CHRISTMAS TREE FARM COST OF PRODUCTION AND OPPORTUNITIES IN NOVA SCOTIA

For the Christmas Tree Council of Nova Scotia (CTCNS)

Abstract

The purpose of this report is to demonstrate the costs incurred by a Christmas Tree grower to produce Christmas trees and to recommend opportunities for growers to reduce costs

Barrington CONSULTING

Presented by: Robert Newcombe
The Barrington Consulting Group
rnewcombe@barringtongrp.ca

Contents

Table of Figures

List of Tables

1. Executive Summary

The purpose of this report is to demonstrate the costs incurred by a Christmas tree grower to produce Christmas trees and to recommend opportunities for growers to reduce costs. Every Christmas tree grower in Nova Scotia is unique and the cost of production can vary dramatically from farm to farm. This report is focused on identifying the largest contributors to decreasing costs so profitability for all Nova Scotia Christmas Tree Producers can increase.

To start a 40-acre Christmas tree farm from scratch, with no land or equipment, it will cost anywhere between $60,000 and $125,000, with the low end representing a natural stand with minimum investment up front, and the high end indicating a plantation lot with all site preparations and equipment purchased in the first year.

The variable costs per unit range from approximately $4.00 - $7.00 a Christmas tree. This range counts all Christmas trees grown, so Christmas trees that are cultivated and not sold will increase the variable costs per unit. The $3.00 range captures differences in methods and activities for growing a Christmas tree. Larger and more efficient operations with more advanced technology will be on the low end of the scale, and potentially lower than $4.00 a tree, while smaller operations with less or dated technology and light stocking, could see variable costs per unit over $10.00.

The annual revenue for a Christmas tree grower is based on four factors: number of trees harvested, height of trees, grade of trees, and market price. The most important factor that is in control of the grower is the number of trees harvested. Increase stocking within lots is the most cost-effective way to increase the number of trees harvested each year and improve profits. Another critical factor is market price. If the grower can increase their price to match their current market, or switch markets for a higher price, it will have a dramatic effect on the bottom line.

The lot type for growing Christmas trees was not as an important factor on profitability compared to other attributes. With all things equal, natural stands that practice even-aged management are the highest profitable lot type in the long run. However, natural stands and plantations that have a low cost per tree by using mechanical equipment and efficient techniques, can be more profitable. Plantations are more cost-effective for activities such as fertilizing, shearing, and harvesting when compared to other lot types, but the cost of mowing is significant and reduces the overall cost-effectiveness.

Christmas tree growers in Nova Scotia are knowledgeable and resourceful, but there are many areas that can be improved to increase profitability. Business planning, human resources (e.g., training), and data collection are three key areas that could be improved for many growers. Data collection, especially as it relates to effort required for each activity, will help with many business decisions such as the need for effective planning, the benefit of transplanting, the gains of adding roads, and the return on investing in high-quality, mechanical tools.

With proper industry expertise, business knowledge, innovation, and motivation, growing Christmas trees can be profitable for any Nova Scotian that is interested and willing to invest their time, energy, and resources.

2. Introduction

2.1. Objectives

The purpose of this report is to demonstrate the costs incurred by a Christmas tree grower to produce Christmas trees. It includes all factors such as fixed costs (land, administration, outbuildings, tools, and equipment) and variable costs by activity (lot management, planting, spraying, fertilizing, shearing, butt pruning, grading, and harvesting). The report also evaluates the differences in costs between natural stands and plantation sites.

The secondary objective of this report is to offer recommendations to lower the cost of production and/or increase the sales price of Christmas trees. Knowing the dollar figure for the cost of an "average" farm to grow a Christmas tree is not useful for any farmer or potential new entrant to the industry. What is valuable is understanding the various factors that affect the cost of production, the importance of each of those factors, and opportunities for improvement.

This report is organized such that a grower can evaluate their own processes and activities and gauge their cost of production. With representative data, current producers can see how their profitability compares. The report will also give those that may be interested in becoming a producer a better view into the costs, barriers to entry, and opportunities.

This report is meant to positively affect the three overarching objectives of the Christmas Tree Council of Nova Scotia's (CTCNS) 2018 strategic plan:

1. Increase the profitability for NS Christmas Tree Producers.
2. Increase the number of growers in the industry and the number of Christmas trees produced.
3. Increase the overall quality of the product.

This cost of production report is not meant to present a guide to growing Christmas trees and greenery, rather, it should be used in conjunction with the 2021 Christmas Tree Grower's Manual (Atlantic Canada). The Christmas Tree Grower's Manual entails strategies for all areas of management including establishing a lot, fertilization, harvesting, pest management and much more

2.2. Organization

The report is structured so that it follows the lifetime of a Christmas tree from establishing a farm, to planting a tree, growing a tree, harvesting a tree, then selling a tree. It is broken into five main sections:

- **Fixed Costs** – This section aims to answer, "how much does it cost to start a Christmas tree farm?" It includes what administration is required, options for outbuildings, tools and equipment, and costs to prepare the site.
- **Variable Costs** – This section aims to answer, "how much does it cost to produce a Christmas tree?" It is based on the activities required and supplies needed from planting a tree to shipping a tree.

- **Sales Price** – This section evaluates the four contributors to sales price: production, height, grade, and price.
- **Costs and Returns** – This section combines the fixed and variable costs with the sales price to evaluate break-even points and the impact on profit by changing any one of the input factors.
- **Opportunities for Improvement** – This section is a combination of insights for all types of producers across the province to increase their production, quality, and profitability.

It is important to note that it is unlikely that any farm will be an exact fit of the model data presented. This report is structured and written so any grower can learn from the principles and calculations to make their own decisions based on their unique conditions.

2.3. Background

Growing Christmas trees is of significant economic importance to many rural areas of Nova Scotia. In 2016, there were 319 Christmas tree producers reporting in the province with 15,269 acres in production[1] (not including growers with gross sales of < $10,000).

Approximately 90% of the trees harvested in Nova Scotia are exported out of the province, either through brokers/customers within Canada or abroad. According to Statistics Canada, of the trees exported from Nova Scotia to other countries, the largest markets for Nova Scotian grown trees are the United States (75%) and Panama (20%) with the remainder going to several other markets, namely within the Caribbean, but some as far as the United Arab Emirates.

It has been widely reported that there is a shortage of Christmas trees in the United States, which is the result of reduced supply as many farmers transitioned from growing plantations of Christmas trees to growing other crops. The growing demand being created is a direct result of the U.S. Christmas Tree Promotion Board's campaigns. According to the NCTA, 27.4 million trees were purchased in the U.S. in 2016, and this figure continues to grow.

2.4. Overview of Balsam Fir Christmas Tree Establishments

The returns of a Balsam Fir Christmas tree farm can be broken down into six basic components from costs and revenue:

- Costs
    - Operating Costs
    - Capital Costs
- Revenue
    - Number of Trees Produced
    - Height of Trees Produced
    - Grade of Trees Produced
    - Price of Trees Sold

[1] Statistics Canada. Table 32-10-0421-01 Christmas trees (https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3210042101)

The cost associated with establishing and operating a Christmas tree farm varies due to site characteristics and management strategies used by operators such as labour and equipment. The establishment of a stand is a long-term investment, with seedlings having a production cycle of seven to nine years before becoming a 7-8 ft Christmas tree.

2.5. Costing Approach

A cost accounting (or managerial accounting) approach is used for this report. The purpose is to identify all variable and fixed costs associated with the growing and production process. Costs are measured and recorded individually to measure financial performance and make future business decisions. This approach is used for two main reasons:

1. A lack of financial data from Christmas tree farms makes a financial accounting approach nearly impossible; and,
2. Taking a cost accounting approach focusing on all the components required to grow a Christmas tree highlight the challenges and opportunities for growers in the province.

2.6. Costing Assumptions

The following list of costing assumptions are used for the entire report:

- All activities, times, and costs are based on balsam fir trees.
- Operating costs associated with general farm overhead like accounting, legal, office and general farm maintenance have not been included due to the variability that exists from situation to situation.
- Land tax has not been included due to the differences within each municipality and due to it being close to negligible when compared to other costs (approximately 25 cents per acre).

2.7. Disclaimer

The material in this report is not intended to duplicate the work compiled in “The Christmas Tree Growers’ Manual”. This is not intended to be a complete guide to growing Christmas trees and greenery in Nova Scotia, rather, it is intended to demonstrate the costs associated to growing Christmas trees.

The material in this report is not intended to be comprehensive or to cover all jurisdictions and scenarios, and it is not intended to provide legal advice or to fulfill any specific legal requirements. Readers are advised to consult with a representative of the relevant government departments in their province or with a qualified consultant or other appropriate persons to determine the status of their individual practices, policy, or program and its compliance with any legal acts or other requirements. Although every effort has been made to ensure accuracy, currency, and reliability of this material, the author and reviewers accept no responsibility for any errors and omissions. Furthermore, the author and reviewers accept no responsibility for the accuracy, currency and reliability of any documents suggested as sources of further information; these are supplied for your information only. The Christmas Tree Council of Nova Scotia makes no representations or warranties, either express or implied, as to any matter including, without limitation, the quality or freedom from error of this publication. Any

references to, and images of, commercial brands and services were chosen for their educational value only. The Christmas Tree Council of Nova Scotia does not endorse any brand, product line, or service.

The recommendations in this report are based on optimal conditions for Balsam fir production in Nova Scotia as obtained from research projects, scientific literature values for Balsam fir Christmas Tree production, and a Professional Agrologist's interpretation of the available information. For most accurate recommendations, always follow best practices for sampling. Please keep in mind, your nutrient recommendations will change on an annual basis, we recommend sampling lots at least every three years. If you have questions about the recommendations, please be sure to connect with your agrologist prior to application. As a lot owner, it is your responsibility to make nutrient management decisions that will not only provide good results in terms of yield, but that also minimize the impact to the environment. In preparing this report, your Agrologist has kept this in mind and as a result, following recommendations exactly (especially when it comes to application rate) is essential.

This report has been reviewed by a Professional Agrologist. Persons who hold themselves out to be a professional agrologist must be registered with the Nova Scotia Institute of Agrology under the Agrologists Act. Professional Agrologists work to serve the agricultural industry to the best of their ability with the objectives of the Institute which are to serve, improve, protect, and promote agriculture. Across Canada, Agrology is a regulated profession, like accountants, doctors, engineers, and lawyers. Registration to practice Agrology is required in all provinces in Canada.

3. Fixed Costs

There is significant variation in the cost of land preparation depending on the need for clearing, leveling, and drainage. However, it has been found that the added expenses of land improvement will result in an earlier and more consistent crop, thus bringing an earlier return on investment. Variation in the establishment costs is affected by many cultural practices such as planting density, pest management, and the location of the site. A new entrant into the Christmas tree industry must carefully consider the advantages and disadvantages of a site because management decisions will have a significant impact on the profitability of a site.

For the purposes of this report, all **fixed costs** are captured under this section. Fixed costs do not change because of an increase or decrease in acreage. Machinery, equipment, buildings, and administration are examples of fixed costs. It is worth considering that there are constraints with many of these fixed costs and they likely will increase if a farm or production grows extensively.

Variable costs change directly with an increase or decrease in acreage. Trees, pesticides, fertilizers, labour, flagging tape, and operating expenses for machinery are examples of variable costs and are captured in the Variable Costs section.

3.1. Land

The cost of land varies dramatically across the province based on the location, road system, growth of trees, and many other factors. The cost for land varies from about $200 an acre for cutover land that requires a lot of work and $1000 an acre for land that used to operate as a Christmas tree farm. This report will use a value of $500 an acre which assumes a moderate amount of preparation work and stocking is required to make it a viable Christmas tree farm.

3.2. Administration

An overhead cost that does not scale directly with the business is an administrative cost. Administrative costs include any activities such as business planning, bookkeeping, completing pay slips, communicating with buyers, marketing trees, etc. that can be done by the owner based on their business savvy and interest or it can be outsourced.

For purposes of calculating a total cost, the operator's time has been arbitrarily assigned an amount of $17 per hour. For all administration activities mentioned above, it is estimated an operator requires 130 hours a year (an average of 30 minutes a day, five days a week, 52 weeks a year).

Costs for lawyers, accountants, and bookkeepers can vary drastically, especially considering the amount of work the owner may be able to take on themselves. This report has assumed a cost of $2000 a year for a lawyer, $2000 a year for an accountant, and $2000 a year for a bookkeeper.

3.3. Outbuildings

Unlike many other businesses, a Christmas tree farm does not require a building for the work to be done. The primary purpose of an outbuilding on a Christmas tree farm is to store gear such as a baler,

hand tools, chainsaws, sprayers, and supplies such as spare parts, twine, flagging tape, pesticides, fertilizers, and gas cans. An outbuilding will range from $50 to $250 per square foot depending on materials and requirement for electricity, plumbing, and HVAC. For this report, it is assumed a 20ft x 20ft outbuilding is required at $200 per square foot for a total cost of $80,000. If the grower plans on expanding operations and getting more gear (such as a tractor they want to store indoors), they should plan accordingly and build a larger shed.

Another building that may be required is a small, heated cabin. Employees that work outside in the late Fall and early Winter harvesting will require a heated building for lunch and breaks. These cabins are usually heated by wood stove for cost-effective and timely heating. The investment summary assumes that the outbuilding will act as a heated cabin (or a heated cabin is not required).

3.4. Tools and Equipment

There are many different types of equipment that an operator can own to make their production processes faster and more efficient. The "**must-haves**" are tools and equipment that every operator should own, no matter what type of lots or size of operation they have. The "**nice-to-haves**" is a list of potential upgrades for operations that grow or generate enough profit to justify upgraded equipment.

3.4.1. Must-haves

- **Pickup Truck** – A pickup truck is an essential vehicle for a Christmas tree farm due to the terrain and road conditions of most lots as well as the requirement to haul trailers and small equipment. A pickup truck will cost in the range of $10,000 (used) - $80,000. For this report, a pickup truck is assumed to cost **$25,000**.
  Some choose and cut operations may be able to do without a pickup truck if they are not concerned about hauling trees, bale trees in the yard, and have an all-terrain vehicle (ATV) or similar vehicle to travel out to the lot with some small equipment.
- **Baler** – Every Christmas tree operation will require a baler for harvesting. Balers are difficult to rent because everyone requires a baler at the same time of the year and usually require it for the entire harvest season. A Howey Model 214A baler will cost approximately **$3,000 used and could cost up to $10,000 brand new**. A **larger baler**, such as the Howey Model 400A that bales medium to large trees, will cost approximately **$15,000** range.
- **Trailer** – A trailer is required to haul Christmas trees from the lot to the yard. There are many different types of trailers that can be used for Christmas trees. An operator must choose based on the conditions of their lot, size of their truck, number of trees harvested per year, and amount they want to spend. For this report, a flatbed trailer is assumed to cost **$3,000**.
  If the operation is dedicated solely to choose and cut, or if you know someone that does not use their trailer in the winter and is open to lending their trailer, a grower may be able to avoid purchasing a trailer.
- **Planting Hand Tools** – Depending on the grower's planting technique, they may want a few hand tools such as a planting dibble, spade, and shovel. These tools should cost no more than **$150** combined.

- **Shearing Hand Tools** – Shearing and pruning equipment such as shearing knives, two-handled shearers, hand pruners, and pole (long) shears are important to maintain quality trees. These tools should cost no more than **$200** combined.
- **Basic Hand Tools** – With small and large gear, it is necessary to have basic hand tools such as wrenches, screwdrivers, hammers, handsaws, etc. These tools should cost no more than **$200** combined.
- **Backpack sprayer –** A backpack sprayer is necessary to apply pesticides to Christmas trees. A backpack sprayer will cost around **$200**.
- **Chainsaws** – Every operator will require at least one durable chainsaw. Most operators rely on gas-powered saws, but electric and battery-powered saw are also good options. Depending on the make and model, a chainsaw will cost around **$500**.

3.4.2. Nice-to-haves

The following equipment is not required for starting a small Christmas tree farm but, depending on the growth of the business and the interest of the operator reducing the amount of labour required, the following should be considered:

- **Tractor** – Most Christmas tree growers own a tractor to do many different tasks around the farm. Natural stands with rough roads may need a tractor if a truck is unable to travel with a trailer and/or baler. Tractors come in many different makes, models, and sizes but a used tractor starts at **$20,000** and a new tractor could cost up to **$200,000**.
- **Tree elevator** – For Christmas tree growers that load a lot of large trucks, a Christmas tree elevator may be a worthwhile purchase. Used elevators can start at **$1000**.
- **Tractor-mounted sprayer** – These large sprayers connect by three-point hitch to a tractor and cost **between $500 and $3000**.
- **Shaker** – Christmas trees that are shipped internationally by container ship (to Panama or Asia for example), often require trees to be shaken before loaded onto a container. The cost for a shaker can range **between $1000 and $2000**.
- **All-terrain vehicle (ATV or four-wheeler)** – An ATV is a convenient vehicle to drive through stands quickly. It can access more of the lot than a truck or tractor for activities such as soil sampling, planting, spraying, fertilizing, and shearing. The cost of a new ATV can range **between $5000 and $15,000** while a side-by-side or John Deere Gator can cost between $15,000 - $40,000.
- **Backhoe** – A backhoe attachment to a loader tractor could cost **between $10,000 - $15,000** new depending on the make and model. A backhoe can be very effective for building roads, digging ditches, and removing debris from stands.
- **Mechanical shearing equipment** – Many Christmas tree growers choose to use two-handled shears but there are many electric and gas-powered options available that can increase the efficiency of shearing and reduce the risk for injury. Mechanical shearing equipment can range between **$100 - $500**.
- **Brush cutter** – A brush cutter (or brush saw) is used for clearing brush on natural stands. The cost can range between **$300 - $1000**.

- **Ride-on Lawn Mower –** A ride-on lawn mower is close to a necessity for plantation lots. Since a cover crop is recommended for Christmas trees, it will need to be mowed on a regular basis. A new ride-on lawn mower will cost approximately **$3500**.

All the “nice-to-have” tools are evaluated in the ‘Equipment Payback Period’ section under ‘Opportunities for Improvement’.

3.5. Site Preparation

Administration, buildings, tools, and equipment do not vary significantly between natural stands and plantation lots but for preparing a site they are two completely different approaches. This section separates the two and provides details for each. This section can also be used to evaluate the cost of expansion.

3.5.1. Natural Stand

A natural stand (or wild stand) is a lot where Christmas trees regenerate naturally on their own. Mature trees known as "seed trees" are left standing to provide replacement seedlings for the trees that are harvested. This represents that vast majority of Christmas tree farms in Nova Scotia.

For a new Christmas tree lot, most growers recommend purchasing cutover land (land that has been cleared of trees). Typically, cutover land has at least one main road would have been built for heavy equipment to access the lot for clearing that can be re-used for the Christmas tree lot. The lot should also have some natural regeneration present from previous balsam fir trees.

Preparing Land

The effort and cost of preparing land depends on the state of the lot. Generally, a new site will require approximately 20 hours of work per acre. This is often physically demanding labour removing “slash” (woody material left behind after a timber harvest) from the lot. This will cost approximately **$13,600** ($17/hour * 20 hours/acre * 40 acres). The lot will also need to be sprayed for hardwood the following year.

Building Roads

A well-placed, properly spaced road system is an important factor in ensuring that a natural Christmas tree stand will be profitable. From a return-on-investment perspective, designing and building a road system needs to consider all the activities performed and equipment to be used on the road, in the short and long term.

There are several factors to consider when building a road system:

- **Type of road** – For Christmas tree lots, there are three general categories or roads that all have different options for construction and material. **Main roads** are well-constructed roads that will need to support heavy equipment coming to the lot such as large trucks and tractor trailers. **Main branch roads** can be narrower and use less costly materials than main roads. Their main function is to support farm equipment such as tractors, pick-up trucks, balers, wagons, and

sprayers. **Branch roads** are the least costly roads that are not required for equipment but used less often to access trees for activities such as planting, spraying, fertilizing, shearing, etc.

- **Spacing of road** – The spacing of roads has a direct impact on labour costs and the efficiency of spray equipment. If operators are using tractor-mounted mist blowers for spraying insecticides, they will want to consider the swath width or reach when planning the spacing of roads. A road **spacing of 200ft** is a good target to reduce walking and physical work such as fill planting, fertilizing, and dragging cut trees to the roadside.
- **Road placement** – Straighter roads are easier to navigate large equipment. Intersecting roads and turns need to be designed with large equipment in mind.
- **Environment** – When building a road system in a natural stand, it is important to understand the lot in detail. The ideal road system on paper may not match the natural stand which may contain swamps, boundary lines, hills, and opportunities for more cost-effective road construction.

Road costs can vary greatly depending on the material used, method of construction, and the clearing work required. Estimate $15,000 per kilometre (or $15 per metre) for a main road into and through the lot. For branch roads that do not use gravel, estimate $3000 - $5000 per kilometre (or $3-5 per metre).

The length of roads per acre depends on the road system design, shape of lot, and spacing of roads. If the lot is square and the grower wants to maintain a maximum distance of 100ft between any point of the lot and road, there will need to be approximately 65m of road for every acre. Assuming a ratio of 1m of main road for every 5.5m of branch roads, the average cost for roads is **$425 per acre**.

3.5.2 Even-Aged Management

For even-aged management practices, all trees within a block are approximately the same age and size. It has the same benefits and challenges of a natural stand while it contains similar benefits and efficiency as a plantation site.

Preparing land is more extensive for even-aged management than cultivating a wild stand. All trees are cleared, harvested, culled, or transplanted so a block has trees approximately all the same age and size. The extra effort up front is intended to be balanced by the labour savings from all operational activities with less walking and better spacing between trees.

Transplanting

An activity that is unique to setting up a new site for even-aged management is transplanting trees from one block to another so all trees on any given block are of the same age and size. This activity requires a lot of effort as shown in the calculations below.

Transplanting assumptions:

- There are 8 five-acre natural stand lots to be transplanted
- All 8 five-acre lots have evenly distributed growth
- 7 out of every 8 trees need to be transplanted (87.5%)
- Each of the five-acre lots will end up with its own size of tree

- It takes 60 seconds to properly extract a tree
- It takes 60 seconds to properly replant a tree
- For each tree, it takes 60 seconds to transport the tree from one lot to another (understanding it is done in batches of trees so a batch of ten trees would take ten minutes)
- Spacing of trees that are not cleared or culled is 8ft x 8ft.

