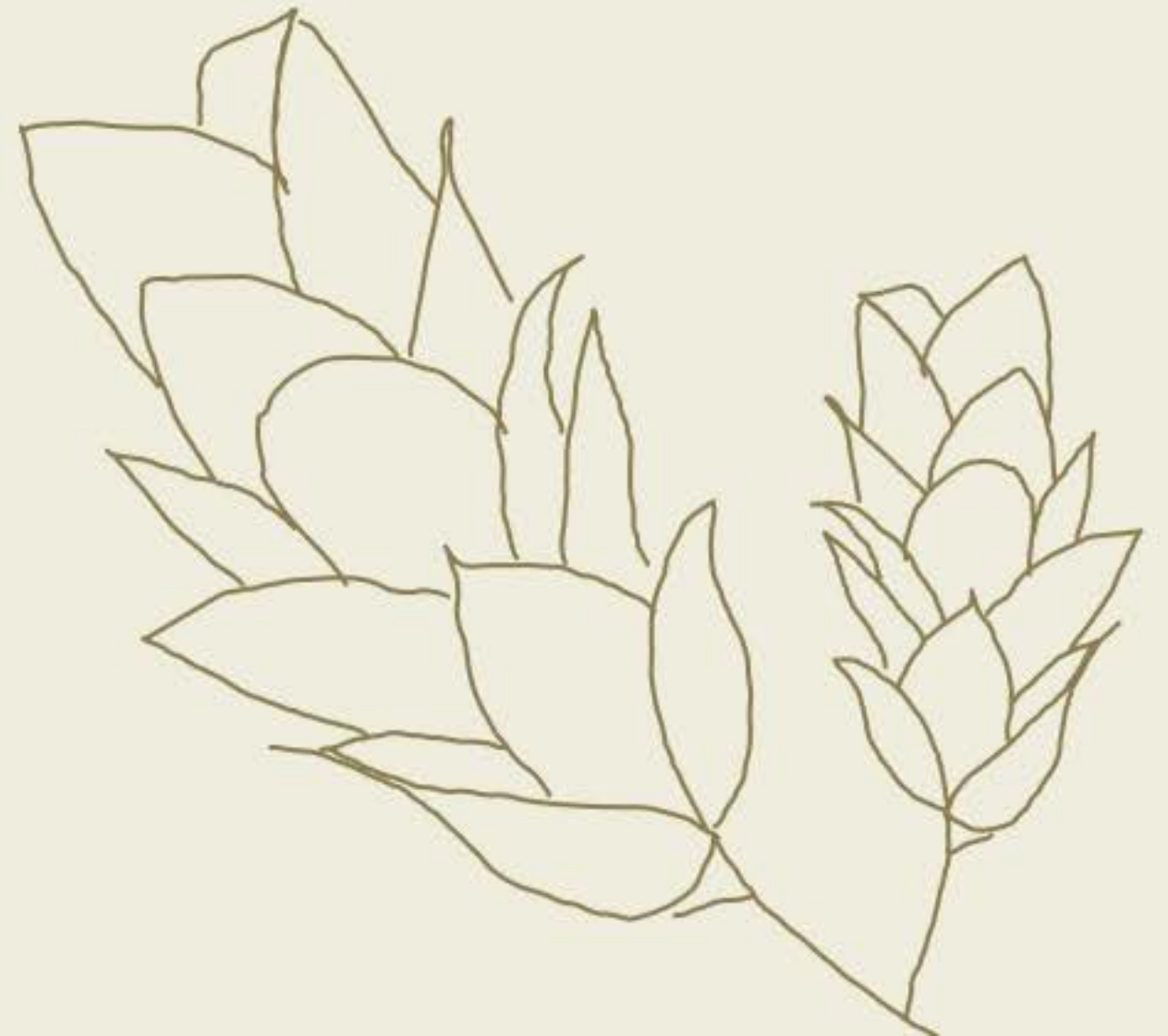


# Development of Public Support

Canada is a nation blessed with vast amounts of land and robust natural resources. It is uniquely positioned to leverage healthy forests to support our long term climate goals and provide global leadership.

It is clear that investment is needed and that in order to drive investment, broader public support for the sector is required. As tree seed industry labour pools are retiring and knowledge is lost, compounded by the fact that the industry continues to be challenged by an inability to forecast demand, it is clear that greater investment and interest in the sector would be helpful at attracting new participants and innovation.

We recommend launching a broad-based awareness and engagement campaign to build interest, drive public discourse and ultimately mobilize more resources (both human and financial) to accelerate and scale the tree seed market. As Canadians become more conscious of the climate emergency, and more disruptions are felt on the individual level, we have an opportunity to create paths of engagement and advocacy that bring us into greater balance and partnership with nature.





# Funding for Enhanced Infrastructure and Longterm Contracts

The majority of respondents cited that they are struggling to modernize; it is expensive and often fails to produce the desired outcome. The industry requires a significant increase in infrastructure to support seed processing, propagation and greenhouse growing of the trees needed to support the 2 Billion Tree Program as well as ongoing needs. This could come in the form of dedicated funding for public seed centres and multiyear grants for small and medium businesses in the industry.

Without clarity around species or quantities of seed required, collectors cannot accurately collect requisite seed and, likewise, without guarantees that stock will be utilized, growers are hesitant to expand their operations and increase capacity. Greater visibility to long-term projections around species and quantities along with formalized contracts would help focus the efforts of the industry and drive scale.





# Incentivization of Labour and Pricing

In order to draw more participants into the labour force and ensure ongoing and future seed capacity, pricing needs to be increased to recognize the effort expended and the complete future value of high quality seed. Seed can and should be priced in a way that accounts for value generated in carbon markets. Mechanisms that shift the transfer of profit from the back end (tree planting) of the supply chain, closer to the sourcing and collection effort would incentivize participation by making the work feel more valued and remuneration more meaningful.

The development of a coordinated national standard for seed collection would also help drive labour by producing a standard against which collectors can be trained. Finally, public and private partnerships could further incentivize seed collection by limiting expenses (tax credits, free data plans, shipping credits), delivering financial incentive and/or enabling connectivity (through software, hardware sponsorship).





# Standardization of Technology and Knowledge Sharing

Standardization of technology that can support the transfer of knowledge and coordination of data across collectors, growers and planters would allow the entire supply chain to deliver greater volume of seed. Using technology to harness collaborative, regional seed forecasting efforts is one idea that could contribute to greater quantities of seed collected. Another is to develop an easy-to-use, standardized online inventory and tracking system to reduce current attrition of data between collectors, growers and planters and to increase visibility of demand.





# Appendix



# Methodology



# Methodology

From 2020-2021, five bilingual SurveyMonkey surveys were prepared from literature review and existing Canadian Forest Service reforestation surveys. Separate surveys targeted respondents from the most important steps involved in the FLR supply chain. From March 4-May 2, 2022, the surveys were promoted through targeted email lists prepared by the National Tree Seed Centre, Natural Resources Canada social media and publically available on the NTSC website:

- Sizing Canada's National Seed Supply (24 questions, n=111): The primary goal of this survey was to understand current and short-term forecasted activity and organizations involved in the domestic seed supply chain in Canada prior to the launch of the 2 Billion Tree Program.
- This “base” survey encouraged respondents to then take one or more of the following surveys to determine specific roles, challenges and needs for the coming decade
- Planning, policy, research and education providers (28 questions, n=26) \*note: due to the small base size, we were unable to analyze the majority of data from this survey.
- Seed collectors, orchards and producers (22 questions, n=40)
- Growers (30 questions, n=56)
- Restoration and reclamation planners, practitioners and planters (35 questions, n=62)



# Methodology

Responses were anonymized as per Government of Canada Public Opinion Research guidelines. Given COVID-19 and funding delays in outreach, insights are likely biased towards those a) with desire to benefit from the 2 Billion Tree Program funding, and/or b) those with capacity to grow their operations.