The time required to transplant a 40-acre block based on the above assumptions equals:

680 trees per acre * 40 acres * 0.875 trees * 3 minutes effort per tree = **1190 hours** (approximately 30 hours per acre)

The resulting labour cost to transplant a 40-acre block to convert to an even-aged managed lot is:

1190 hours * $17/hour = **$20,230** (approximately $500/acre)

Building roads

The costs for building roads are estimated to be the same as a natural stand, $15 per metre for a main road and $3-5 per metre for a branch road.

3.5.3 Plantation

A plantation is a Christmas tree lot that is not a native balsam fir stand and is cultivated for the sole purpose for growing and harvesting Christmas trees. Old fields are often good sites for Christmas tree plantations due to their smooth surfaces, light brush cover, and an access road likely present.

Planning

Before selecting a site, a plan should be created for the Christmas tree farm. These factors may influence the location, features, and size of the site. Many factors are important for all plantation sites, such as:

- Protection from thieves, fire, insects, and disease
- Environmental conditions such as soil type, degree and aspect of slope, and water drainage
- Road system (main access road and secondary road system)

There are other factors that are farm-specific depending on the grower and business plan.

- **Markets:** How the trees will be sold will influence the type of lot to be purchased. A choose-and-cut operation will need to be accessible with any type of vehicle and have ample parking (ideally near the centre of the lot).
- **Equipment:** If shipping trees long distances with tractor trailers, roads will need to be large enough and in good enough condition to accommodate the trucks. If using tractor-mounted sprayers, road spacing is important.
- **Production volume:** If the costs have been calculated so a certain number of trees need to be sold each year at a specific price, the lot should be large enough to grow that number of trees.
- **Initial investment:** If the farm has a maximum spending amount for the first year of business, certain fields may not be attainable. Understanding the additional investment required outside

of the purchase of the lot (such as all the other costs mentioned in this section) can help determine what lot is right for the grower.

Layout

The most critical factor when determining the plantation layout and spacing is the proposed size of trees at harvest. The smaller the tree, the tighter the spacing can be between trees, and the more trees per acre can be planted. The spacing guide (Table 1) demonstrates that a 4' x 4' spacing can produce 2.2 times more trees than 6' x 6' spacing. Even with 4' x 4' spacing, 50% of the trees can be harvested between four and six feet tall and allow enough space for growing tall trees (8' or higher). The market and customer base for trees should be forecasted to help determine the proposed size of trees.

Table 1 - Christmas Tree Spacing

Spacing in Metres (Feet)	Trees/Acre	Comments
1.2 X 1.2 m (4' X 4')	2720	Will require a market for 1.2-1.8 m (4-6') trees, also loss of sales for a year or two could create overcrowding.
1.5 X 1.5 m (5' X 5')	1740	Produces a 1.8-2.4m (6'-8') tree with narrow taper.
1.8 X 1.8 m (6' X 6')	1210	Great for U-Cuts. Allows buyers to see the tree from all sides. Good for 1.8-3m (6'-10') trees.
2.1 X 2.1 m (7' X 7')	890	Good for growing 2.4-3m (8'-10') trees.
2.4 X 2.4 m (8' X 8')	680	Good for growing tall trees.

The costs for planting are captured in the cost of operations since planting will be required on an annual or bi-annual basis to ensure a consistent, annual harvest.

Preparing site

The condition of the site will determine how much preparation is required. A complete treatment may be required which involves an initial deep plowing then using harrows or disks to break up the sod. If the field is in good condition, a partial treatment of herbicides may be able to replace the amount of plowing required. A soil test costs $30 and requires a soil sample every five acres. It is shown as $50 in the table below to include labour costs to retrieve soil samples.

Most field sites will require a cover crop for healthy Christmas trees. A cover crop has four purposes:

1. To prevent erosion.
2. To prevent excessive drying of the soil.
3. To add organic matter and nutrients to the soil; and
4. To help discourage competing vegetation.[2]

[2] The Christmas Tree Growers' Manual (Atlantic Canada)

The approximate cost for preparing a site that requires a complete treatment and cover crop is $13,800 for a 40-acre site. This includes custom work for deep plowing, herbicide treatment, and planting the cover crop.

The main purpose of drainage is to obtain optimal soil moisture to increase the growing capacity of the soil. Improved drainage on land that is wet provides a better rooting environment through increased aeration. It will also improve the ability for equipment to travel on the site.[3]

Many fields must consider surface and subsurface drainage. The most common method for surface drainage is open ditches. The cost for drainage will vary based on the drainage requirements, soil type, size of ditching (depth, width, and length), equipment used, and other factors. For this report, a cost of $19,850 is used to plan and construct a drainage system for a 40-acre field ($150/hour for an 8-tonne excavator, 1000 metres of ditching, at a speed of 25 metres/hour).

$$\$150/\text{hr} * \frac{1000\ metres}{25\ \text{metres/hour}} = \$6000$$

Table 2 - Cost associated with treatment in a 40-acre site

Preparation	Cost per Acre	Cost for 40 Acres
Soil Test	N/A	$50
Cover Crop Seeds (Fall Rye)	$250	$10,000
Cover Crop Custom Planting	$30	$1,200
Custom Plowing	$30	$1,200
Custom Herbicide Treatment	$35	$1,400
Drainage System	$150	$6,000
Total Costs	**$495**	**$19,850**

3.6. Investment Summary

The following costs of establishment assume a 40-acre farm and no financing required. They are separated into two tables: startup costs (year 0) and activities and purchases that can wait after the first year. The cost of a storage shed was left off the investment summary since most equipment can either be stored in an existing basement, garage, or be kept outdoors.

Table 3 – Startup costs for 40-acre site

	Natural Stand	Even-Aged Management	Plantation
Land			
40 acres	$20,000.00	$20,000.00	$60,000.00
Total Land Costs	**$20,000.00**	**$20,000.00**	**$60,000.00**
Administration			
Owner activities	$1,703.00	$1,703.00	$1,703.00

[3] The Christmas Tree Growers' Manual (Atlantic Canada)

Lawyer (business registration)	$2,000.00	$2,000.00	$2,000.00
Bookkeeping	$2,000.00	$2,000.00	$2,000.00
Accountant	$2,000.00	$2,000.00	$2,000.00
Total Administration Startup Costs	**$7,703.00**	**$7,703.00**	**$7,703.00**
Tools and Equipment			
Pickup Truck	$25,000.00	$25,000.00	$25,000.00
Ride-on Lawn Mower	-	-	$3,500.00
Planting Hand tools	$100.00	$100.00	$100.00
Shearing Hand tools	$200.00	$200.00	$200.00
Basic Hand tools	$200.00	$200.00	$200.00
Backpack sprayer	$200.00	$200.00	$200.00
PPE Allowance	$500.00	$500.00	$500.00
Chainsaws	$500.00	$500.00	$500.00
Total Tools and Equipment Startup Costs	**$26,700.00**	**$26,700.00**	**$30,200.00**
Site Preparation			
Preparing Land	$13,600.00	$13,600.00	$19,850.00
Transplanting	-	$20,230.00	-
Total Site Preparation Costs	**$13,600.00**	**$33,830.00**	**$19,850.00**
Total Startup Costs	**$68,003.00**	**$88,233.00**	**$117,753.00**

The only cost differences between establishing a natural stand, even-aged natural stand, and a plantation are the costs of land and site preparation.

It is important to note that there are some fixed costs that do not need to be purchased in the first year. A baler and trailer are likely only required when harvesting begins, which may not be for at least five years depending on the site. Similarly, all roads do not need to be constructed in the first year and can likely be spread out over many years until harvesting is required. It is assumed a main road has already been constructed to clear the land which is all that is needed for the first few years.

Table 4 - Delayed purchases and activity for 40-acre site

	Natural Stand	Even-Aged Management	Plantation
Building Roads	$17,000.00	$17,000.00	$0.00
Baler	$3,000.00	$3,000.00	$3,000.00
Trailer	$3,000.00	$3,000.00	$3,000.00
Total Delayed Purchases and Activity Costs	**$23,000.00**	**$23,000.00**	**$6,000.00**
+ Total Startup Costs	$68,003.00	$88,233.00	$117,753.00
Total Establishment Costs	**$91,003.00**	**$111,233.00**	**$123,753.00**

4. Variable Costs per Unit

The largest and most critical component of variable costs is the cost of labour. It is important to note that the description is a snapshot for a current year and does not include capital costs (such as building roads) or extra costs due to extreme environmental effects, such as a late frost or infestation.

See Appendix C – Cost of Production Calculations for detailed calculations, assumptions, and options for each activity.

4.1. Cost per Activity

A Christmas tree farm will require the following activities to be performed on an annual basis. Some activities only happen once per tree in its lifetime (e.g., planting, butt pruning, grading, and harvesting) while other activities will happen many times to a tree (e.g., fertilizing and shearing).

4.1.1. Lot Management

Lot management incorporates all "work farming" activities such as thinning, brush cutting, culling, and review of tree lots. Thinning is an important management practice to drive quality in natural stands. The main reason for thinning is to create conditions that allow for full and unimpeded tree development and to promote the regeneration of succeeding crops. Thinning assures adequate growing space for each tree and enhances the development of uniform, symmetrical crowns with high-quality foliage. Balsam fir can only produce abundant foliage in full sun; therefore, thinning is important in the production of quality.

The most effective and cost-efficient option seems to be the pair of a power brush cutter and ratcheting hand snips. They are extremely efficient at clearing small trees and they take out competing growth as the same time. The physical demand is also lower compared to other options. Depending on the size of the tree, more time will be required to limb and junk a tree using ratcheting hand snips.

Depending on the tools, on average, it will take 20-40 seconds to cut a stump, limb, and junk a tree, costing about 4-7 cents per tree sold. This work is done about every other year.

4.1.2. Fill Planting (Natural Stand)

Many growers will choose to interplant to increase their stock density and future harvest. Relying solely on seed trees for seedlings can be risky and can decrease density. When fill planting, the focus should be on effective planting for the highest chance of survival, not planting trees as fast as possible.

There are many different options for fill planting including different varieties of seedlings, transplants, container stock, and wildings, with different tools that can be used for each. Wildlings are free but take the most time to plant. Seedlings are the most expensive at but are quick to plant, especially when using a dibble.

Depending on the method, it will take 20 seconds to 3 minutes to plant a tree, costing between 63-85 cents per tree.

4.1.3. Planting (Natural Stand Even-Aged Management)

The methods for planting an even-aged management natural stand are like fill planting, except the distance between trees is much smaller.

Depending on the method, it will take 20 seconds to 3 minutes to plant a tree, costing between 61-85 cents per tree.

4.1.4. Planting (Plantation)

There are two basic designs for planting a plantation: checkerboard and row planting. The choice depends on what equipment is available to the operator and how precise they wish to be in their spacing.

Depending on the method, it will take 10 to 25 seconds to plant a tree, costing between 65-75 cents per tree.

4.1.5. Spraying

Pesticides are used to manage weeds, insects, and disease. It can be applied multiple times a year, once every few years, or not at all.

There are four main options for spraying: backpack hydraulic sprayer, backpack mist blower, tractor-mounted sprayer, and tractor-mounted mist blower.

Using a tractor will cost less than one cent per tree to spray while manual using a backpack hydraulic sprayer will cost about 15 cents per tree and a backpack mist blower will cost about 10 cents per tree.

4.1.6. Fertilizing

Fertilizing Christmas tree soil helps increase overall Christmas tree productivity. There are two main ways to apply fertilizer: dripline application and field application. If a grower using plantation style with irrigation, they can also apply fertilizer through the drip line irrigation.

Dripline application involves managing nutrients on a per tree basis and applying fertilizers around the dripline of individual trees. Fertilizing around the drip line allows for more efficient use of product, however it requires individual tree evaluation which is challenging to do accurately.

Field application is to apply and manage nutrients across the entire field. This method will improve soil fertility of the entire site over time, which will show benefits such as improved germination and growth for decades.

Dripline application costs approximately $0.10 per tree while field application costs approximately $0.02 per tree.

4.1.7. Shearing

Shearing is a proven way of increasing the quality and quantity of Christmas trees in balsam fir stands. It controls tree form and promotes foliage density, the most important characteristic determining tree grade and value. Many injuries and growth abnormalities can be treated by appropriate shearing

practices, which prevent serious deformities and tree loss. Proficiency increases with experience and practice.

Shearing costs between 11 cents and 20 cents a tree for every time it is sheared. Most trees will be sheared for six years before being sold, costing between $0.66 and $1.20 for the life of the tree. Mechanical shearing is the least expensive, because it is the quickest, while two-handled shearing is the most expensive.

4.1.8. Butt Pruning

Butt pruning to establish a “handle” and a strong bottom whorl are usually combined with the first shearing. The removal of branches near the ground may reduce the incidence of foliage diseases such as needle casts by improving the air circulation with the tree lot.

Shearing for symmetry and taper, whether in wild stands or plantations, is easier when the bottom branches of the Christmas tree have first been determined and the stem butt has been pruned. The exact amount of pruning necessary for a well-formed tree is easier to determine while the tree is standing. Also, pruning assures a more accurate inventory of saleable trees and greatly speeds up the harvesting operation.

Between 36 and 45 seconds per tree which equates to $0.26 and $0.31 per tree.

4.1.9. Grading

Most grading systems for balsam fir are based on two key factors: density and symmetry. Density refers to the abundance of needles and is influenced largely by the number of branches. This is sometimes described in terms of amount of stem coverage. Most trees require shearing to produce heavy foliage. Classifications of density are usually heavy, medium, or light. Symmetry is a measure of the evenness, taper, and balance of the tree.

Grading a tree on the stump is the method most growers use to document the inventory of trees to be sold for the year. Most operators use a different colour or patterned ribbon to indicate the grade/height combination.

Proper grading on the stump will take approximately a minute. If grading is done as its own activity, it will cost approximately $0.40 a tree. If grading his done while shearing, the cost of walking between trees does not need to be accounted for twice and the cost can decrease to approximately $0.30 per tree.

Some growers that do not need to keep track of inventory, such as those that are selling trees to a Co-operative, can cut trees and bring them to the yard for someone to grade. When grading cut trees in a yard, efficiency can be increased.

4.1.10. Harvesting

There are many different activities that make up harvesting. For costing purposes, it is easiest to group the following activities together:

- Cutting and dragging
- Baling, hauling, and storing
- Loading

Cutting and Dragging

Cutting trees is the "pacemaker" for the entire harvesting operation. Trees can only be baled at the rate they are cut. Usually, a cutter's sole job is to walk through the lot and cut down every tree that is planned to be harvested. Most trees that are ready to be cut are flagged, often based on height and grade. Once cut, "draggers" will take the cut tree, drag it to the nearest road, and position it so it's ready to be baled (stump pointing towards the road).

Some operations choose to cut all their trees at once, no matter what grade the tree is. Other operations will cut based on the order they need to fill and will pass over flagged trees to get them another day. Both methods have their pros and cons in terms of quality, sales, and cost efficiencies.

Option 1: Cut to Order

Cutting trees based on coloured flags makes it easier to sort trees in the yard, but every lot needs to be walked through more than once. This cost approximately $0.30 a tree to cut and $0.30 to drag for a total of $0.60 a tree.

Option 2: Cut all tagged trees

The other option is to cut all tagged trees and sort by size and/or order in the yard. This method saves on walking through lots more than once and costs approximately $0.21 a tree to cut and $0.22 to drag for a total of $0.43.

Baling, hauling, and storing

Baling is one of the most important operations on a Christmas tree farm since, unlike other activities, it requires a small team of at least three to manage, but also it needs to be managed during a small window of time. Between increased labour and a smaller season, harvest time is known in the industry to be the busiest and most hectic time year-round. That is why it is crucial to be able to complete these activities efficiently and effectively to increase revenue and decrease costs.

Option 1: Three-person baling crew with one hauler

With efficient spacing and trees small enough for one person to handle, a baling crew of three people seems to be the most effective with the least amount of idle time. The first person carries the trees from roadside to the baler, the second person operates the baler, and the third person unloads the baled tree and places it roadside. This process allows the baler to be baling trees with the shortest amount of waiting time between trees as possible.

The cost for this option works out to approximately $0.84 a tree.

Option 2: Four-person crew with the baler attached to a wagon/truck

Some operations pair hauling and baling activities together to limit the double-handling and traveling of equipment. The roles might look something like this:

- Baler loader
- Baler operator
- Baler unloader
- Wagon/flatbed loader

For this to work, the grower needs a truck and large flatbed with the ability to haul a baler behind and a solid road system to allow for large (and long) equipment to navigate. The challenge to this approach is balancing the work so employees are not idle but are also doing value-add work. For example, the wagon loader must wait for trees to come of the baler before loading the wagon. The other consideration is the entire crew needs to unload the wagon, so the baler is not running for long stretches of time.

The cost for this option works out to approximately $0.86 a tree.

Option 3: Baling in the yard

A third option for baling is to bale after the trees are hauled from the lot and into the storage area. There is a big advantage of the baler being able to run non-stop – it does not need to be transported between trees, instead the trees are transported to the balers. However, hauling trees that are not baled take up a lot more space on a wagon and can potentially harm the tree with extra dragging and transportation.

The cost for this option works out to approximately $0.71 a tree.

Loading

Once the trees are baled and organized in the yard, they need to be loaded onto trucks to be shipped to retail lots. There are many different methods to organize a crew and load a truck, so the options below focus on using equipment to improve the loading efficiency.

Option 1: Loading by hand

This option assumes there is no technology involved and only a crew of five that are carrying and loading trees. The cost for this option works out to approximately $0.24 a tree.

Option 2: Loading with elevator

This option calculates the labour cost when an elevator is used to carry trees from the loading area onto the truck. It assumes that a crew of three employees can load just as fast as a crew of five that don't have an elevator. The cost for this option works out to approximately $0.14 a tree.

Option 3: Loading with a truck and grapple

This option calculates the labour cost when a truck with a grapple is used to carry trees from the loading area onto the truck. It assumes that two employees (one to position trees and one to operate the grapple) can load just as fast as the first two options. The cost for this option works out to approximately $0.09 a tree.

4.2. Effort per Tree

Table 2 can be read top to bottom then left to right. It shows the amount of labour required for to plant, grow, harvest, and ship one Christmas tree. You can think of this from the tree's perspective – how much work is required by people to get the tree from seed to sale. **This effort does not include walking, preparing equipment, supplies, or materials, travelling to the lot, or any other activity not done at/on the tree.**

Table 5 - Direct Effort Required per Tree (in minutes, rounded to the nearest quarter minute)

Activity	Year											Total
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Planting	0.25											**0.25**
Spraying			0.25			0.25			0.25			**0.75**
Fertilizing					0.2	0.2	0.2	0.2	0.2	0.2	0.2	**1.4**
Shearing					0.5	0.5	0.5	0.5	0.5	0.5	0.5	**3.5**
Thinning			0.25									**0.25**
Butt Pruning						0.75						**0.75**
Grading											0.5	**0.5**
Cutting											0.25	**0.25**
Dragging											0.25	**0.25**
Baling											1.5	**1.5**
Storing											0.5	**0.5**
Loading											1	**1**
Total	**0.25**	**0**	**0.5**	**0**	**0.7**	**1.7**	**0.7**	**0.7**	**0.95**	**0.7**	**4.7**	**10.9**

In total, just over 10 minutes of labour is required per tree from planting to shipping (loading). In "Lean" terms, this is known as value-added time since the product (Christmas tree) is being positively altered by these activities.

If more than one person is required to complete the activity, such as baling, the time to complete the activity is multiplied by the number of people needed. For example, if it takes 30 seconds for three people to bale a tree, it is 1.5 minutes of effort.

Some activities are required for every tree, every year, but other activities only happen once in a tree's lifetime (or not at all, depending on the lot and attributes of the tree). Appendix C – Cost of Production Calculations explains the percentage of trees that may require that activity to get to a total labour and material cost.

4.3. Cost per Tree

This section demonstrates the variability in costs depending on the size of the farm, spacing of trees, and the different methods for growing. Each activity below has a cost range. The low end of the range represents the most automated methods with additional equipment and technology while the high end of the range represents farms that use simpler methods.

In general, even-aged management is less expensive than natural stand because less walking is required. For example, only lots that are ready to be graded need to be walked for even-aged management, where all lots for natural stands require to be walked. Plantations is even more efficient because there is no natural regeneration to consider, and lots are flat and easy to walk through.

The overhead cost percentage captures the variable costs that are not directly captured in the activity breakdown such as travelling to and from the lots.

It is important to note that these costs apply to every tree that is grown, not for every tree that is sold. There are many trees that are culled throughout this process and other trees that are cut but do not end up being sold. These losses need to be captured and made up by the trees that are sold and will artificially increase the cost per tree sold if using financial accounting methods.

		Total Cost per Tree by Type of Farm		
Activity	Years Performed	Natural Stand	Even-Aged Management	Plantation
Lot Management	4	$0.16 - $0.28	$0.16 - $0.28	N/A
Fill Planting	1	$0.63 - $0.85	N/A	N/A
Planting	1	N/A	$0.61 - $0.85	$0.65 - $0.75
Spraying	3	$0.03 - $0.45	$0.03 - $0.45	$0.03 - $0.45
Fertilizing[4]	5	$0.40 - $0.50	$0.36 - $0.45	$0.27 - $0.40
Shearing[5]	6	$0.66 - $1.20	$0.59 - $1.08	$0.53 - $0.96
Butt Pruning[6]	1	$0.26 - $0.31	$0.21 - $0.25	$0.18 - $0.22
Grading[7]	1	$0.20 - $0.40	$0.16 - $0.32	$0.14 - $0.28
Cutting/Dragging	1	$0.43 - $0.60	$0.26	$0.26
Baling/Hauling	1	$0.71 - $0.86	$0.71 - $0.86	$0.71 - $0.86
Loading	1	$0.09 - $0.24	$0.09 - $0.24	$0.09 - $0.24
Mowing	8	N/A	N/A	$0.81
Cost per Tree		$3.57 - $5.69	$3.18 - $5.04	$3.67 – $5.23
Overhead Costs (20%)		$0.71 - $1.14	$0.64 - $1.01	$0.76 - $1.09
Total Cost per Tree		**$4.28 - $6.83**	**$3.82 - $6.05**	**$4.40 - $6.28**

[4] Even-aged management is 10% more cost-effective and plantation is 20% more cost-effective than natural stands
[5] Even-aged management is 10% more cost-effective and plantation is 20% more cost-effective than natural stands
[6] Even-aged management is 20% more cost-effective and plantation is 30% more cost-effective than natural stands
[7] Even-aged management is 20% more cost-effective and plantation is 30% more cost-effective than natural stands

5. Sales Price per Unit

This section will look deeper into the factors that increase and/or decrease revenue. Each factor will be labelled as:

- **Uncontrollable** – These factors are out of the growers' control. They can often be planned against and/or mitigated but cannot be managed beyond that (e.g., weather).
- **Influenceable** – These factors cannot be directly controlled but often they can be managed with proactive planning and action (e.g., pests).
- **Controllable** – These factors are in direct control of the grower and should be leveraged, when appropriate, to increase the returns of a Christmas tree lot (e.g., spacing).

5.1. Production

Production is simply the number of trees harvested and sold. This factor sometimes competes with height and price and needs to be balanced accordingly. The smaller the tree, the less time is required for growing, and the area can be used to grow another tree and potentially double production. Quality and quantity often compete when time is involved. A tree can be sheared and left in the ground for another year in hopes it jumps a grade but that also lowers the production number for that year.

While there are too many factors to list for what drives production, here are some of the most critical factors:

- **Spacing** *(controllable by thinning and interplanting)* – too much space means less production per acre. Not enough space means the trees cannot grow adequately and will not make the grade to be harvested.
- **Time** *(controllable by grading and harvesting)* – The less time the tree is in the ground, the greater the production per year considering the same amount of spacing and acreage. A lot that harvests trees after six years of growth compared to nine years of growth will produce 50% more trees in the long run.
- **Acreage** *(controllable by expanding)* – The most straight forward method to increasing production is to increase acreage while maintaining density. This can be done by converting existing land to Christmas tree lots or purchasing more land.
- **Quality** *(a mix of uncontrollable, influenceable, and controllable)* – While there is a mix of quality for harvested trees that can be sold, there can be trees that are of lower quality that cannot be sold. These trees can exist for many reasons such as weather (late frost), pests, and lack of management.

5.2. Height

- **Time** *(controllable by grading and harvesting)* – The more time the tree is in the ground, the taller it will grow.
- **Soil conditions** *(influenceable by site selection, fertilizer, and cover crops)* – The better the soil, the quicker the Christmas tree will grow.

- **Genetics** *(influenceable by seed trees and interplanting)*
    - **Seed Trees** – By selecting trees with superior characteristics to be seed trees, the grower can help ensure that future trees in the lot will have better branch angle, more buds, better needle retention, and later bud break in the spring. Superior seed trees help to ensure superior future crop trees by passing on their genes or traits to the next generation. Once a tree is growing, we can only maximize the characteristics it has inherited.
    - **Interplanting** – The genetic quality of a seedling is a strong indicator of the potential for that Christmas tree.

5.3. Grade

Most grading systems for balsam fir are based on two key factors: density and symmetry. Density refers to the abundance of needles and is influenced largely by the number of branches. This is sometimes described in terms of amount of stem coverage. Most trees require shearing to produce heavy foliage. Trees with the heaviest density receive four or five shearings. Classifications of density are usually heavy, medium, or light. Symmetry is a measure of the evenness, taper, and balance of the tree.

- **Density and Symmetry** *(influenceable by shearing and genetics)* – The more shearings that a Christmas tree gets over its lifetime, the better the density and quality (i.e., fewer defects). The final shearing of a Christmas tree is focused on getting the best symmetry.

 USDA Premium	 USDA Number 1	 USDA Number 2
Characteristics typical of the species		
Butt trimmed; except for trees graded "on the stump"		
Normal taper		
Fresh		
Clean	Fairly clean	
Healthy		
Well shaped		
Not less than **heavy density**	Not less than **medium density**	Not less than **light density**
Handle length not less than 6 ", or more than 1–1/2" for each foot of tree length (unless graded "on the stump")		
3 faces; **1 minor defect**	3 faces; **2 minor defects**	
Remaining face may not have more than 1 noticeable defect		

Figure 1 - Christmas tree grade descriptions

5.4. Price

Production, height, and grade are all factors of operations and production – ensuring you plant the right trees, grow the trees effectively, and harvest at the right time in the right way – there is still one major factor contributing to revenue: price. A grower can produce the most pristine Christmas trees, but if there is no market for them and the price per tree is not greater than the cost to grow that tree, it is impossible to make a profit.

Price per tree should be maximized to collect as much revenue as possible while still selling all trees and reducing the costs to sell that tree. There are several different options to sell that will affect the price. The best choice will depend on the size of the operation, the setup of the lot, and the skills/attitude of the grower (e.g., risk tolerance, interest in sales/marketing, connections in the industry).

- **Broker/Exporter** – This method includes working with one (or several) parties to manage sales and relationships with retail outlets. This is the simplest option that removes the effort involved with negotiating, communicating, and managing client relationships. It also guarantees sales as they (and/or their customers) must manage the risk of not selling all the trees. The downside is the broker/exporter will take a cut to manage the additional effort and risk, decreasing your revenue per tree.
- **Retail Outlets** – A grower may choose to work directly with retailers to buy a portion or all the grower's trees. In this relationship, the grower often handles all aspects of grading, baling, and shipping. This can be one of the most lucrative ways to sell but is also one of the most dangerous if the grower is not careful about collecting money or about who they are dealing with.
- **End Consumers (Retail lot)** – Some Christmas tree growers find they enjoy the challenge of direct retailing either in a nearby town or a distant city. Although the amount of money received for each tree sold may be greater than in any other way of selling, the risk is also a lot higher. It is of critical importance to know the market area before setting up a retail lot. For example, you must know how much people are willing to pay for trees in the area, what sizes are most suitable for the housing conditions, what species of trees sell best, when the buying season begins, how many trees you can reasonably expect to sell, how much competition there is, and so on. You must also consider the substantial overhead such as wages, lighting, and advertising.
- **Choose and Cut** – For a choose and cut operation, customers come to the lot and cut their own tree. It is becoming more popular every year and can be a means for a grower to make revenues like retail lots at a fraction of the cost (no harvesting or retail lot setup required). For a choose and cut operation, be sure to account for the time to supervise customers, cost of appropriate insurance coverage, and all the other amenities that could be expected from a choose a cut operation (e.g., sleigh rides, hot chocolate, entertainment, parking, etc.).

Growers can choose to sell using one of the above methods or a combination of any/all four. Diversifying income streams is likely the best way to reduce risk, but it may be at the expense of maximizing profit.

6. Costs and Returns

In the introduction, returns were introduced as a function of costs (fixed and variable) and revenue (a function of production, height, grade, and price).

6.1. Cost Accounting Assumptions

Due to the vast number of variabilities that can affect costs and revenue, this subsection makes the following assumptions to reduce the number of variables for the different types of Christmas tree farms:

- Returns are based on the number of trees sold. Some factors that differentiate the production, height, grade, and price of trees are set as variables to show the difference in costs and returns, while others are held as constants (even though they vary between farms).
- Risk for disease, pests and extreme weather events are treated the same for all types and sizes of lots.
- Quality of tree is the same for all types and sizes of lots.
- Plantation and natural stands are assumed to grow a marketable tree at the same rate.
- Unique characteristics for each farm type are explained in each section.

6.2. Sensitivity Analysis

A sensitivity analysis is a model that determines how a target variable is affected based on changes in input variables. For this analysis, the target variable is profit with the following input variables:

- Spacing
- Cost per tree
- Grade (premium, #1, #2)
- Height
- Harvest Percentage
- Sales price per tree
- Market Mix (wholesaler, retail outlet, end consumer)
- Size of Farm
- Fixed Costs

This method is used to demonstrate the variation in profits based on many different factors relevant to growers in the province. As this analysis will show, some factors are much more important than others for profit. It is important to note, this sensitivity analysis only changes what factor at a time, even if two factors are correlated.

For example, if spacing is reduced, so there are twice as many trees growing on the same acreage, fixed costs will need to increase to accommodate for the extra equipment needed to grow and harvest the trees. This analysis does not try to estimate the correlation between factors and instead shows the impact of each factor alone.

6.2.1. Baseline

For a sensitivity analysis to work, baseline values need to be set. This analysis uses the following baseline values to determine the inputs impact on profit:

- Size of farm: **40 acres**
- Spacing: **6ft x 6ft**
- Percent of trees harvested: **12%**
- Trees harvested: **5808**
- Harvested trees sold: **100%**
- Cost per tree: **$5.00**
- Market mix: **Wholesaler = 100%**; **retail outlet = 0%; end consumer = 0%**
- Fixed costs: **$50,000**
- Quality and height mix: **See table 3**
- Sales price per tree: **See table 4**

Table 6 - Quality and Height Baseline Mix

Grade	Height	Baseline Mix
Premium	6'	40%
#1	6'	10%
#2	6'	10%
Premium	7’	10%
#1	7’	10%
#2	7’	0%
Premium	8’	10%
#1	8’	10%
#2	8’	0%

Table 7 - Sale price per tree

Market	Grade	Height	Sale Price
Wholesaler	Premium	6'	$20
	#1	6'	$18
	#2	6'	$16
	Premium	7’	$22
	#1	7’	$20
	#2	7’	$18
	Premium	8’	$24
	#1	8’	$22
	#2	8’	$20

Retail Outlets	Premium	6'	$24
	#1	6'	$22
	#2	6'	$20
	Premium	7’	$26
	#1	7’	$24
	#2	7’	$22
	Premium	8’	$28
	#1	8’	$26
	#2	8’	$24
End Consumer	Premium	6'	$30
	#1	6'	$30
	#2	6'	$25
	Premium	7’	$35
	#1	7’	$35
	#2	7’	$30
	Premium	8’	$40
	#1	8’	$40
	#2	8’	$35

6.2.1. Spacing

- **4’ x 4’ (2723 trees per acre):** This is target spacing if a portion of the lot will be used for tabletop or smaller trees.
- **5’ x 5’ (1742 trees per acre)**
- **6’ x 6’ (1210 trees per acre):** This is the target spacing for most growers to have a full lot of marketable 7’ trees without trees impeding on other trees.
- **7’ x 7’ (889 trees per acre)**
- **8’ x 8’ (681 trees per acre)**
- **9’ x 9’ (538 trees per acre)**
- **10’ x 10’ (436 trees per acre):** This is not the ideal spacing but some growers in natural stands that have not been interplanting every year may be faced with.

Table 8 - Tree spacing versus profit analysis

Spacing	4’x4’	5’x5’	6’x6’	7’x7’	8’x8’	9’x9’	10’x10’
Ft^2/tree	16	25	**36**	49	64	81	100
Trees/acre	2723	1742	**1210**	889	681	538	436
Total trees	108920	69680	**48400**	35560	27240	21520	17440
Trees harvested	13070	8362	**5808**	4267	3269	2582	2093
Total profit	$148,664.00	$77,102.40	**$38,281.60**	$14,858.40	-$311.20	-$10,753.60	-$18,186.40

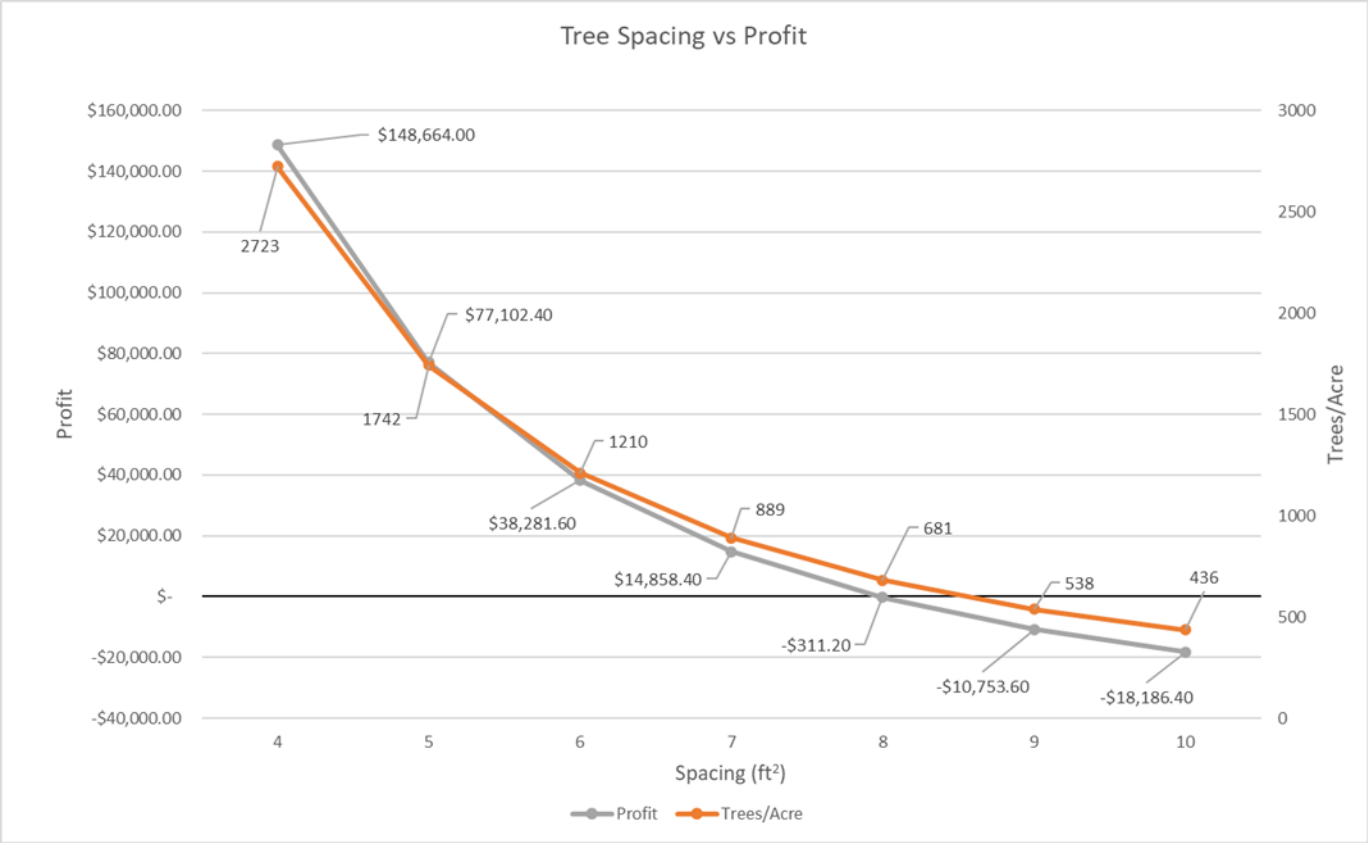


Figure 2 - Tree spacing versus profit analysis (chart)

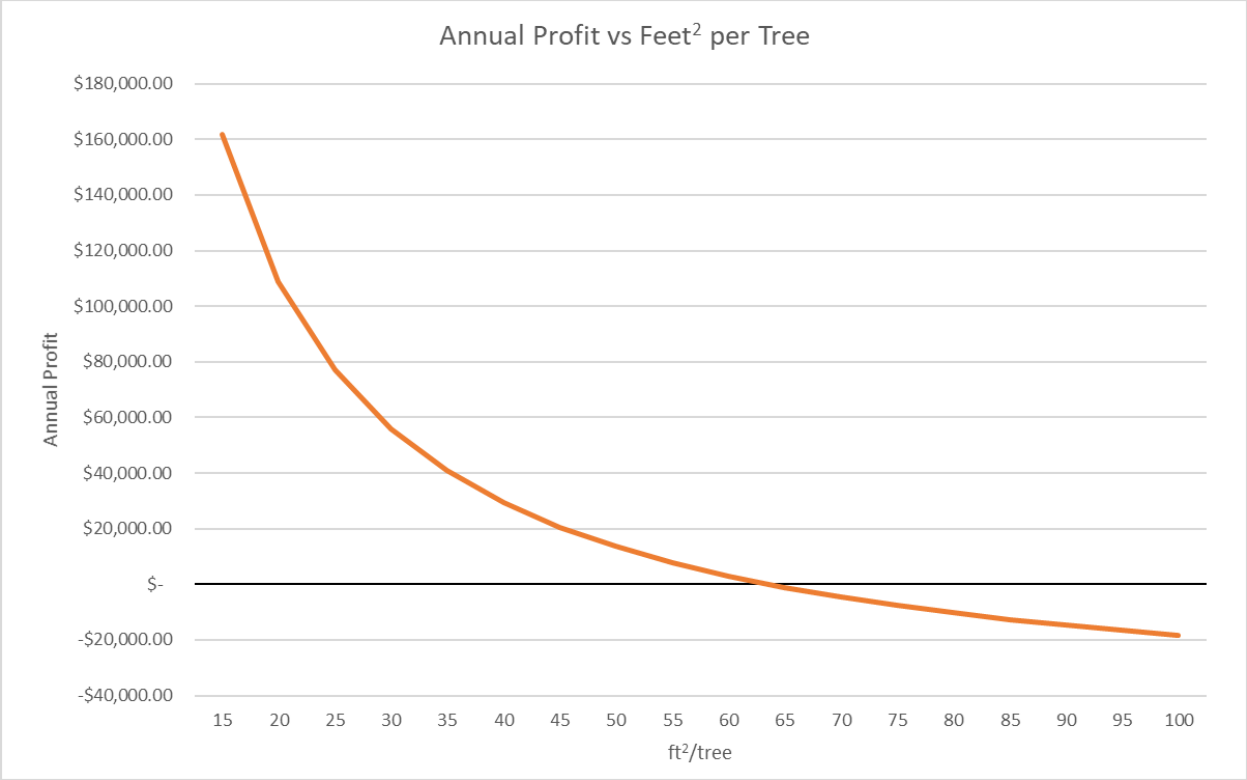


Figure 3 - Annual profit versus square feet per tree (chart)

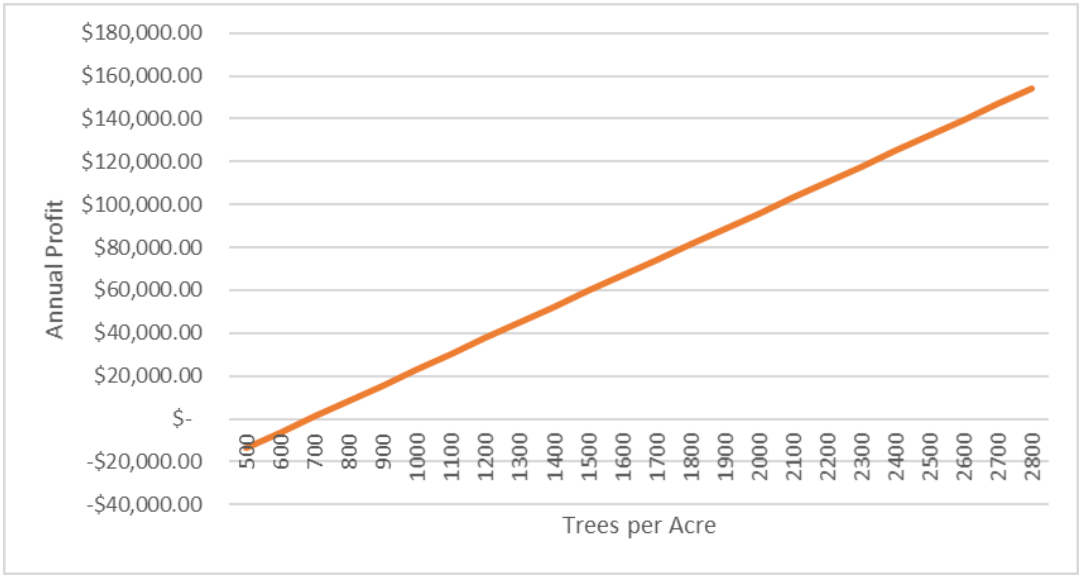


Figure 4 - Annual profit vs. trees per acre (chart)

Considering the baseline data, every **additional tree per acre** will **add $72.96 in profit** every year. An **extra 100 trees per acre** will **add $7296 in profit** every year.

If fixed costs and operating costs stay the same, for every extra tree planted and harvested, an extra $1.82 per tree can be added to the bottom line.

6.2.2. Costs

The following costs are used based on the range presented in the cost of operations section. It is possible that costs could exist outside the range of $4.00 - $6.00 per tree but this should represent that majority of farms in Nova Scotia.

Farms that effectively use more automation and equipment likely have lower costs per tree while farms that have high labour costs and less effective labour would see higher costs per tree.

Table 9 – Cost per tree effects on annual profit

Cost per tree (%)	-20%	-10%	Baseline	+10%	+20%
Cost per Tree	$4.00	$4.50	**$5.00**	$5.50	$6.00
Profit	$44,089.60	$41,185.60	**$38,281.60**	$35,377.60	$32,473.60

Figure 5 - Cost per tree effects on annual profit (chart)

Considering the baseline data, every **$0.10 saved per tree** (in labour, seed, or material costs), will **add $580.80 in profit** every year.