Respondents were not required to complete the survey questions. We do not have insight into why respondents may have skipped questions. As a result, there may be selection bias in responses. To accommodate for skips, data presented as percentages (%) has been based on “all answering”, rather than among all respondents. Once fielding was complete, data was cleaned. Respondents were removed if they:

- Did not meet survey qualifications (indication of relevant seed supply chain activity)
- Were speeding through the survey and/or leaving a large percentage of questions blank

From April 12 - May 26, 2022, 21 qualitative interviews were conducted with voluntary and informed consent. The NTSC specifically sought active and recently retired subject matter experts from potentially under-represented geographic areas in the quantitative surveys (Far North, Prairie provinces, Quebec, British Columbia, northern Ontario). Semi-structured interviews were 30-60 minutes long, and transcripts coded by the team at Accenture. Eight of the interviewees had not completed any of the SurveyMonkey links, so their roles in the supply chain were added to the Base Survey Question 1 response totals only.

\*Please contact the National Tree Seed Centre for related publications and upcoming forums regarding survey results: [ntsc-cnsf@nrca-nrcan.gc.ca](mailto:ntsc-cnsf@nrca-nrcan.gc.ca)



While deployment of seeds and plants spans the country, across all five surveys, Ontario was the most represented region followed by British Columbia. New Brunswick (driven by collection) and Alberta (driven by growers) are the next strongest players.<sup>35</sup>

#### **Grower's Survey (n=56)**

In 2019, growers collectively reported growing more than 370.3 million native coniferous trees (median 630,000, Q7, n=27), and 32.8 million native deciduous trees (median 19,000, Q8, n=28).<sup>36</sup> However, production is not evenly shared, with one company reporting annual domestic production of 220 million native conifers. 88% percent of growers surveyed think Statistics Canada's Annual Greenhouse Nursery and Sod survey should include definitions of native plants and report share of production units in the standard categories.<sup>37</sup>

#### **Restoration and Reclamation Planters, Practitioners and Planners Survey (n=62)**

Just under half of planters surveyed claim to use a native species definition in their procurement contracts. Three quarters (78%) of planters using a native plant definition, say that it makes reference to ecoregion, seed zone, local provenance, or otherwise specify plants with genetic origin parameter.<sup>38</sup>





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We'd love to hear from you - please reach out with any questions, thoughts or ideas.



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# The Collaborators



# The Collaborators

## WILDER

Wilder Climate Solutions is leveraging the power of data to fast-track global reforestation by producing nature-based climate solutions that improve biodiversity and enhance resiliency. We work with nature and technology to deliver climate-saving interventions that are based on science and focussed on driving big results. By bringing together powerful players, creativity, cutting-edge tech and the might of nature we aim to deliver transformative results.

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Accenture is a leading global professional services company that helps the world's leading businesses, governments and other organizations build their digital core, optimize their operations, accelerate revenue growth and enhance citizen services—creating tangible value at speed and scale. We are a talent and innovation led company with 738,000 people serving clients in more than 120 countries. Our capabilities, together with our culture of shared success and commitment to creating 360° value, enable us to help our clients succeed and build trusted, lasting relationships. We measure our success by the 360° value we create for our clients, each other, our shareholders, partners and communities. Visit us at [www.accenture.com](http://www.accenture.com).

## The National Tree Seed Centre

The National Tree Seed Centre (NTSC) was established in 1967 with the focus of obtaining, storing and providing tree and shrub seed of known origin for research. Since then, the mandate of the centre has grown to include the conservation of genetic resources under threat from invasive pests, pathogens and climate change. The NTSC's living library contains over 13,000 geolocated seed collections from over 200 tree and shrub species – the most diverse collection of its kind in Canada.

Today, the NTSC is supporting Indigenous communities, reclamation and restoration organizations in scaling up high quality, ecologically-appropriate seed supply through training, collecting, processing, and seed banking services. The seed bank is located at the Canadian Forest Service's Atlantic Forestry Centre in Fredericton, New Brunswick.

The original scoping for this research was provided by the Canadian Forest Service Cumulative Effects program (CE-13, 2019-2021), and continued through in-kind collaboration with Wilder Climate Solutions and Accenture in 2022. Mention in this report of specific commercial products or services does not constitute endorsement of such by the Canadian Forest Service or the Government of Canada.



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