6.2.3. Grade

- **10% increase in height:** 10% of #2s become #1s; 10% of #1s become premium
- **20% increase in height:** 20% of #2s become #1s; 20% of #1s become premium
- **30% increase in height:** 30% of #2s become #1s; 30% of #1s become premium
- **40% increase in grade:** 40% of #2s become #1s; 40% of #1s become premium

Table 10 - Profit increase by increasing grade

Grade Increase	0% (Baseline)	10%	20%	30%	40%
Premium	60%	63%	66%	69%	72%
#1	30%	28%	26%	24%	22%
#2	10%	9%	8%	7%	6%
Profit	$38,281.60	$38,746.24	$39,210.88	$39,675.52	$40,140.16

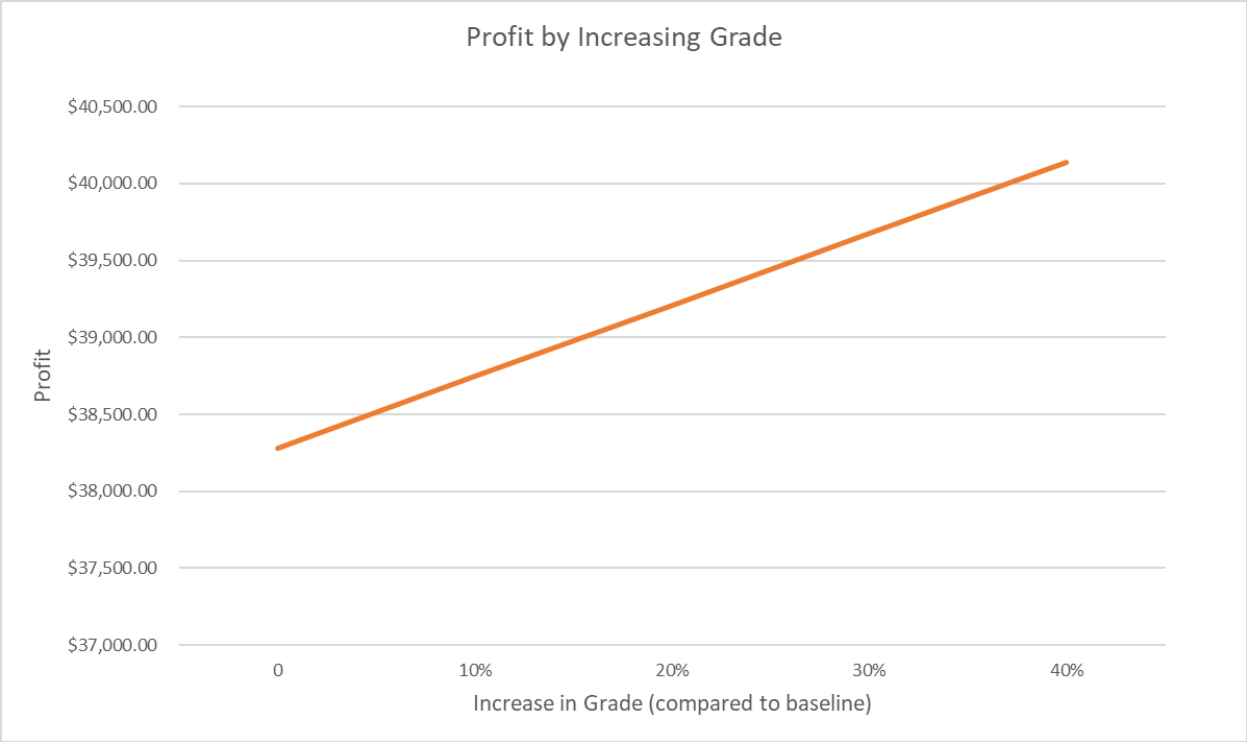


Figure 6 - Profit increase by increasing grade (chart)

6.2.4. Height

- **0% increase in height:** Baseline data (60% 6ft trees; 20% 7ft trees, 20% 8ft trees)
- **10% increase in height:** 10% of 6ft trees become 7ft trees; 10% of 7ft trees become 8ft trees
- **20% increase in height:** 20% of 6ft trees become 7ft trees; 20% of 7ft trees become 8ft trees
- **30% increase in height:** 30% of 6ft trees become 7ft trees; 30% of 7ft trees become 8ft trees
- **40% increase in height:** 40% of 6ft trees become 7ft trees; 40% of 7ft trees become 8ft trees

Table 11 - Profit increase by increasing height

Height increase	0% (Baseline)	10%	20%	30%	40%
6ft trees	60%	54%	48%	42%	36%

7ft trees	20%	20%	20%	20%	20%
8ft trees	20%	26%	32%	38%	44%
Profit	$38,281.60	$39,675.52	$41,069.44	$42,463.36	$43,857.28

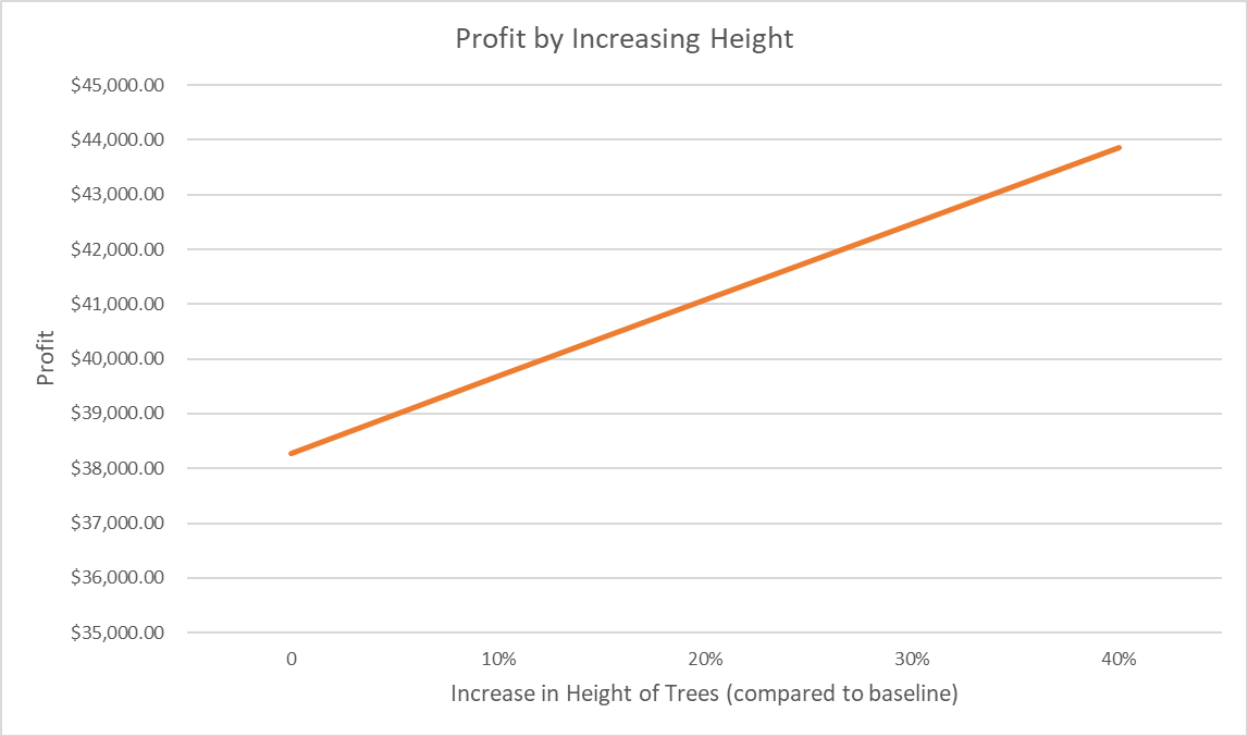


Figure 7 - Profit increase by increasing height (chart)

6.2.5. Harvested and Sold

- **High:** Assumes 16% of all trees are cut and sold
- **Moderately High:** Assumes 14% of all trees are cut and sold
- **Normal:** Assumes 12% of all trees are cut and sold
- **Moderately Low:** Assumes 10% of all trees are cut and sold
- **Low:** Assumes 8% of all trees are cut and sold

Table 12 - Percentage of trees harvested versus annual profit

Percentage harvested	8%	10%	12% (baseline)	14%	16%
Trees Harvested	3872	4840	5808	6776	7744
Profit	$8,854.40	$23,568.00	$38,281.60	$52,995.20	$67,708.80

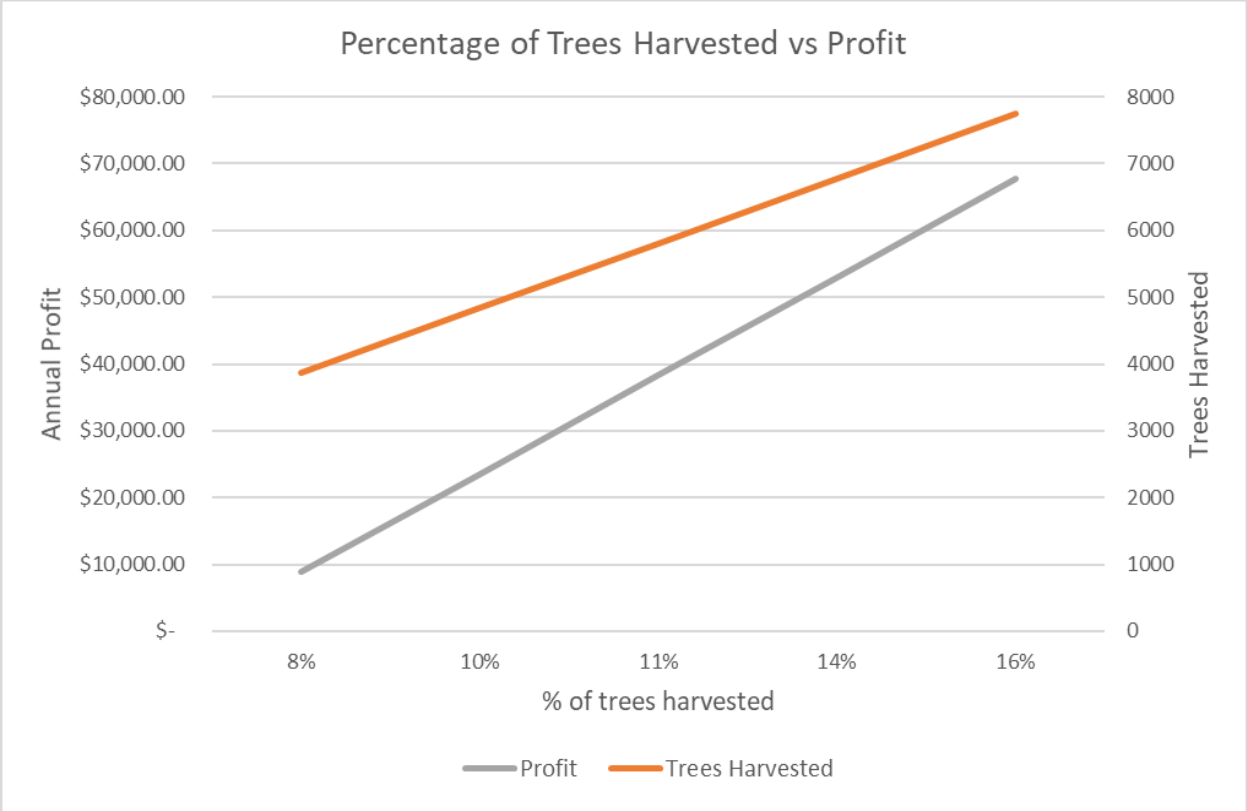


Figure 8 - Percentage of trees harvested versus annual profit (chart)

Considering the baseline data, every **additional percentage of trees harvested**, will **add $7,356.80 in profit** every year.

6.2.6. Sales price per tree

- **40%:** All sales prices increase by 40%
- **30%:** All sales prices increase by 30%
- **20%:** All sales prices increase by 20%
- **10%:** All sales prices increase by 10%
- **0:** All sales prices remain the same as the baseline

Table 13 - Sales price increase vs. annual profit

Sales Price Increase	0	10%	20%	30%	40%
Avg. Revenue per tree	$20.20	$22.22	$24.24	$26.26	$28.28
Profit	$38,281.60	$50,013.76	$61,745.92	$73,478.08	$85,210.24

Table 14 - Sales price based on market, grade, and height

Market	Grade	Height	Sales Price

Wholesaler	Premium	6'	$20
	#1	6'	$18
	#2	6'	$16
	Premium	7’	$22
	#1	7’	$20
	#2	7’	$18
	Premium	8’	$24
	#1	8’	$22
	#2	8’	$20
Retail Outlets	Premium	6'	$24
	#1	6'	$22
	#2	6'	$20
	Premium	7’	$26
	#1	7’	$24
	#2	7’	$22
	Premium	8’	$28
	#1	8’	$26
	#2	8’	$24
End Consumer	Premium	6'	$30
	#1	6'	$30
	#2	6'	$25
	Premium	7’	$35
	#1	7’	$35
	#2	7’	$30
	Premium	8’	$40
	#1	8’	$40
	#2	8’	$35

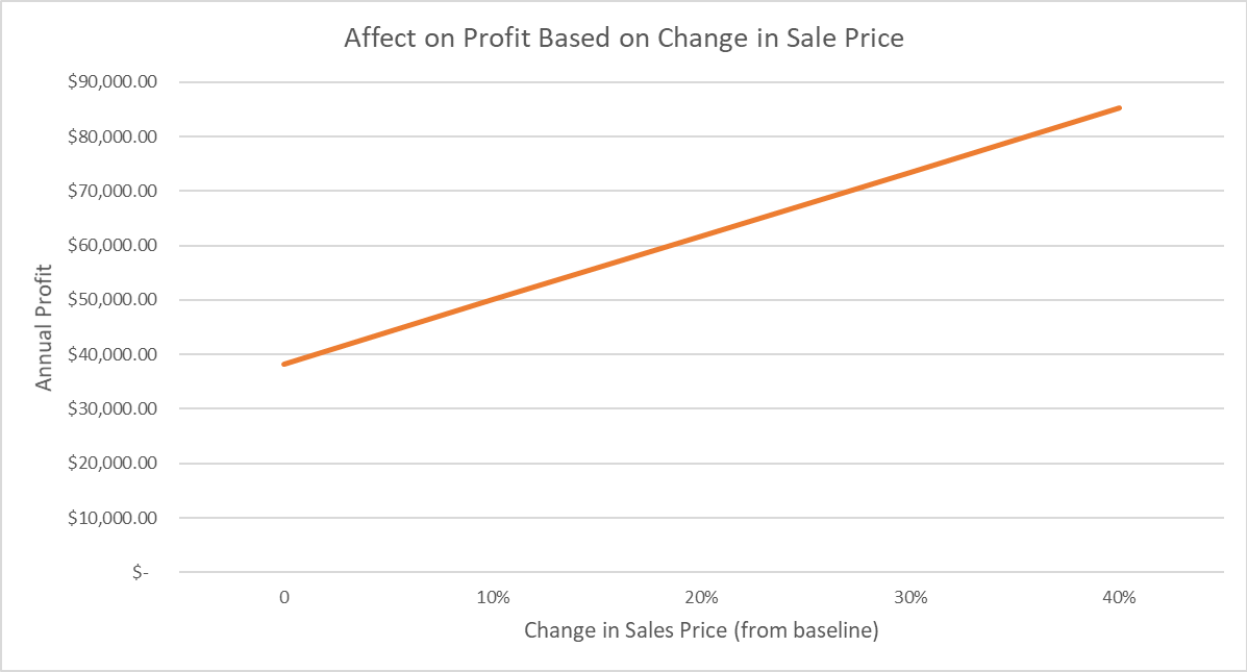


Figure 9 - Annual profit vs. change in sales price

Considering the baseline data, a **10% increase in sales price per tree,** will **add $11,732.16 in profit** every year.

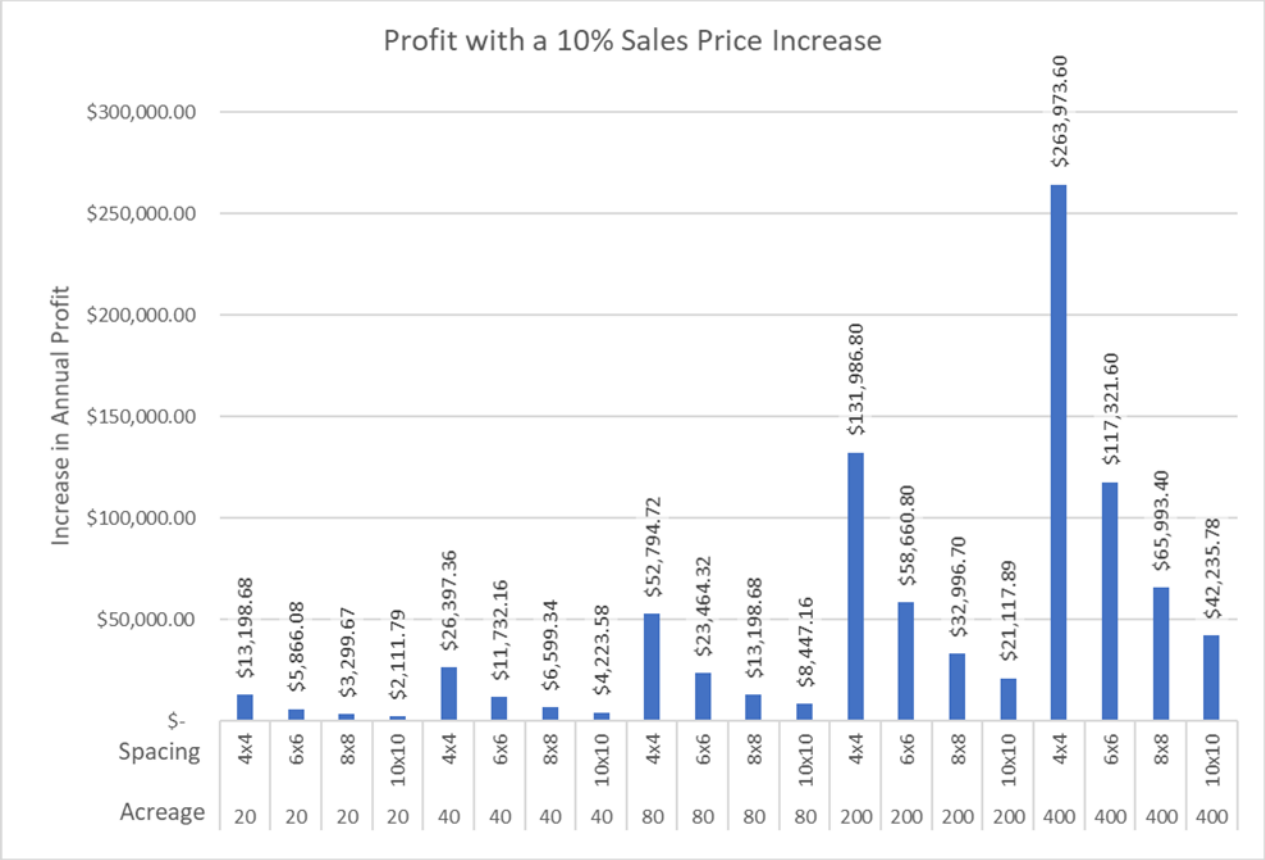


Figure 10 - Profit with a 10% sales increase by lot characteristics

6.2.7. Market Mix

Table 15 - Profit by market mix

Mix	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2
Wholesaler	100%	75%	50%	25%	0%	0%	0%	0%	0%
Retail Outlets	0%	25%	50%	75%	100%	75%	50%	25%	0%
End Consumer	0%	0%	0%	0%	0%	25%	50%	75%	100%
Profit	$38k	$44k	$50k	$56k	$62k	$74k	$86k	$98k	$110k

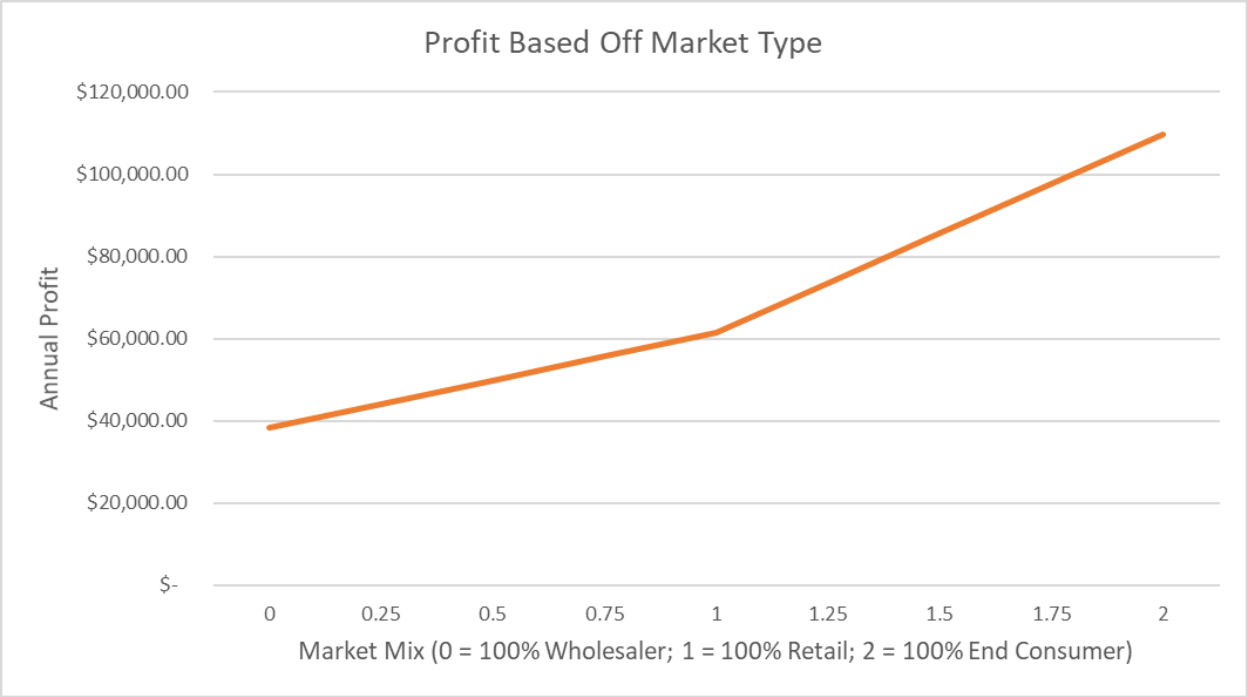


Figure 11 - Profit by market mix (chart)

Table 16 - Increase in profit by selling more directly to end customer

Market Mix	100/0 split	90/10 split
10% Wholesale to Retail	$ 38,281.60	$ 40,604.80
10% Retail to End Consumer	$ 61,513.60	$ 66,334.24
10% Wholesale to End Consumer	$ 38,281.60	$ 45,425.44

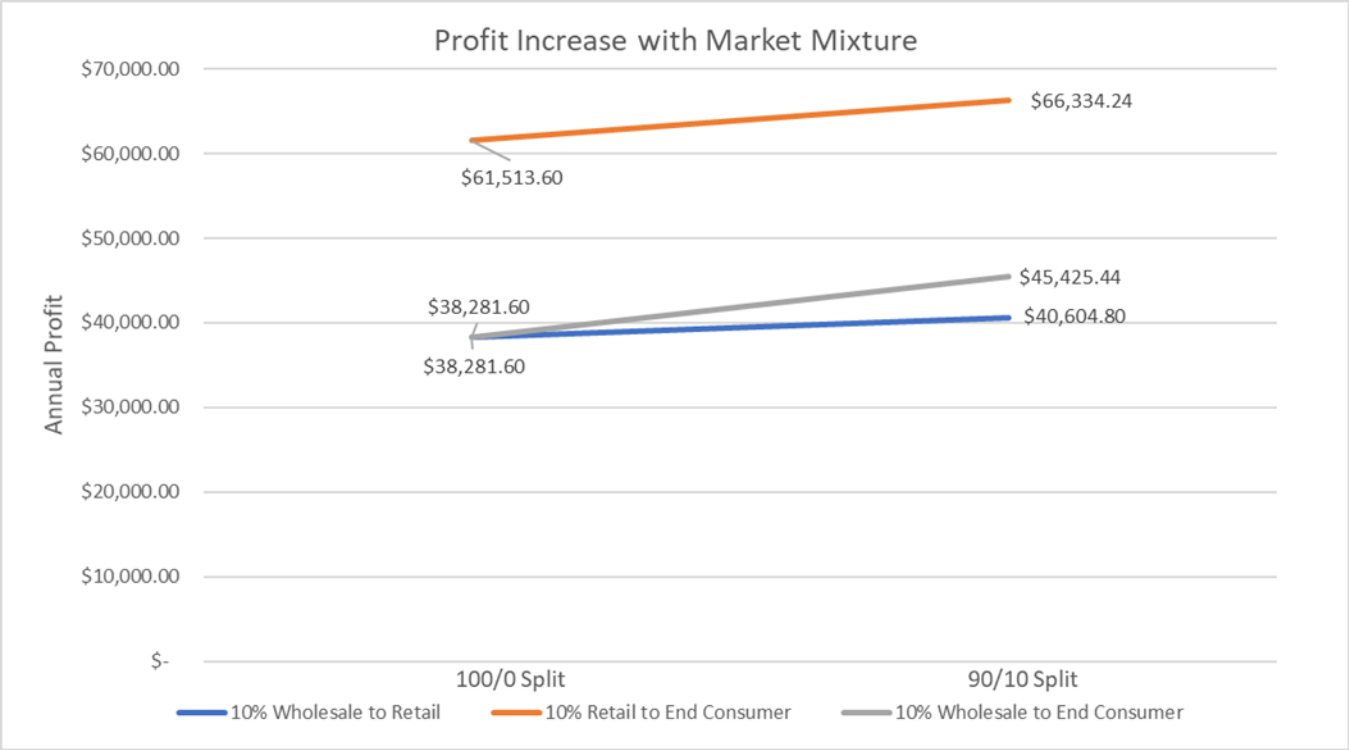


Figure 12 - Profit increase by selling more directly to end customer (chart)

If 10% of trees are sold directly to the **end consumer instead of wholesalers**, it will result in a profit increase of **$7,143.84.**

If 10% of trees are sold directly to the **end consumer instead of retail outlets**, it will result in a profit increase of **$4,820.64.**

If 10% of trees are sold to **retail outlets instead of wholesalers**, it will result in a profit increase of **$2,323.20.**

6.2.8. Size of Farm

For the baseline analysis, a 40-acre farm was used.

Table 17 – Annual profit versus size of farm

Acreage	20	40	60	80	100	120	140	160	180	200
Profit	-$5.6k	$38k	$82k	$127k	$171k	$215k	$259k	$303k	$347k	$391k

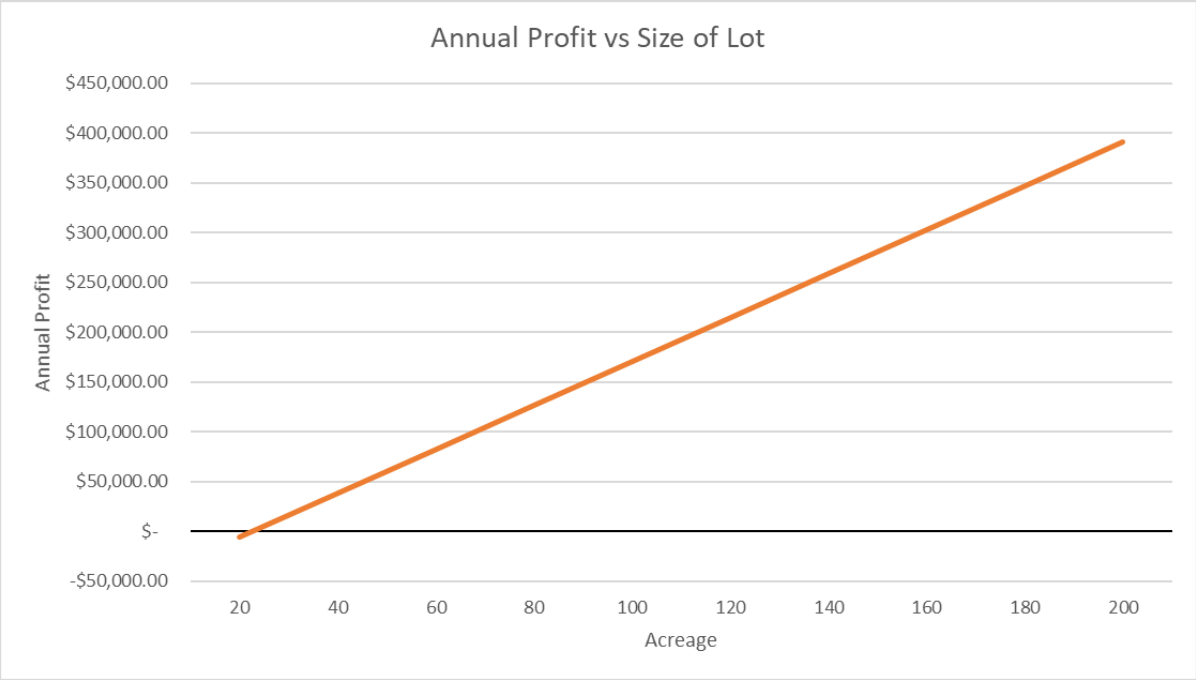


Figure 13 - Annual profit versus size of farm (chart)

Considering the baseline data, a **10% increase in acreage from 40 to 44 acres** will **add $8,828.16 in profit** every year.

6.2.9. Fixed Costs

Table 18 - Annual profit versus fixed costs

Annual Fixed Costs %	-20%	-10%	0% (baseline)	10%	20%
Annual Fixed Costs	$40,000.00	$45,000.00	$50,000.00	$55,000.00	$60,000.00
Profit	$48,281.60	$43,281.60	$38,281.60	$33,281.60	$28,281.60

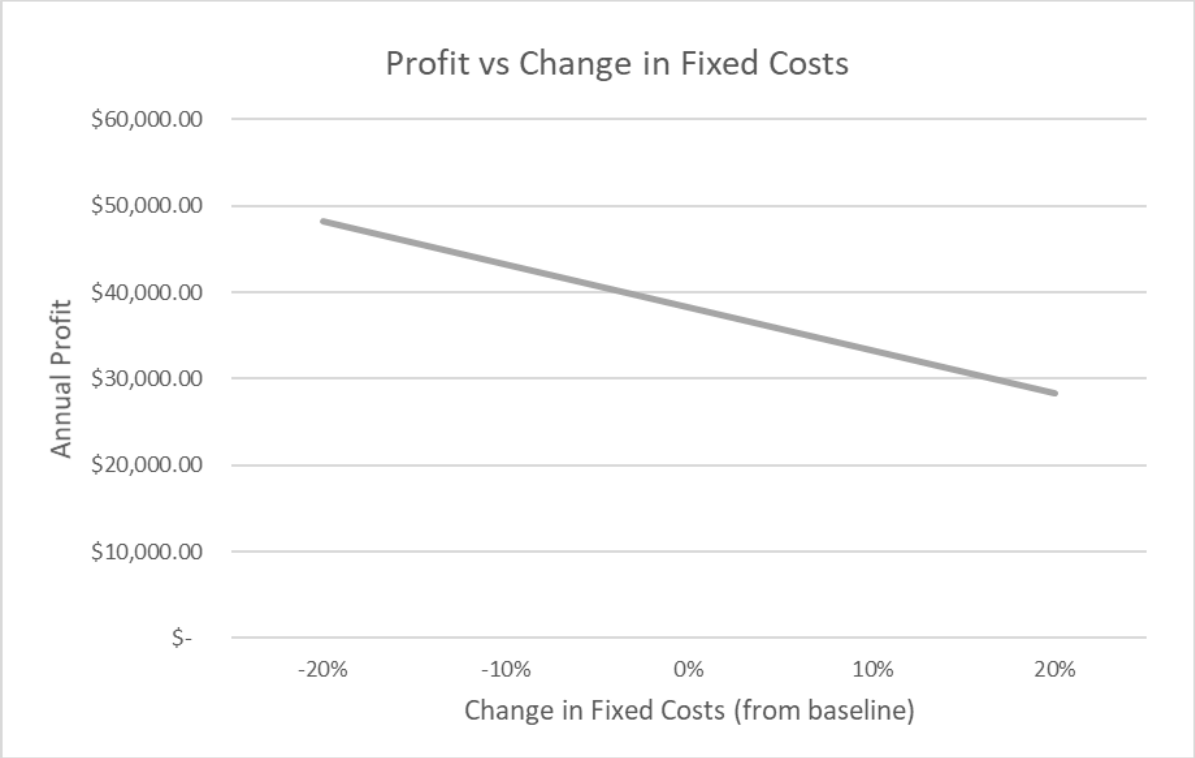


Figure 14 - Annual profit versus fixed costs (chart)

6.2.10. Summary

To summarize the impact of all the different factors presented earlier in this section, the following list shows what a 10% improvement in each area does to the resulting profit of a 40-acre farm (assuming the cost per tree and fixed costs stay the same, except where noted). This information can be valuable to determine where to focus efforts to improve by 10%. The list is in order of largest positive impact to profit.

1. If **sales price per tree** increases 10%, from an average of $20.20/tree to $22.22/tree, it will result in a profit increase of **$11,732.16.**
2. If **acreage** increases 10%, from 40 acres to 44 acres, it will result in a profit increase of **$8,828.16.**[8]
3. If **trees per acre** increases 10% from 1210 trees/acre to 1331 trees/acre, profit will increase by **$8,828.16.**[9]
4. If **trees harvested and sold** increases 10%, from 121 trees/acre to 133 trees/acre, it will result in a profit increase of **$8,828.16**[10]**.**
5. If 10% of trees are sold directly to the **end consumer instead of wholesalers**, it will result in a profit increase of **$7,143.84.**

[8] Assuming costs do not increase with the increase of production
[9] Assuming costs do not increase with the increase of production
[10] Assuming costs do not increase with the increase in harvest. It is important to note this could be profit borrowed from a later year.

6. If **fixed costs** decrease 10% from $50,000 to $45,000, it will result in a profit increase of **$5,000.00**.
7. If 10% of trees are sold directly to the **end consumer instead of retail outlets**, it will result in a profit increase of **$4,820.64.**
8. If **cost per tree** decreases 10% from $5.00 per tree to $4.50 per tree, profit will increase by **$2,904.00.**
9. If 10% of trees are sold to **retail outlets instead of wholesalers**, it will result in a profit increase of **$2,323.20.**
10. If **tree height** increases 10%, it will result in a profit increase of **$1,393.92.**
11. If **tree grade** increases 10%, it will result in a profit increase of **$464.64.**

6.3. Summary by Lot Type

The following tables summarize the differences between type of lot. The purpose of these tables is not to calculate an accurate contribution margin or profit by lot type, rather, show the importance of lot type vs. cost per tree on profit.

Table 19 - Cost and return summary by lot type

Type	Investment	Cost per Tree		Returns for 40-acre Lot		Contribution Margin		
		Min	Max	Trees/year	Price/tree	Max	Min	Median
Natural Stands	$91,003.00	$4.28	$6.83	4840	$20.00	$76,084.80	$63,742.80	$69,913.80
Even-aged Management	$111,223.00	$3.82	$6.05	4840	$20.00	$78,311.20	$67,518.00	$72,914.60
Plantation	$123,753.00	$4.40	$6.28	4840	$20.00	$75,504.00	$66,404.80	$70,954.40

As shown in the table above, if picking the middle point (i.e., median) of the minimum and maximum cost per trees, even-aged management has the highest contribution margin, followed by plantation, and then natural stands.

Since the investment for plantation (“P”) and even-aged management (“E”) are higher, the profit margin is better for natural stands (“N”) for many years until the higher contribution margin overcomes the higher investment for even-aged management.

Table 20 - Comparison of cost associated with each type of stand over the course of 10 years

		Harvest Year									
Cost	Type	1	2	3	4	5	6	7	8	9	10
Min	N	-$54,918	-$18,833	$17,251	$53,336	$89,421	$125,506	$161,591	$197,675	$233,760	$269,845
Min	E	-$72,922	-$34,611	$3,701	$42,012	$80,323	$118,634	$156,945	$195,257	$233,568	$271,879
Min	P	-$88,249	-$52,745	-$17,241	$18,263	$53,767	$89,271	$124,775	$160,279	$195,783	$231,287
Max	N	-$67,260	-$43,517	-$19,775	$3,968	$27,711	$51,454	$75,197	$98,939	$122,682	$146,425
Max	E	-$83,715	-$56,197	-$28,679	-$1,161	$26,357	$53,875	$81,393	$108,911	$136,429	$163,947
Max	P	-$97,348	-$70,943	-$44,539	-$18,134	$8,271	$34,676	$61,081	$87,485	$113,890	$140,295
Med	N	-$61,089	-$31,175	-$1,262	$28,652	$58,566	$88,480	$118,394	$148,307	$178,221	$208,135
Med	E	-$78,318	-$45,404	-$12,489	$20,425	$53,340	$86,255	$119,169	$152,084	$184,998	$217,913

Med	P	-$92,799	-$61,844	-$30,890	$65	$31,019	$61,973	$92,928	$123,882	$154,837	$185,791

The most important conclusion from this table, and the chart the summarizes the same data below, is that the activities to grow and harvest a tree are more important than the type of lot.

The colours on the chart below represent cost per tree:

- Blue is the low-end of cost per tree (as calculated in Appendix C and summarized in Variable Costs per Unit).
- Orange is median cost per tree.
- Green is the high-end of cost per tree.

The gradient of colour represents the lot type:

- Dark is natural stands
- Medium is even-aged management
- Light is plantation

The chart shows that the colours (cost per tree) are grouped together rather than the gradients. This illustrates that there are more opportunities to decrease costs by improving operations rather than changing lot types.

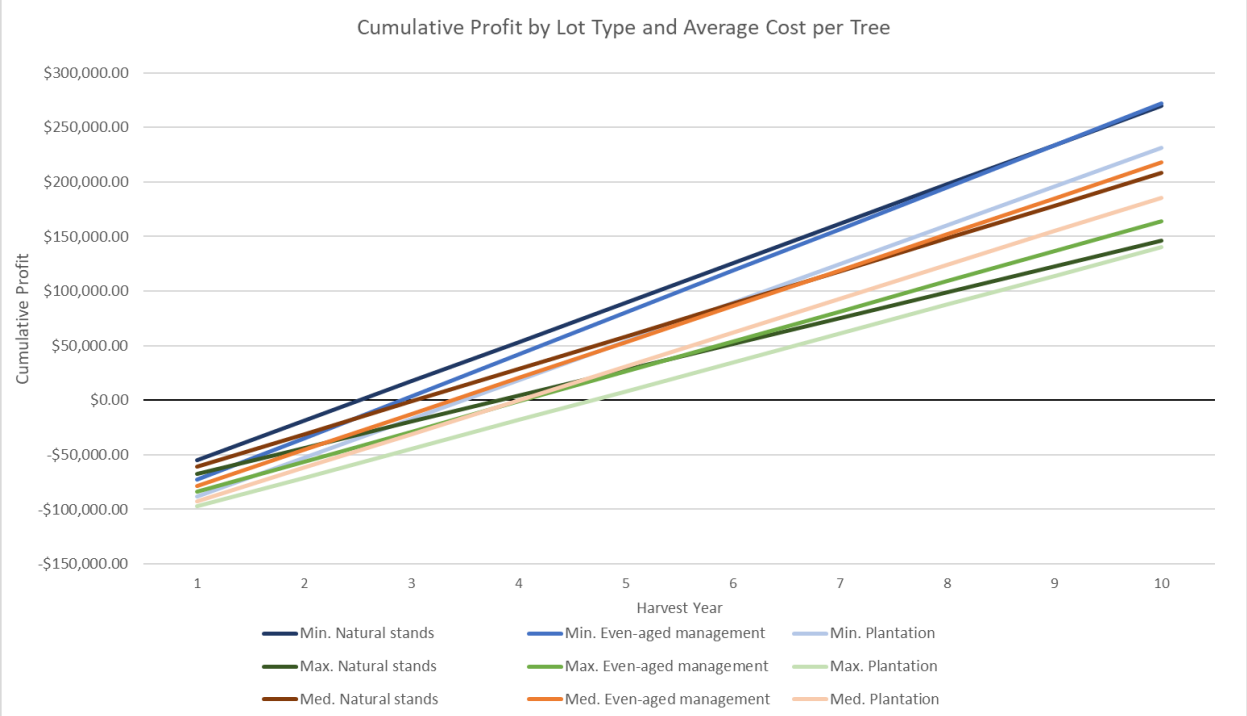


Figure 15 - Comparison of cost associated with each type of stand over the course of 10 years (chart)

7. Opportunities for Improvement

The following section lists value-added, feasible opportunities for many farms to improve their operations to be more cost-effective in the short- and long-term. Many recommendations have a "Lean" perspective with a focus on creativity over capital (continuous improvement over large capital investments).

Many of these factors are described in earlier sections of the report to show the variations in costs but have been pulled together in this section to make it easier to review, understand, and apply to your own operation. Where possible, each opportunity for improvement has been stated to quantify the return on investment or payback period.

The five sections are:

- **Business Planning** – how to think of your farm as a business to increase revenue and decrease costs
- **Human Resources** – how to get the most, and best, out of your employees
- **Operations** – general principles to decrease cost and increase quality
- **Business Decisions** – how to analyze certain situations many growers face to make the most cost-effective decision
- **Purchasing Decisions** – how to analyze whether purchasing a piece of equipment is worth the cost

7.1. Business Planning

The following sections are presented in a logical sequence that build on each other. If you don't have a strategic plan, the rest of the sections will not have as much value.

7.1.1. Strategic Planning

A strategic plan is a document that gives the owner, and everyone in the business, a clear direction. It is meant to prioritize efforts and effectively allocate resources to meet the goals of the business.

Every business should create a strategic plan, no matter how big or small. Even a sole proprietor should create a strategic plan to help them understand why they are in business. If the goal is not to increase profit but rather to get outside, get exercise, and grow beautiful trees, that can all be documented in a strategic plan to help guide business and purchasing decisions.

It is not good enough to have a strategy in mind, it needs to be put on paper. At the beginning of the year, after harvest season, is a great time to create and review the strategic plan for the upcoming year. Strategic planning is an ongoing process. Opportunities and threats change regularly in the industry, and farms will need to adapt to stay competitive.

7.1.2. Sales Mix

One key element of a strategic plan is your target market: the type of customer you expect to sell your trees to every year. There are three main types of markets:

- **Wholesale:** When a grower decides to sell to a buyer who then sells to retail outlets and similar buyers. This is advantageous for growers of large operations with low operating expenses and is more concerned with selling a large volume of trees instead of maximizing the return per tree.
- **Retail Outlets:** This a combination of wholesale and direct to consumer. The grower works directly with a retail outlet that sells directly to the consumer. This requires a little more coordination and administration than working with a wholesaler but also provides a greater return per tree.
- **Direct to Consumer:** This could be a grower that sets up in a parking lot or operates a choose-and-cut operation; they are selling their trees directly to the end customer with no buyer in between. This is advantageous to smaller growers that do no need to sell a large volume of trees and are looking to maximize the return per tree.

The other decision that will come out of the strategic plan that relates closely to the target market is the type, size, and grade of trees to be grown and harvested. Not all trees need to be premium, 8ft trees. What the customers are willing to pay for and the cost for growing that type of tree are important factors in choosing what trees to grow.

For example, a tree that might have originally been culled may now have a market as a tabletop tree.

7.1.3. Understanding the Customer

For all Christmas tree growers, whether they are selling wholesale, to retail outlets, or directly to consumer, it is important to understand what the customer values. If you don't know what your customers value, you won't know which of your activities are creating that value and which are contributing to waste.

For example, a wholesale customer may be willing to pay more for trees that are palletized because it's easier for them to unload on-site. Or the wholesale customer may not be willing to pay extra for 8ft trees because they don't have a market for it.

If selling directly to the end customer, there may be certain heights and tapers they are willing to pay more money for.

As soon as you find out what customers truly value, this information should guide every decision you make.

7.1.4. Key Performance Indicators

Key performance indicators (KPIs) should come out of the strategic plan. These are measures, with goals, that tell the owner and the rest of the employees whether the business is being successful or not. These metrics are measurable, meaningful, and easy to track. While revenue and profit are the ultimate

goals, there are many measures that can be used throughout the year to tell a grower whether they are likely to be successful or not at the end of the year.

Some example KPIs are:

- Number of trees planted
- Number of trees planted per day
- Number (or percentage) of trees sheared
- Number of trees sheared per day
- Number (or percentage) or trees fertilized
- Date shearing is complete
- Harvest start date
- Harvest end date
- Number of trees baled per day
- Number of premium trees tagged

7.1.5. Cash Flow

For all farms, but especially for new farms, monitoring cash flow is crucial. Because Christmas trees have such a long sales cycle (at least eight years from seed to sale), cash flow is critical to stay in business and make money.

There are many costs for a new farm that can be delayed. For example, harvesting equipment such as a baler and wagon do not need to be purchased until closer to year 8 instead of year 1. Simple, low-cost equipment may be more cost-efficient in the first few years of operation until the farm gets to a scale where those purchases make more sense.

To increase cashflow for the first eight years, the grower can consider selling brush, greenery, wreaths, and tabletop trees. These activities will not sacrifice any cashflow from later years. It will take from trees that would otherwise not be harvestable and turn it into revenue.

7.2. Human Resources

One of the highest costs for large-scale operations is labour. Labour is also the biggest opportunity for decreasing costs; not by decreasing salaries or hiring less staff, but by increasing productivity and quality of the product.

At the time of writing this report, hiring labour in all industries is one of the largest challenges in the province. Because of labour shortages, many farms have taken advantage of the temporary foreign workers program accessible through the government.

7.2.1. Temporary Foreign Workers

An opportunity for the industry, specifically larger farms that require skilled labour during shearing and harvest seasons, is to hire temporary foreign workers. There are many factors to consider if temporary foreign workers are the right fit for your farm.

- **Cost of labour** – while the hourly rate for temporary foreign workers may be less expensive than local workers, the extra costs of housing, food, healthcare, benefits, and other things need to be included to give a holistic view of the cost for labour.
- **Labour experience, efficiency, and effectiveness** – Cost is only one factor to consider. If temporary foreign workers are more effective and efficient (i.e., they can do more work or more quality work), you should be willing to pay more for the labour. Skilled labour, local and foreign, is an important factor for reducing the cost per tree.
- **Administrative time and costs** – Temporary foreign workers require more paperwork and coordination than local workers. Even if the owner does this themselves at no cost, there's still an opportunity cost involved where the owner could be spending that time on other value-add activities.
- **Management** – Generally, there are different work cultures between local and temporary foreign workers. It is important to understand the differences and how they match your management style to see what type of worker may be the best fit (or if a mix may be the best fit).

7.2.2. Training and Supervision

For all new employees, local and temporary foreign workers, training is a critical part of the job. The most important part of training is to ensure they are using all equipment safely. Shearing and harvesting equipment can cause serious injuries if not operated properly.

The second benefit of training is to increase the productivity of workers and the quality of the product. The more effectively and efficiently the activities are performed, the more work can get done in a day (or the fewer workers are required).

Training should be a continuous exercise and shouldn't just be on the first day of the job. Workers can get into bad habits and forget key steps, especially for activities they don't do on a regular basis.

7.2.3. Training Documentation

People learn best by different methods. If possible, many options should be available for employees to learn the most safe, efficient, and effective ways to do their work such as:

- On-the-job supervision and coaching to share what's being done right and correct what's being done wrong.
- Video instructions so the employee can see and hear how the work should be completed.
- Written instructions (also known as standard operating procedures or SOP's) so the employee can read the details of how the work should be completed. Written instructions should also include as many pictures as appropriate to visualize the work.

7.3. Operations

This section includes opportunities of improvement based on "how" the work gets done.

7.3.1. Reducing Waste

In Lean Manufacturing, there are eight types of waste that fit the acronym TIMWOODS. These wastes add costs and should be reduced or eliminated whenever possible.

Transportation

Transportation waste is when people, product, or equipment are travelling. Below are some examples of transportation wastes and potential solutions:

- **Walking between trees**
  - Decrease the spacing between trees or batch activities together (e.g., shearing and butt pruning or shearing and grading).
- **Dragging cut trees to the road**
  - Decrease the spacing between roads.
- **Transporting baled trees to the yard**
  - Increase the number of trees transported per trip so less trips are required.

Inventory

Inventory waste is product that the customer has not received or excess supplies and equipment. Because of the eight-year growing cycle, there will always be large amount of "inventory" (growing trees), but there are other areas that inventory can be reduced to save costs.

There are many disadvantages to carrying excess inventory such as:

- Reduced cashflow (paying for excess inventory up front)
- More storage area required
- More risk to expiry of inventory
- More risk to losing inventory
- More risk of inventory becoming obsolete

Below are some examples of inventory wastes and potential solutions:

- **Excess supplies (e.g., fertilizer, herbicide, fuel, flags, twine)**
  - Understand how much inventory is required each year and setup minimum and maximum inventory on hand limits.
  - Create a clean and organized storage location for supplies (see 5S for more details) so it's easy to see how much is on hand at any given time.
- **Excess equipment (e.g., shears, chainsaws, planting equipment, etc.)**
  - Old equipment that is not going to be re-used or fixed should be sold, recycled, donated, or thrown away.
  - Any equipment that is kept should be cleaned, well maintained, and organized so it can easily be found.

Motion

Motion waste is excessive movement of a worker to get the job done. It includes the excess time required for motion but also the added fatigue that is associated with extra movement. Below are some examples of motion wastes and potential solutions:

- **Planting (e.g., excess reaching, turning, twisting, and bending)**
  - Use tools to help reduce the amount of motion required such as a dibble bar and a planting bag.
- **Shearing (e.g., excess reaching, turning, and twisting)**
  - Use mechanical equipment
  - Use long-handled shears for taller trees
- **Baling (e.g., excess dragging)**
  - Pile cut trees in larger piles so the baler can be parked closer and less dragging is required
- **Loading (e.g., excess reaching and bending)**
  - Purchase an elevator to load trees unto a truck instead of doing it manually

Waiting

Waiting waste is any time a worker is idle due to waiting for instructions, waiting for equipment, or waiting for product. Below are some examples of waiting wastes and potential solutions:

- **Instructions for next activity**
  - Workers should always be aware of what activities come next if they are to finish an activity early in the day
- **Instructions for problem solving**
  - Workers should have autonomy to make certain decisions on their own if something unexpected it to happen
  - For more challenging or urgent problems, they should have the tools to contact the owner/operator as quickly as possible
- **Equipment breakdown**
  - Make backup equipment readily available
  - Have tools and skills available to fix any equipment breakdown
  - Have secondary activities to complete while equipment is being fixed
- **Dependent activities**
  - For any activity that relies on another worker (e.g., baling requires trees to be dragged to the side of the road, dragging requires trees to be cut) there are enough resources or enough buffer time, so a worker is never waiting on another worker
  - Have secondary activities to complete while waiting for the bottleneck worker/activity

Overprocessing

Overprocessing waste is doing more work than is necessary. Below are some examples of overprocessing wastes and potential solutions:

- **Excess shearing**
    - Train workers on effective and efficient shearing
    - Limit the amount of time spent shearing trees that are not to be harvested the same year
- **Late culling (extra time spent shearing and fertilizing trees that will never make it to market)**
    - Train workers to spot opportunities for culling whenever they are working in the lot
    - Create rules for culling

Overproduction

Overproduction waste is doing more work before it is needed. Below are some examples of overproduction wastes and potential solutions:

- **Harvesting without customer orders**
    - Trees should be flagged for harvest and should match customer orders by height and grade
    - Trees should be organized and counted in the yard to understand how many more trees need to be harvested and when to fulfill customer orders
- **Cutting trees too early in the season or too far ahead of shipping**
    - Schedule harvest to be in line with the season and shipping dates of customers

Defects

Defect wastes are mistakes and errors that need to be reworked or can no longer be sold. Below are some examples of defects wastes and potential solutions:

- **Low quality trees**
    - Cull the tree
    - Harvest early for a bale, tabletop tree, or for greenery
    - Invest in the tree with corrective shearing for a high-quality harvest in future years
- **Trees spaced too close together**
    - Transplant the tree to a space where it has room to grow
    - Cull the tree that has the lower estimated return

Skills

Skills wastes are not using workers to the fullest of their abilities. Below are some examples of skills wastes and potential solutions:

- **Proficient use of equipment**
    - Some workers are much better at using certain pieces of equipment than others and should use the equipment more often
    - Workers should be given the right equipment to do the job effectively (and safely)
- **Repairing equipment**
    - Some workers have the skills to repair equipment themselves instead of taking it back to the dealer or a mechanic to fix

7.3.2. Record Keeping

Complete, documented records are essential to any business, including Christmas tree farms. The more data that is recorded, organized, and readily accessible, the better the decision-making can be. There are five categories of records that should be kept: geography, activities, trees for harvest, outcomes, and financials.

Geography

Geography records include a map of the farm layout, with fields, roads, topography, drainage systems, species, number of trees per field, and planting dates. Other records that may accompany these records include soil test data, weather conditions at the time of planting, pest and weed control efforts. These records will give the owner a good overview of the farm.

Activities

The most important things to track for activities are what's being done, when's it being done, and how much effort is it taking. This data is extremely valuable to continuously improve the operations and make purchasing decisions for investing in equipment, new hires, and other resources.

Trees for Harvest

Flagging trees is the most common and easiest method to track how many trees of each size and grade are ready for harvest. Buy flags that are numbered to make it easier, and more accurate, to record the number of flags used. The number, height, and grade of trees should also be recorded by each lot to help with harvesting logistics.

Outcomes

At the end of the year, all outputs and outcomes should be tracked to connect back to the inputs. Performance metrics such as:

- Number of trees sold by height, grade, customer, and truck
- Number of trucks loaded and shipped

Financials

All input and output financial information such as detailed expenses and revenue.

7.3.3. Visual Management

Visual management is a form of communication to show how the operations are performing. Below are a few examples of how visual management may be valuable for a Christmas tree farm:

- **Map of Christmas tree lots** – A physical map of the Christmas tree lots posted on a wall can be used in many ways to communicate to workers. The status of the lot such as quality, percentage ready for harvest, amount of fertilizing/spraying/shearing complete, can be recorded, and easily tracked and communicated with all workers.

- **Activity Schedule** – A large calendar or schedule can be printed off and posted on a wall to communicate the expectations and targets for completing activities for the year. The workers can track their performance and progress against the plan to see if they are on schedule, behind, or ahead. The schedule could be especially valuable during harvest season when there's an extra layer of coordination required with loading trucks and communicating with customers.
- **Task Board** – There may be lots of odd jobs and tasks that can be identified by anyone and tracked in a central place that is visible by all. It may include parts or supplies to purchase, activities to be completed on a rainy day, or equipment that needs to be fixed. Having a board that's visible to everyone and seen daily can ensure the tasks aren't forgotten about.
- **Key Performance Indicators (KPIs)** – The farm may have some KPIs to show how well it is operating throughout the year. It could be based on activities completed, incurred expenses, or quality of trees. Each KPI would have a target and a current value to be compared against the target.

7.3.4. 5S

5S is a methodology that results in a workplace that is clean, uncluttered, safe, and well organized to help reduce waste and increase productivity. It stands for: sort, set in order, shine, standardize, and sustain.

1. **Sort:** The first step of 5S is to ruthlessly eliminate anything that is not necessary for your operations. When in doubt, get rid of it. The only items left in your production spaces should be those you use regularly or are important to your operations (e.g., balers).
    - Often you are better off with fewer tools that accomplish a wider range of tasks. It is easier to take care of a few carefully chosen items rather than a barn full of random items.
    - Every time something is washed, stepped over, stashed away, even though about — that item is taking an investment from the farm.

2. **Set in Order:** Every tool on the farm should have a place. It should be in its place or in the hands of a worker. There is no third option. Use the tool, then put it back home. Keep spares labeled and organized. Every time something is washed, stepped over, stashed away, even though about — that item is taking an investment from the farm.
    - This may mean investing in hooks or magnets so tools can be hung at eye level, within easy reach. Reserve easiest-to-reach spaces for the most-used tools.
    - Use shadow boards. Draw contoured outlines around tools to indicate a home for each. Shadow boards show quickly and effectively what tools are missing from their home.
    - Post photos. Show workers what spaces look like in their cleaned state.
    - Label spaces and lots. Each lot should have a post with a number or name. Different barns, rooms, and sheds should also be labelled if it is a larger farm.
    - Post magnetic whiteboards that can be used for visual management.

3. **Shine:** Shine represents keeping workspaces clean and tidy. Tasks that involve cleaning up are best accomplished in short steps done frequently, as part of day-to-day routines, rather than as time-gobbling chores set aside for once or twice a year.

4. **Standardize:** All areas of the farm should be consistent in its 5S practices. Standardize includes scheduling regular cleaning and maintenance by sorting, setting in order, and shining daily.

5. **Sustain:** 5S should be a habit, incorporated into a daily routine, and a part of any hiring or training.

The benefits of implementing a Lean 5S program include:

- Improved safety
- Higher equipment availability
- Lower defect rates
- Reduced costs
- Improved employee morale
- Better asset utilization

7.3.5. Evidence-Based Decision Making

Any decision made by a Christmas tree grower should be an evidence-based decision, not a decision based on hunches or a gut feeling. Evidence can come in many different forms such as:

- **Record keeping** – The most powerful form of evidence is data. Keeping records of how much effort is required for each activity can inform purchasing decisions for new equipment and mechanization.
- **Time studies** – When data does not exist or isn't trustworthy, timing operations can be a strong alternative. A time sample can be extrapolated to determine what the cost may be for the year and what investments can be made to reduce costs.
- **Best practices and research** – There are many Christmas tree growers, balsam fir experts, agrologists, and experts across the province, the continent, and the globe. Much of their research and best practices can be found online.
- **Experimentation** – Sometimes, reviewing data and conducting research may not give enough insight. Experimenting in different ways can give a Christmas tree grower the evidence required to make an informed decision. It might be as simple as trying a different technique, tool, piece of equipment, or material. For experiments that may last years before the results are clear, detailed record keeping is vital.

7.4. Business Decisions

There are many decisions that a grower will face regularly that might have a different answer for each grower depending on the size of the farm, labour, sales, and many other factors. This section discusses a few of the most common decisions with sample calculations. Other business case decisions which involve purchasing equipment are listed in the next section.

7.4.1. Harvest now or harvest later?

One of the decisions that every grower faces is “should I cut this average tree this year, or let it grow taller and potentially receive a higher grade next year?”

Here some of the key factors to make this decision:

- **Additional costs:** The only additional costs to letting a tree grow a year is one more year of shearing. The time to walk to the tree and shear it is no more than a minute (or $0.28 worth of labour).
- **Additional revenue:** The Christmas tree has an opportunity to increase in height, grade, and sales price. If the tree can grow from a 6ft to a 7ft tree, increase from a #1 to premium grade, or the market could turn, and a $20 tree could be worth $25 the following year.
- **Additional risk:** There is no guarantee the tree left to grow for another year will be harvestable the following year. Due to pests, weather, and other factors, it may go down a grade or simply need to be culled in extreme scenarios. There is also a chance that the market will go down and a tree will be worth less money than the previous year.
- **Time value of money:** A dollar earned this year can be worth at least 5% more than a dollar earned the following year due to inflation and potential for investing that dollar.
- **Opportunity cost:** The $20 in revenue “lost” by not harvesting the tree could have gone towards investing in the farm instead of waiting another year to earn.
- **Cashflow:** There are some years where a short-term focus on revenue is more important to avoid taking on bad debt.
- **Order Fulfillment:** The priority should be to fulfill orders that have already been promised/sold to customers. Even if a tree can increase in value by 20% if left in the ground for a year, it is likely a bad idea to short a customer if the trees are available.

Calculation example:

- Time value of money: 5%
- Additional labour cost for an extra year: $0.28
- The tree could be sold for $20 this year
- ($20/tree * (1+5%)) + $0.28 = $21.28

If you believe you can get at least $1.28 more for that tree next year, it is worth letting the tree grow for an additional year.

To calculate the estimated value for the tree next year, you need to consider all the different outcomes for the tree with a percentage chance for each outcome.

For example:

Table 21 - Calculating the estimated value of a tree next year

Outcome	Probability	Return Breakdown
$0 (worth nothing)	1%	$0

$18 (loses 10% of its value due to market or other risks)	9%	$1.62
$20 (does not increase in height, grade, and sales price stays the same)	40%	$8.00
$22 (10% increase in price due to height, grade, and/or sales price)	25%	$5.50
$25 (25% increase in price due to height, grade, and/or sales price)	25%	$6.25
All Outcomes Considered	**100%**	**$21.37**

Considering the outcomes above with the percentages, for this scenario it would be beneficial to leave the tree for a year since $21.37 > $21.28.

7.4.2. Cull, leave, or transplant?

Every grower has likely been faced with a decision when two seedlings are growing too close to each other and the likelihood of them both thriving is very low. The grower is faced with three options:

1. **Cull.** This involves removing the tree that will be of lower quality when it comes to harvest time.
2. **Leave.** This involves leaving the two trees for now and potentially removing one at another time.
3. **Transplant.** This involves digging up one of the trees and re-planting it nearby where it has space to grow.

The following assumptions are used to evaluate the costs and returns of the three different options:

- Both trees will reach 7 feet in 5 years.
- If left alone, one tree will be unsellable and the other will be a #2 grade.
- If culled, the tree left will be a premium grade.
- If transplanted, the tree left will be a premium grade and the transplanted tree will have a 50% chance of being a #1 grade, and a 50% chance of a failed transplant.
- A 7 ft premium tree can be sold for $26
- A 7ft #1 tree can be sold for $24
- A 7ft #2 tree can sold for $22.

Culling costs and returns

The cost to cull a tree is close to negligible. For a seedling, it takes a few seconds to pull out of the ground. Five seconds of labour is worth $0.02. Therefore, the return of the premium tree will be $26 - $0.02 = **$25.98.**

Leaving costs and returns

If left alone, only one tree can be sold at a #2 grade for a return of **$22.00**.

Transplanting costs and returns

To transplant a tree, let's assume it takes three minutes to properly pull a wildling from the forest floor, find a suitable location for the wildling, and properly plant the wildling. Three minutes equals $0.85 if the worker is making $17/hour.

The probabilistic return is ($0 * 50%) + (($24 - $5) * 50%) = $9.50. **Since the return of $9.50 is much greater than the cost of transplanting ($0.85), the worker should transplant in this scenario.**

The only time a worker should not transplant is if the chance of a successful transplant is less than 4.5%: ($0 * 95.5%) + (($24 - $5) * 4.5%) = $0.855.

7.4.3. Plant for speed or for quality?

The short answer for should you plant for speed or quality is: "both." But what's more cost-effective if you have the option to speed up with slightly lower quality planting, or to slow down for higher quality planting?

A few assumptions for these calculations:

- The cost for planting is $0.72 (a seedling is $0.60 for a seedling and $0.12 for labour – see Option 1: Seedlings (2+0) with a dibble or hoe pipe for detailed calculations)
- The cost for labour is $17/hour (i.e., one minute costs $0.28, 30 seconds costs $0.14).
- Current rate of successful planting for container stock is 80%.
- Evaluating one acre planting 100 trees
- The comparison evaluates opportunity cost and assumes that a well-planted tree will be cut and sold in 8 years for a gross margin of $15 ($20 sales price and $5 cost per tree).
- Successful planting = $15 gross margin
- Unsuccessful planting = $0.72 loss

Based on the current assumptions, the average gross marking per tree = [($15 * 80%) – ($0.72 * 20%)] = **$11.86**.

If an extra 30 seconds of effort increased the likelihood of successful planting from 80% to 81%, the average gross margin per tree would increase to: [($14.86 * 81%) – ($0.86 * 19%)] = **$12.01**.

$12.01 > $11.86, therefore, an extra 30 seconds is a good investment of time, even if it only increases the likelihood of successful planting by only one percentage point.

7.4.4. Grade on stump or in yard?

If you are a grower that does not need to keep track of inventory during the year and have a market for all the trees that you can cut (i.e., are selling trees to a Cooperative), you have the flexibility to grade the trees in the yard instead of on the stump.

It is advantageous to grade in the yard (off the stump) for a few reasons:

- There is no effort required to walk from tree to tree (stump to stump)
- Trees can be held up and spun around instead of walking around 360 degrees on the stump

- It's quicker (and more accurate) to measure the height of the tree

Assuming a grader can grade 25% quicker in the yard than on the stump, from 60 seconds to 45 seconds, it would result in an increase of $0.07 per tree. On a 40-acre farm that harvests 121 trees per acre per year, this would result in a profit increase of $338.80.

7.4.5. Bale in lot or bale in yard?

There are a few different approaches to baling trees, which is one of the most important activities for Christmas tree growers as it's often a three-person job with a very small window during the year for which it can be done.

One approach is to take the baler to the trees while the other is to take the trees to the baler. From the calculations in Baling, Hauling, and Storing, it seems that taking the trees to the baler, and baling in the yard is the most cost-effective method based on the following factors and assumptions:

- When the baler is travelling behind the tractor in the lot, there is a significant amount of time when the baler is not running, and the crew is not baling (the tractor and baler is going out to the lot, travelling on the road between cut trees, and travelling back from the lot for breaks). If the baler is in the lot, it (and its crew) does not need to travel.
- It is assumed the baling crew can put its trees directly in the unloading area without having to transport the baled trees again.
- If baling in the yard, the crew in charge of bringing trees from the lot to the yard is fast enough to keep the balers busy without waiting.

The estimated cost for a three-person baling crew with a dedicated loader to bale and transport baled trees to the yard is $0.55 for baling, $0.29 for hauling and storing, for a total of $0.84.

The estimated cost for a three-person baling crew in the yard, with a dedicated hauler to transport trees to the yard is $0.49 for baling and storing, $0.22 for hauling, for a total of $0.71.

7.4.6. Single or double twine?

Some Christmas tree farms choose to use double the twine for baling their Christmas trees. The assumption is that the additional cost of baler twine is worth the expense to reduce breakage and to increase the number of trees that can fit on a trailer, saving on shipping costs.

- The cost of a tube of twine is $12.
- There is 6750 ft of twine on a tube.
- On average, 30 ft of twine is required per tree.
- It takes 60 seconds to replace a tube of twine.
- It takes the same amount of time to double twine a tree vs. single twine a tree.

Single twine:

$$\$17/hr * 121\ trees/acre * \frac{60\ sec/twine\ replacement}{3600\ sec/hr * 225\ trees/twine\ replacement} = \$0.15/acre$$

$$\frac{30ft/tree}{6750ft/tube} * 121\ trees/acre * \$12/tube = \$6.45/acre$$

$$\$0.15 + \$6.45 = \$6.60/acre\ for\ twine\ and\ labour$$

Double twine: $6.60 * 2 = $13.20 per acre (or $6.60 more than single twine per acre).

$$\frac{\$6.60/acre}{121\ trees/acre} = Extra\ \$0.05\ per\ tree\ to\ double\ twine$$

If a 40-acre farm that sells 4840 trees per year can save $242.00 on shipping and breakage from double-twining instead of single-twining, double-twining is a good investment.

7.4.7. Should I upgrade roads?

The quality of roads allows more types of equipment access (e.g., pickup truck instead of a tractor), decreases the wear and tear on equipment, and allows equipment to travel at a faster speed.

There are three reasons for upgrading roads:

1. The road conditions make it near impossible to take equipment on without damaging.
2. More equipment can travel on the roads.
3. Equipment can travel faster on roads.

The first reason is not worth investigating since it must be done, no matter what the cost is.

The rationale behind the second reason is to use a pickup truck instead of a tractor for the activities. Assuming the roads are already in a condition that a tractor must be used, the savings are related to speed and productivity and not equipment savings.

Assuming the average distance travelled on the roads on any day is 1km, and the average difference of speed is 20km/hour between truck and tractor, the average time saved per day is 3 minutes per person. If the roads are travelled on 160 days per year, this results in 8 hours of time saved per year per person (or $136 per person).

The bigger impact is when a grower is starting a natural stand farm with a blank slate for roads. If the grower can avoid purchasing a $100,000 tractor by building roads that can support a pickup truck, the investment is worthwhile.

7.4.8. Should I add roads?

The spacing of roads can decrease the amount of dragging required during harvest season. The less distance between roads, the less walking is required from road to tree. It is assumed all other activities such as lot management, planting, spraying, fertilizing, shearing, butt pruning, grading, and cutting have no savings with more roads since these activities are walking from tree-to-tree and not tree-to-road.

This example examines a 20-acre lot (800ft x 1089ft) with current spacing between roads of 400ft with the goal to cut that spacing in half by tripling the number of roads.

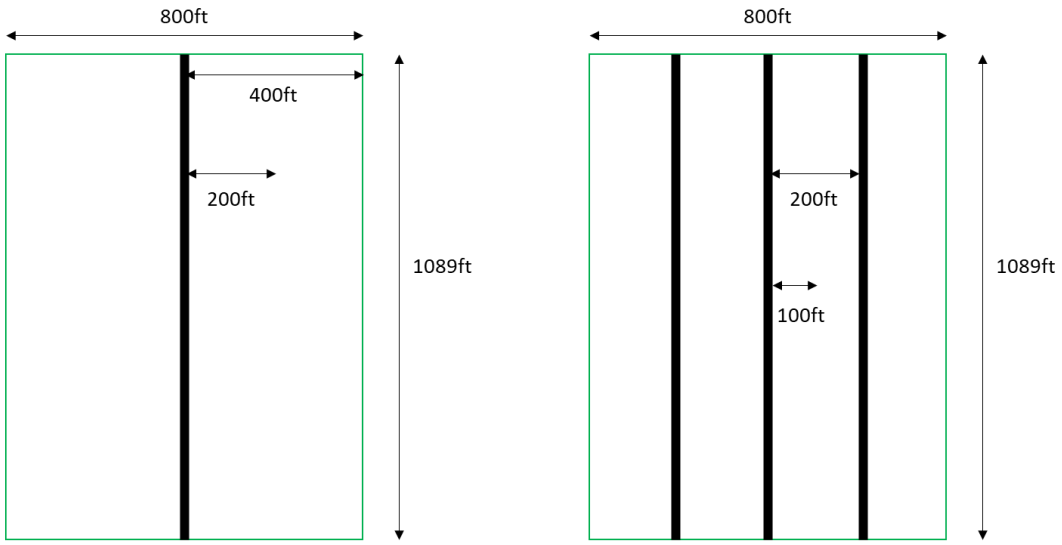


Figure 16 - One road versus three roads on 20-acre lot

Cost assumptions:

- 2178ft of main branch road = 663.85m * $5/m = $3319.25
- 2178ft of main branch road removes 2.5% of growing area
- The average tree is dragged half the distance to the closest road (i.e., 200ft for 400ft spaced roads and 50ft for 200ft spaced roads)
- There are 24,200 trees on the 20-acre lot (6ft x 6ft spacing)
- 10% of trees are cut and dragged each year (i.e., 2420)
- The average speed per dragger is 2.4ft/sec while dragging a tree and 3ft/sec without a tree

$$400ft\ Spacing\ Cost\ of\ Dragging = \$17/hr * \left(\frac{200ft/tree}{2.4ft/sec} + \frac{200ft/tree}{3ft/sec}\right) * 2420\ trees * \frac{1hr}{3600sec}$$

$$400ft\ Spacing\ Cost\ of\ Dragging = \$1714.14$$

$$200ft\ Spacing\ Cost\ of\ Dragging = \$17/hr * \left(\frac{50ft/tree}{2.4ft/sec} + \frac{50ft/tree}{3ft/sec}\right) * 2420\ trees * \frac{1hr}{3600sec}$$

$$200ft\ Spacing\ Cost\ of\ Dragging = \$428.54$$

$$Loss\ of\ Revenue = 2420\ trees * 2.5\% * \$15/tree = \$907.50$$

$$Payback\ period = \frac{cost\ of\ investment}{savings/year - loss\ of\ revenue/year}$$

$$Payback\ period = \frac{\$3319.25}{\$1285.63 - \$907.50} = 8.8\ years$$[11]

7.5. Purchasing Decisions

Investing in new technology and equipment can decrease the labour and material costs per tree. For any investment to be worthwhile, it needs to factor in the number of trees sold each year to see if the potential cost savings will pay for the investment. The larger the operation, the more likely an investment in equipment will pay off. Each operation will have to do its own evaluation to determine if the investment is worthwhile.

It is important to understand not only the price of any tool or piece of equipment, but the returns and other hidden costs. There are many factors to consider when evaluating the value of a piece of equipment such as:

- **Life cycle:** If properly maintained and used, most equipment should have several years before it needs to be replaced, but some brands have better reputations than others when it comes to quality.
- **Breakdowns:** There are many different factors to consider for potential equipment breakdowns such as:
    - How often does the equipment breakdown?
    - How quickly can it be repaired?
    - Are special skillsets required to repair it?
    - How much does it cost to repair?
    - Are backups required if the equipment is not functioning?
- **Maintenance:** Like breakdowns, the maintenance of equipment needs to be evaluated. The time, skills, and cost for maintenance are all important considerations.
- **Productivity gains:** Lots of equipment will help a worker do activities faster, easier, and with higher quality. This is an important when purchasing any piece of equipment.
- **Flexibility of use:** Some pieces of equipment can be used for several tasks instead of one specialized task. For example, a wagon may be used for harvesting but it could also be used earlier in the year for thinning, hauling brush, or transporting equipment. A tractor is an example of a vehicle that can be used for many different activities year-round.
- **Bottleneck tools:** Some tools are required even if there are cheaper alternatives. Since there is only so much time and labour during harvest time, a large farm will require many balers. If time was not a constraint and the harvesting season could be twice as long, half the number of balers could likely be used.
- **Use during year:** Some equipment is only used during a few weeks of the year such as balers, elevators, and even chainsaws for some operations. The hourly cost of this equipment is much higher than similar priced equipment that can be used year-round.

[11] This assumes there are no additional costs or savings related to baling or any other growing/harvesting activities (only dragging).

The following sections give some suggestions to technology, automation, and innovation that can be incorporated on the farm that could have a quick payback period in the right situation.

To simplify the calculations below, the focus will be an increase of productivity for calculating payback period. The following calculation is used to determine payback period, where payback period is measured in years:

$$Payback\ period = \frac{cost\ of\ investment}{savings/year}$$

$$= \frac{cost\ of\ investment}{savings/activity * current\ activity\ effort\ (hrs/year) * \$17/hr}$$

$$= \frac{cost\ of\ investment}{\frac{current\ time\ per\ activity - new\ time\ per\ activity}{current\ time\ per\ activity} * current\ activity\ effort\ (hrs/year) * \$17/hr}$$

7.5.1. Lot Management

Power brush cutters

Power brush cutters are extremely efficient at clearing small trees and they take out competing growth as the same time. Including the time to limb and junk trees, it is about twice as fast to use a power brush cutter vs. manual methods of an axe and specialized machetes.

If a power brush cutter costs $400, and there's an average of 50 hours of brush work required per year, the payback period will be under one year.

$$Payback\ Period = \frac{\$400}{50\% * 50\ hrs/year * \$17/hr} = 0.94\ years$$

Tractor

The decision to buy a tractor should not be taken lightly. It is an expensive piece of equipment that can help in so many areas and with many different tasks. If a tractor is only required for certain activities or at certain times of the year, it is worth investigating the costs of renting a tractor.

To determine if a tractor is worth the investment, the amount of time saved in your operations will be a big factor in that decision. To ballpark how many hours you need to save, you can rearrange the payback period formula to the following:

$$Savings/year = \frac{cost\ of\ investment}{Payback\ period}$$

$$savings/activity * current\ activity\ effort\ (hrs/year) * \$17/hr = \frac{cost\ of\ investment}{Payback\ period}$$

$$Savings/activity = \frac{cost\ of\ investment}{Payback\ period\ * current\ activity\ effort\ (hrs/year) * \$17/hr}$$

$$Savings/activity = \frac{\$100{,}000}{20\ years\ * 40hrs/person/week * 5\ people * 40\ weeks/year * \$17/hr}$$

$$\mathbf{3.7\%} = \frac{\$100{,}000}{20\ years\ * 40hrs/person/week * 5\ people * 40\ weeks/year * \$17/hr}$$

All-terrain vehicle (ATV or four-wheeler)

An ATV is a convenient vehicle to drive through stands quickly. It can access more of the lot than a truck or tractor for activities such as soil sampling, planting, spraying, fertilizing, and shearing.

In this example, a new ATV costs $10,000, will save 5% of the time required for planting, spraying, fertilizing, and spraying, which added up to 1600 hours the previous year.

$$Payback\ Period = \frac{\$10{,}000}{5\% * 800\ hrs/year * \$17/hr} = 14.7\ years$$

7.5.2. Planting

SMART Trees

SMART trees are genetically modified balsam fir trees that have enhanced needle retention, sturdy architecture, unique fragrance, blue-green needles, and increased immunity to pests. SMART trees are expected to sell for 20% more than the average Christmas tree, and save 20% on variable costs other than the seedling (i.e., takes one less year to grow, requires less shearing, spraying, fertilizing, etc.)

The payback period calculation does not work for the 8-year life cycle of a Christmas tree, so a break-even formula is used instead. The break-even formula shows what the maximum cost to pay for a SMART tree to maintain the same profit margin based on the following assumptions:

- Fixed costs are the same for SMART and balsam fir trees
- Sales price for balsam fir tree: $20
- Sales price for SMART tree: $20 *120% = $24
- Variable costs (other than seedling) for balsam tree: $10
- Variable costs (other than seedling) for SMART tree: $10 * 80% = $8
- Seedling for balsam fir tree: $0.60

$$Sales\ Price_{BF} - Variable\ Costs_{BF} - Seedling_{BF} = Sales\ Price_{SMART} - Variable\ Costs_{SMART} - Seedling_{SMART}$$

$$Seedling_{SMART} = Sales\ Price_{SMART} - Sales\ Price_{BF} + Variable\ Costs_{BF} - Variable\ Costs_{SMART} + Seedling_{BF}$$

$$Seedling_{SMART} = \$24 - \$20 + \$10 - \$8 + \$0.60$$

$$Seedling_{SMART} = \$6.60$$

For this scenario, a SMART seedling that costs $6.60 would result in the same profit (or contribution margin) as a balsam fir seedling that costs $0.60.

Mechanical tree planter

A mechanical tree planter can be used for plantations in open fields. It requires one operator driving the tractor and one sitting behind the tractor placing seedlings into the ground.

While trees can be planted at a rate of 10 seconds vs. 25 seconds for the manual method, the effort for a mechanical tree planter is 20 seconds per tree since two people are required. This results in labour savings of 20%.

In this example, a new mechanical tree planter (transplanter) costs $5000, will save 20% of labour costs compared to the previous year, which added up to 40 hours.

$$Payback\ Period = \frac{\$5000}{20\% * 40\ hrs/year * \$17/hr} = 36.8\ years$$

Because the labour savings only works out to about five seconds per tree, the investment required for a transplanter does not make sense when looking solely at effort. If the quality of planting is better with a mechanical tree planter, that should be factored into the calculations.

7.5.3. Spraying and Fertilizing

Tractor-mounted sprayer

A tractor-mounted sprayer is exponentially more efficient than spraying or fertilizing by hand. To spray or fertilize by hand, the worker needs to walk from tree to tree and spend 3-15 seconds at each tree to apply. Also, the worker can only carry so much spray or fertilized on their back, so they will need to refill regularly, taking time away from application.

A tractor-mounted sprayer will have a large swath and can cover many trees at once, all without the need to walk between trees and requiring less time (or no time) to refill.

In this example, a new tractor-mounted sprayer costs $3000, will save 99% of the time compared to the previous year, which added up to 40 hours.

$$Payback\ Period = \frac{\$3000}{99\% * 40\ hrs/year * \$17/hr} = 4.46\ years$$

7.5.4. Shearing

Mechanical (electric) shears

Mechanical equipment for shearing Christmas trees come in many different shapes, sizes, and prices. The Beneke electric trimmer, designed specifically for shearing Christmas trees, costs around $1000. It is estimated to be 33% quicker (20 seconds vs. 30 seconds) for shearing a Christmas tree when compared to conventional two-handled shears.

$$Payback\ Period = \frac{\$1000}{33.33\% * 1200\ hrs/year * \$17/hr} = 0.15\ years$$

7.5.5. Butt Pruning

Reciprocating saw

It is assumed trained and skilled operators with a reciprocating saw can butt prune 20% faster than hand cutters. An electric reciprocating saw will cost about $200.

$$Payback\ Period = \frac{\$200}{20\% * 50\ hrs/year * \$17/hr} = 1.18\ years$$

7.5.6. Harvesting and Storing

Chainsaws

To increase productivity with chainsaws, it's less about the speed and power of a chainsaw but it's durability. The less time spent fueling up, replacing a chain, or having to deal with a broken chainsaw, the more time can be spent in the lot cutting trees.

In this example, a new chainsaw costs $500, will have 50% less downtime compared to the previous year which added up to 20 hours.

$$Payback\ Period = \frac{\$500}{50\% * 20\ hrs/year * \$17/hr} = 2.94\ years$$

Balers

Like chainsaws, the efficiencies gained with a baler is less about the speed of baling and more on the time required to replace twine, clear jams, fix the baler, and other general downtime.

In this example, a new baler costs $10,000, will have 75% less downtime compared to the previous year that averaged 20 minutes of downtime a day.

$$Payback\ Period = \frac{\$10{,}000}{75\% * 0.33\ hrs/day\ * 3\ employees\ * 28\ days * \$17/hr} = 28\ years$$

While a 28-year payback period makes it seem like a new baler is a poor investment, other factors such as the length of the harvest season, challenges getting employees, and the inactive time for the rest of the employees if the baler is not running is not included in this formula.

7.5.7. Loading and Shipping

Palletizer

There are a few advantages to using a Christmas tree palletizer:

- Where loading Christmas trees onto a truck manually requires the coordination of a crew and everyone to be ready on-site when the truck arrives, using a palletizer can be done at any time.
- The time to load Christmas trees on a truck is reduced.
- Only one person is required to load Christmas trees on a truck when they're on a pallet.
- Christmas trees on pallets take up less space on a truck.

In this example, a Christmas tree palletizer costs $5000, will save 20% of the labour hours, save 5% on shipping costs of $2000, and the previous year involved two full days of loading.

$$Payback\ period = \frac{\$5000}{(20\% * 8\ hrs/day\ * 2\ \ days\ * 5\ employees * \$17/hr) + (5\% * \$2000)}$$

$$Payback\ period = 13.4\ years$$

Although not included in the payback period calculations, some buyers require palletized trees or are willing to pay extra to have trees on pallets.

Elevator

With an elevator, fewer workers are required to move trees onto the truck (three instead of five if doing it manually).

In this example, a new elevator costs $3,000, will require 60% of the crew to load in the same amount of time, and the previous year involved two full days of loading.

$$Payback\ Period = \frac{\$3000}{40\% * 8\ hrs/day\ * 2\ \ days\ * 5\ employees * \$17/hr} = 5.5\ years$$

Truck and Grapple

A log (or similar) truck with a grapple can make loading a much easier task with fewer loaders required.

In this example, a new truck with a grapple costs $100,000, will require 40% of the crew to load in the same amount of time compared to loading by hand, and the previous year involved 10 full days of loading.

$$Payback\ Period = \frac{\$100{,}000}{60\% * 8\ hrs/day\ * 10\ \ days\ * 5\ employees * \$17/hr} = 36.8\ years$$

Even if the farm produces enough Christmas trees to require five employees to load for 10 full days, a truck with a grapple is a poor investment if only used for loading Christmas trees. An elevator is a more cost-effective purchase.

7.5.8. Summary

All the scenarios presented in this section will vary from farm to farm based on the size of their operation, the price of the equipment they're looking to purchase, and their current productivity levels.

In summary, equipment with have a shorter payback period when:

- It is a large farm with a lot of acreage

- It is for an activity that takes a lot of effort each year
- There are extensive time savings between doing it manually vs. with equipment
- Employee costs are high

7.6. Choose and Cut

Many growers may want to consider a small portion of their business as choose and cut. Agri-tourism is on the rise, especially in our province, and Nova Scotians want to support local businesses. The experience of walking through a Christmas tree lot, choosing a tree from the stand, cutting the tree with a handsaw, and carrying the tree to your own car, is something customers are willing to pay for at a similar (or same) price as a retail lot.

Along with the increase of revenue per tree, there are also a lot of cost savings. Not having to hire a crew to bale, haul, and load trees is substantial. If these trees were to alternatively go to a retail lot, there is significant cost savings of shipping, lights, and equipment required to run a retail lot. A grower may still have to hire staff to run the choose and cut and deal with customers, handle cash, and bale trees, but this position is much easier to hire for than the traditional manual labour of harvesting Christmas trees.

7.6.1. Marketing

Many choose and cut operations rely on word of mouth and repeat customers to sustain the business from year to year. Many Nova Scotians are willing to travel long distances from major cities and town centres to pick their own tree and have that experience. Traditional marketing such as the newspaper and street signs can be used but there is also a lot of opportunity using digital marketing and social media to target specific customers and spread the word of your operation with minimal cost.

7.6.2. Additional Products

Once customers are at your lot, many are willing to spend extra money of products and services other than cutting a Christmas tree. Products may be byproducts from Christmas trees, such as Christmas wreaths, brush, or tabletop trees, but there may be other related products such as ornaments, Christmas tree stands, or mementos that customers may be willing to buy.

7.6.3. Enriched Experience

COVID-19 restricted the ability for choose-and-cut operators to distribute food and drink in 2020 and 2021, but experiences like these are often what keep customers coming back year after year and spreading the word to their family and friends. Activities such as sleigh rides, farm tours, and outdoor games can play a large part of drawing customers in. Food and drink such as hot apple cider, hot chocolate, coffee, cookies, and other snacks can make the difference between someone visiting your operation and picking up their tree from a retail lot.

8. Conclusion

The purpose of this report was to demonstrate the costs incurred by a Christmas Tree grower to produce Christmas trees. As demonstrated throughout the report, every Christmas tree grower in Nova Scotia is unique and the cost of production can vary dramatically from farm to farm. Knowing the "average" cost for a farm to grow a Christmas tree is not useful for any farmer or potential new entrant to the industry. What is valuable is knowing what actions can be taken to decrease the cost of production or increase the selling price per tree.

The cost of production calculations proves the type of lot (i.e., natural stand, even-aged management, and plantation) has less of an effect on cost per tree than the method and tools used to produce the tree.

The top five considerations to increase profitability for any Christmas tree grower are:

1. **Stocking** – As the data shows in the report, increasing stocking likely has the biggest return on investment for most farms. For example, a farm that has 6' x 6' spacing of trees compared to another farm that has 9' x 9' spacing, is producing more than double the number of trees per year (1210 trees per acre vs. 538 trees per acre). The cost to grow each tree also reduces since there is less walking between trees, and almost all activities require walking between trees.
2. **Tools and Equipment** – Purchasing and using the correct tools and equipment will have a large impact on the bottom line. Most mechanical equipment has a payback period of less than a year if investing over the use of hand tools. Buying quality tools that require less maintenance and result in less downtime are almost always the best investment compared to the less expensive options.
3. **Sales Price** – The easiest way to increase profit is to raise the sales price. While not the main objective of this report, it was demonstrated that increasing the sales price by 10% will have twice the impact than saving 10% on the cost of production.
4. **SMART Trees** – The potential for SMART trees to increase profitability is substantial. With the potential to harvest a year earlier, increase quality of the final product, require less inputs and labour, and to sell at a higher price, the extra cost for seedlings is well worth the investment.
5. **Cashflow** – Growing Christmas trees is a unique industry since it takes approximately eight years to sell a marketable tree. Most of industries measure their production lifecycle in days or weeks. Because of this, cashflow will be one of the biggest challenges for new entrants. Finding ways to delay costs such as only buying equipment when needed is important. It is also valuable to discover methods to increase revenue earlier such as selling wreaths, greenery, and tabletop trees.

In summary, it's important to track your costs, understand the impact of actions and activities on the bottom line, and continuously review for opportunities to improve operations.

> *"Measurement is the first step that leads to control and eventually to improvement. If you can't measure something, you can't understand it. If you can't understand it, you can't control it. If you can't control it, you can't improve it." — H. James Harrington*

Appendix A - Methods and Procedures

The establishment and production costs in this report were compiled from consultations with selected Christmas tree growers in Nova Scotia and industry specialists. The results reflect the recommended management practices for a typical grower in Nova Scotia at the present time and economic conditions. It is important to note that revenues and expenses will vary depending on the producer and their management decisions.

The cost of production model is founded on activity-based costing principles. Every activity required to grow a Christmas tree is accounted for with a cost assigned to it. This approach can help identify opportunities for growers as high-cost activities can be further analyzed and options to purchase more equipment. In some areas of the business, details and financial records for activities were unavailable. In these cases, estimates were made with traditional costing methods to calculate activities.

Cost of production data was collected and analyzed from surveys, workshops, farm visits, and supporting documentation from CTCNS.

Survey

A 12-part survey was sent to 139 contacts in Fall of 2020. The robust survey was intended to be a cost-effective method to collect information from many different operations and operators across the province. The survey contained questions about the background of the Christmas tree farm and several cost components relating to its production such as inputs, equipment, and labour. The breadth and depth of the survey supports a deeper dive into certain areas of Christmas Tree farming for investigation and on-site analysis.

The survey also contained questions specific to Perennia (Jay Woodworth) and Farm Safety Nova Scotia (Lori Brookhouse). The intention was to ask all relevant questions in one survey instead of sending out three surveys with repeating information.

The survey was broken into 12 sections with a combination of questions related to cost of production, growing practices, and farm safety:

1. Farm Characteristics
2. Administration/Business
3. Roads
4. Shearing
5. Planting
6. Fertilizing
7. Spraying
8. Other Crop Management
9. Harvesting
10. Sales
11. Other Products

12. General (open-ended) Questions

The list of questions from the survey is shown in

Farm Tours

This project started at the same time COVID-19 entered the province and caused significant shutdowns and restrictions across all regions. At critical times during the Christmas tree growing season, it was strongly recommended by Government not to travel in or out of the Halifax Regional Municipality. This constrained the number of farms that could be visited for the cost of production analysis so workshops were held to understand the regional differences that may exist.

Special thanks to Tom Ernst, the DeLong's (Jim and Jenni), Matthew and John Reeves, and Laurie Levy for hosting me on their farms, for some on more than one occasion, and taking time out of their busy days to allow me to collect data and view the process. The observations, time studies, and answers to questions allowed for a more comprehensive costing analysis than what could be provided by surveys, interviews, and workshops alone.

In-Person Workshops

Three workshops held in different areas of the province (Forties, Truro, and St. Andrews) provided a collaborative setting for participants to discuss and agree on the cost of production activities and opportunities for the industry. In total, 28 participants filled out workbooks that were used as a source for the cost of production analysis provided in this report. The workbook provided to participants can be found in Appendix D – Workshop Workbook.

Appendix B – Survey Questions

The following questions were presented online using 12 separate Microsoft Forms. Text in green represents questions required for Farm Safety Services.

1. Farm Characteristics

1. Your Name
2. Name of your farm
3. Farm Address
4. How many lots do you have?
5. If you know the PIDs of those lots, please list them here.
6. What style of lots do you have? (i.e., natural regeneration, natural regeneration with interplanting, plantation, other)
7. What do you believe is your spacing of trees or stocking density (e.g., 6ft x 6ft spacing, 900 stems/acre, 2000 trees/hectare)?
8. How much land is used to produce Christmas trees? (Please specify acres or hectares)
9. How much of that land is occupied by Christmas trees?
10. How many Christmas trees did you harvest last year?
11. Do you know how many Christmas trees were harvested from each lot?
12. How many Christmas trees did you sell last year? (i.e., was it the same or less than what you harvested?)
13. How many Christmas trees do you plan on selling this year?

2. Administration/Business

1. What environments do you work in? Select all that apply
    1. Lot
    2. Shop
    3. Office
    4. Other
2. What Positions are held within the Farming Operation? And what are their general tasks?
    1. Owner
    2. Lot Managers
    3. Tree Techs
    4. Operations Manager
    5. Equipment Operators
    6. Harvesters
    7. Sprayers
    8. Office Administration
    9. General Labour
3. How many employees (including owners, students, temporary foreign workers, etc.) are working in the field working during the following months:
    a. January
    b. February
    c. [list all months]…

4. How many people are doing office/administrative work during the following months. If it is not a full-time position, use a decimal to represent the effort (e.g., 0.25 if someone spends two hours a day on office/administrative work):
    d. January
    e. February
    f. [list all months]…
5. Do you track employee hours worked?
    g. If yes, do you track what activities the employees were doing?
    h. If yes, what categories/activities do you track?
6. Do you track how many hours you put into the business?
    i. If yes, do you track what activities the employees were doing?
    j. If yes, what categories/activities do you track?
7. How do you determine how much you get paid?
8. When do you pay yourself?
9. How do you plan for the year? For example…
    k. How many staff you will hire and when?
    l. Purchasing new tools, equipment, vehicles, new roads, etc.
    m. How many trees you will plant?
    n. What activities you will do, when, and how much (e.g., shearing, fertilizing, spraying, etc.)
10. What types of office equipment do you have?
11. Do you have access to the internet?
12. *Do you have any other thoughts/comments on the administrative side of your business? For example: Things that work well for you. Things that haven't worked well for you. Challenges. Opportunities.*

3. Roads

1. How much space is between your roads? Or how many roads do you have per acre or hectare?
2. Approximately how many metres/kms of roads do you have for your lots?
3. Do you plan on creating new roads in the next year or two?
    a. Yes/No/Maybe
    b. Why or why not?
4. What types of roads do you have?
5. How would you define the quality/grade of your roads?
        a. Great/Good/Good enough/Poor/Very poor
6. What type of equipment do you take on your roads?
7. Roughly how much effort is spent on maintaining/upgrading/building roads every year? (Example: 5 employees * 10 days = 50 days effort)
8. What types of vehicles are driven? Make & Model
9. Do you use trailers? Make & Model
9. *Do you have any other thoughts/comments on roads? For example: Things that work well for you. Things that haven't worked well for you. Challenges. Opportunities.*

4. Shearing

1. When do you start shearing for the year?
2. When do you finish shearing for the year?
3. How old are the trees that you shear?
4. How do you decide what trees to shear?

5. If you only had a limited amount of time to shear trees, which trees which you focus on (e.g., young/old, high quality/low quality, etc.)?
6. What tools do you use to shear? Make & Model
7. What is your thought process when you shear a tree? What things do you look for when shearing? How would you train someone with no experience to shear a tree?
8. Roughly how long does it take you to shear a tree?
    a. Minimum time (tree hardly needs any shearing)
    b. Average time (how long it usually takes)
    c. Maximum time (tree needs a lot of shearing)
9. Roughly how much effort is spent shearing every year? (Example: 5 employees * 10 days = 50 days effort)
10. How long does it take you to train a new hire to shear trees?
11. *Do you have any other thoughts/comments on shearing? For example: Things that work well for you. Things that haven't worked well for you. Challenges. Opportunities.*

5. Planting

1. How many Christmas trees have you planted this year per acre or hectare (please specify)?
2. What date did you start planting this year?
3. What date did you finish planting this year?
4. How did you determine how many trees to plant?
5. Where do you get your seedlings from?
    1. Scott & Stewart
    2. T&D Nursery
    3. Northern Pulp
    4. Strathlorne Forest Nursery
    5. Matt Priest
    6. N/A
    7. Other (please specify)
6. How much does it cost you for seedlings?
7. What tools/equipment do you use to plant? Make & Model
8. How much did the equipment cost?
9. Where did you get it from?
10. How often do you need to buy new equipment?
11. How much does it cost to maintain the equipment each year?
12. Roughly how much effort is spent planting every year? (Example: 5 employees * 10 days = 50 days effort)
13. *Do you have any other thoughts/comments on planting? For example: Things that work well for you. Things that haven't worked well for you. Challenges. Opportunities.*

6. Fertilizing

1. When do you start fertilizing for the year?
2. When do you finish fertilizing for the year?
3. Roughly how much effort is spent fertilizing? (Example: 5 employees * 10 days = 50 days effort)
4. Do you fertilize all trees/lots? If not, what trees/lots do you fertilize?
5. What type of fertilizer do you use?
6. What would you consider to be optimal conditions for soil pH, K2O, P2O5, Mg, Ca?
7. Do you add any micronutrients to your soils (i.e., Copper or Boron, Iron, Zinc)?

8. What do you base your selection of fertilizer on?
9. Did you have an agrologist (ex. Jay or other specialist) review your fertilizer selections?
10. How much fertilizer do you use each season? Specify type and rates
11. How much does the fertilizer cost each season? Break down by mix
12. What equipment do you use to fertilize? Make & Model
13. Do you use any PPE such as masks, respirators, specialty gloves, over-clothing, etc.?
14. How much did that equipment cost?
15. How often do you need to buy new equipment?
16. How much does it cost to maintain the equipment each year?
17. Do you apply lime or another amendment to raise the pH on your lots? If so, how is it applied/what amendment/ how much?
18. Do you apply foliar fertilizers? How are they applied? Where do you get them? What mixes? What do you base your selection on?
19. What would you consider to be an optimal needle nutrient concentration of N, Ca, K, Na, B, Cu, Mg, Zn? (Expressed as percentages)
20. *Do you have any other thoughts/comments on fertilizing? For example: Things that work well for you. Things that haven't worked well for you. Challenges. Opportunities.*

7. Spraying

1. When do you start spraying?
2. When do you finish spraying for the year?
3. Roughly how much effort is spent spraying? (Example: 5 employees * 10 days = 50 days effort)
4. Do you spray all trees/lots? If not, what trees/lots do you spray?
5. What type of sprays do you use? Make & Model
6. Do you use any PPE such as masks, respirators, specialty gloves, over-clothing, etc.?
7. How much spray do you use each season?
8. How much does pesticides cost each season?
9. What pests are you targeting with sprays (i.e., herbicides for weed or ground cover, insecticides- for what insects)?
10. What equipment do you use to spray?
11. How much did that equipment cost?
12. How often do you need to buy new equipment?
13. How much does it cost to maintain the equipment each year?
14. What weed issues do you regularly see? When?
15. What insect pressures do you regularly see? When?
16. What diseases do you regularly see? When?
17. *Do you have any other thoughts/comments on spraying? For example: Things that work well for you. Things that haven't worked well for you. Challenges. Opportunities.*

8. Other Crop Management

1. Roughly how much effort is spent under pruning every year? (Example: 5 employees * 10 days = 50 days effort)
2. Are there any scenarios when you need to use fall protection?
3. Do you use a work positioning system?
4. Roughly how much effort is spent thinning every year?
5. Roughly how much effort is spent clearing and controlling vegetation every year?

6. Do you flag your Christmas trees?
    a. If yes, who flags?
    b. If yes, what gets flagged?
    c. If yes, how many colours do you use? And what does each colour mean?
    d. If yes, how much effort is spent flagging every year?
7. What grading system do you use for your trees?
8. *Do you have any other thoughts/comments on crop management? For example: Things that work well for you. Things that haven't worked well for you. Challenges. Opportunities.*

9. Harvesting

1. When does harvesting typically start for you (what date)?
2. When does harvesting typically end for you (what date)?
3. What types of equipment are used to harvest? Make & Model
4. How many people do you use at harvest time?
5. How long is a typical harvest day?
6. How much time is spent on dragging one Christmas tree? (If some have minimal/no dragging times, and others have longer dragging times, use an average)
7. How long does it take to grade and tag a tree?
8. How long does it take to bale a Christmas tree?
9. How long does it take to load a Christmas tree?
10. Once loaded, where do you haul your Christmas trees? Are you required to store them?
11. In total, roughly how much effort is spent harvesting every year? (Example: 5 employees * 10 days = 50 days effort)
12. *Do you have any other thoughts/comments on harvesting? For example: Things that work well for you. Things that haven't worked well for you. Challenges. Opportunities.*

10.Sales

1. Who do you sell your Christmas Trees to?
2. Where do you sell your Christmas Trees?
3. How does your target market affect the way you grow and harvest Christmas trees? (e.g., different sizes, shapes, styles, quality, etc.)
4. Roughly how much effort is spent selling (and marketing) every year? (Example: 5 employees * 10 days = 50 days effort)
5. Do you use remote tree stand set up in urban and rural areas?
6. Do you handle cash?
7. *Do you have any other thoughts/comments on sales? For example: Things that work well for you. Things that haven't worked well for you. Challenges. Opportunities.*

11.Other Products

1. Do you sell any other products other than Christmas Trees? (Yes/No).
    a. If yes, what products do you sell?
    b. If yes, where do you sell your products?
    c. If yes, roughly how much effort (in days) do you spend in a year specifically on these products? (Example: 5 employees * 10 days = 50 days effort)
2. If you sell brush or make wreaths, when do you start harvesting brush?
3. Do you have a fueling station on farm?
4. Do you have chemical (fertilizers and sprays) storage on farm?

5. Any other types of outbuildings not already mentioned?
6. Do you work in extreme heat and cold? If yes, what tasks are performed under each category?
7. Do you use hand tools? List types of hand tools used.
8. Do you have a storage area? Do you use forklift, pallet jack, or hoists?

9. *Do you have any other thoughts/comments on other products? For example: Things that work well for you. Things that haven't worked well for you. Challenges. Opportunities.*

12. General (open-ended) Questions

Thinking back on all the questions you just answered…

1. What do you believe are your biggest **strengths** as a farm/owner?
2. What do you believe are your biggest **weaknesses** as a farm/owner?
3. What do you believe are your biggest **opportunities** as a farm/owner?
4. What do you believe are your biggest **threats** as a farm/owner?
5. Rate these factors from high importance to low importance (1 being the most important, 9 being the least important) to what you believe leads to the most profitable farm in the short- and long-term.
    a. Lot style/Location
    b. Clearing new land/expanding
    c. Planting
    d. Shearing
    e. Fertilizing
    f. Spraying for weed control
    g. Spraying for insect control
    h. Spraying for disease control
    i. Grading
    j. Ground Control / Saw Work
    k. Harvesting
    l. Roads
    m. Office/Administrative functions
6. Rate these factors from high importance to low importance (1 being the most important, 4 being the least important) to what you believe leads to the most profitable farm in the short- and long-term.
    a. Lot style/Location
    b. Employees' skills/experience/attitude
    c. Equipment/machinery
    d. Crop management (i.e., shearing, planting, harvesting, etc.)
    e. Marketing and sales
7. What do you believe are the most important factors for a profitable farm?

Follow-up

1. Would you be willing to share anonymized financial statements?
2. Would you be willing to share other types of data/information such as timesheets, maps, etc.?
3. Would you be willing to share lot management history such as soil and foliar sample reports and fertilizer and pesticide application records?
4. Would you be interested in hosting a tour of your Christmas tree farm to show your operations?

Appendix C – Cost of Production Calculations

This section is divided by activities to better illustrate the assumptions and difference between farms in the province. Each subsection has the following categories to demonstrate all costs and considerations:

- **Description:** Each subsection describes what the activity is and why it is important to producing Christmas trees.
- **Time Factors:** The effort required to finish an activity has many dependencies and variables depending on the lot, operator, tools, and other factors. This list allows any operator to consider what changes can be made to do the work more efficiently.
- **General Cost Assumptions:** Like time factors, there are many different attributes and variables that effect the cost of production. These assumptions are required to keep costs constant and comparable throughout the report.
- **Options:** For most activities, there are a few different approaches for getting the activity done. The options discussed is not an exhaustive list, but rather a technique to demonstrate the benefits, challenges, and costs of performing an activity in different ways (such as using different tools and equipment). Each option has a brief description, specific assumptions, and a breakdown of variable costs (labour and supplies). Full calculations are written out so any grower can alter the assumptions in the model and see how their own cost of production numbers compare.

Cost of Operations Calculation Assumptions

The following assumptions are used for all calculations in this section:

- Employees are paid **$17.00 per hour** (including taxes and fees).
- The average **spacing** for trees is **6ft x 6ft.**
- The Christmas tree farm as on square **40-acre lot.**
- There are a total of **48400 Christmas trees** growing (with an evenly distributed number of trees at each age for natural stands).
- The average **walking speed** of a worker is **3 ft/sec.**
- The **road spacing is 200 feet** apart.
- The **road width is 12 feet**.
- There is a total of **3 km of roads** (or 75 metres of roads per acre on average).
- Labour and material costs do not include travelling to the lot since they vary greatly between (and even within) farms.
- Fixed costs (such as machinery, equipment, buildings, and administration) are not included.
- Time for preventative maintenance or fixing equipment is not included.
- Averages are used for calculations where there may be a lot of variability.

- Idle time and paid breaks are not included in cost calculations. This time is considered in the costs and returns section of the report.
- Returns, quality of trees, and level of production are not considered in cost calculations but evaluated in the costs and returns section of the report. It is therefore important to note that the **lowest cost for an activity does not necessarily mean it is the best approach**. Other factors such as equipment available, workers available, and effectiveness of activity must be considered.

Other cost calculations are activity-dependent and are captured under each subsection.

Lot Management (natural stands)

Time Factors:

- **Amount of lot management required** – The growth of the lot and number of trees that need to be removed directly impacts the time required to thin the entire lot.
- **Target Spacing –** For operations that are aiming for less spacing (e.g., 4x4 ft for tabletop trees), less thinning will be required.
- **Size of trees –** The thicker the tree, the more time it will take to limb, junk, and cut.
- **Slope and Terrain –** Flatter lots with less brush, stumps, and large rocks are easier to navigate and the worker can walk at a quicker pace.
- **Worker's Ability –** Some workers can work faster and more effectively than others. For thinning, their ability is likely based on experience, training, age, and physical condition.
- **Tools Used** – Some tools will only work on smaller trees, so the right equipment needs to be available for the job. Mechanical tools are likely quicker for most workers.
- **Thinning Method** – The proper approach to thinning includes limbing and junking trees and cutting the stump down to the ground. If shortcuts are taken, the time required to thin can be shortened.

General Lot Management Cost Assumptions:

- To achieve a lot with 6ft x 6ft spacing, one tree needs to be removed every 100ft block (10ft x 10ft).
- All trees are small enough to use a power brush cutter to cut down and ratcheting hand snips to limb and junk.

Option 1: Power saws

Power saws can be effective for trees of all sizes. They take a little longer than a machete to limb and junk a tree but are quicker to remove the stump.

Assumptions:

- It takes 15 seconds on average to limb and junk a tree.
- It takes 15 seconds on average to cut the stump.
- Power saws require $5.00 of fuel per acre.

$$\textbf{Labour cost}: \$17/hr * \left[\left(\frac{30sec/tree}{3600sec/hr}\right) + \frac{10ft}{3\ ft/sec*3600\ sec/hr}\right] * \ 435.6\ trees/acre = \$68.57/\text{acre}$$

$$\textbf{Material and supply cost}: \$5.00/acre$$

$$\textbf{Total thinning cost per acre} = \$68.57 + \$5.00 = \$73.57$$

$$\textbf{Total thinning cost} = \$73.57\ \textbf{per acre} * 40\ \textbf{acres} = \$2942.67$$

$$\textbf{Total cost per tree (on average)} = \frac{\$73.57/acre}{1210\ trees/acre} = \$0.06$$

Option 2: Axe and specialized machetes

By using an axe or specialized machete, branches can easily be stripped from the standing tree with two or three quick swipes and then a few cuts. The final cut of the stump will be at ground level to eliminate regrowth and reducing stumbling hazards.

Assumptions:

- It takes 10 seconds on average to limb and junk a tree
- It takes 30 seconds on average to cut the stump

$$\textbf{Labour Cost}: \$17/hr * \left[\left(\frac{40\ sec/tree}{3600\ sec/hr}\right) + \frac{10ft}{3\ ft/\text{sec} * 3600\ sec/hr}\right] * \ 435.6\ trees/acre = \$89.14/\text{acre}$$

$$\textbf{Material and Supply Cost}: \$0/acre$$

$$\textbf{Total thinning cost per acre} = \$89.14 + \$0 = \$89.14$$

$$\textbf{Total thinning cost} = \$89.14/acre * 40\ acres = \$3565.47$$

$$\textbf{Total cost per tree (on average)} = \frac{\$89.14/acre}{1210\ trees/acre} = \$0.074$$

Option 3: Power brush cutters (brush saws) and ratcheting hand snips

Power brush cutters are extremely efficient at clearing small trees and they take out competing growth as the same time. The physical demand is also lower. Depending on the size of the tree, more time will be required to limb and junk a tree using ratcheting hand snips.

Assumptions:

- It takes 15 seconds on average to limb and junk a tree.
- It takes 5 seconds on average to cut the stump.
- Power brush cutters require $5.00 of fuel per acre.

$$\textbf{\textit{Labour cost}}: \$17/hr * [\left(\frac{20sec/tree}{3600sec/hr}\right) + \frac{10ft}{3\ ft/sec*3600\ sec/hr}] * \ 435.6\ trees/acre = \$48.00/\text{acre}$$

$$\textbf{\textit{Material and supply costs}}: \$5.00/acre$$

$$\textbf{\textit{Total thinning cost per acre}} = \$48.00 + \$5.00 = \$53.00$$

$$\textbf{\textit{Total thinning cost}} = \$53.00\ /\ acre * 40\ acres = \$2119.87$$

$$\textbf{\textit{Total thinning cost per tree (on average)}} = \frac{\$53.00\ /\ acre}{1210\ trees\ /\ acre} = \$0.044$$

Fill Planting (natural stands)

Time Factors:

- **Planting techniques** – There are many different planting techniques such as the slit, wedge, Wifsta hoe, and dibble methods. Each technique takes a slightly different amount of time.
- **Number of seedlings carried** – The more seedlings that can be carried at a time, the fewer trips are required back to the road to refill on seedlings, and more time can be spent on planting.
- **Spacing of roads** – Interplanting can be done quicker with less travelling back and forth to the road if spacing is narrower.
- **Spacing of trees –** Trees that are spaced further apart require more time walking which means less time is available for interplanting.
- **Slope and Terrain –** It is not only the distance, but the speed of the planter walking from tree to tree will determine how much time they can spend planting versus walking during the day. Flatter lots with less brush, stumps, and large rocks are easier to navigate and the planter can walk at a quicker pace.
- **Worker's Ability –** Some workers can work faster and more effectively than others. For planting, their ability is likely based on experience, training, age, and physical condition.
- **Tools Used** – Different planting tools have pros and cons depending on the terrain, seedling, and operator's preference.

General Fill planting Cost Assumptions:

- 2000 trees are planted in half of the 40-acre lot (i.e., 100 trees/acre).
- Stock is planted 21 feet apart on average.
- The worker plants half the seedlings walking away from the truck and the other half walking back towards the truck that is carrying the multi pot seedling trays.

Option 1: Seedlings (2+0) with a dibble or hoe pipe

One of the most common methods for growers planting by hand in Nova Scotia is to use the dibble (or hoe pipe) method. A dibble is solid and pushes dirt into the ground leaving a cone-shaped impression. A

hoe pipe cuts and removes an earth plug when pushed into the soil with the foot. Both are done using the following steps:

1. Push the implement vertically into the soil by stepping on the footplate.
2. Remove the implement using a slight twisting motion.
3. Select a seedling from the tray and place it in the hole.
4. Make sure the top of the plug is slightly below the soil level. At least 2/3 of the plug must extract from the multi-pot to be planted.
5. Firm seedling into the soil with forefinger and thumb.

Assumptions:

- The time required to perform steps 1 to 5 is 15 seconds.
- It takes 60 seconds to dispose of the empty tray, gather a new tray, and move to the new planting site.
- Stock is carried in trays of 24.
- Seedlings (2+0) cost $0.60 each.

$$\textbf{Labour Cost}: \$17 \ / \ hr * \left[\left(\frac{15 sec/tree}{3600 sec/hr}\right) + \frac{21 \ ft/tree}{3 \ ft/sec * 3600 \ sec/hr} + \frac{60 \ sec/tray}{24 trees/tray * 3600 \ sec/hr}\right] * \ 100 trees/acre = \$11.57/\text{acre}$$

$$\textbf{Material and supply cost}: \$0.60 \ / \ tree * 100 \ trees \ / \ acre = \$60.00$$

$$\textbf{Total fill planting cost per acre} = \$71.57$$

$$\textbf{Total fill planting cost} = \$71.57 \ / \ acre * 20 \ acres = \$1431.40$$

$$\textbf{Total fill planting cost per tree (on average)} = \frac{\$71.57 \ / \ acre}{100 \ trees \ / \ acre} = \$0.72$$

Option 2: Transplants (2+2) with shovel (slit method)

The slit method uses a shovel or spade and generally follows these steps:

1. Push the blade straight into the soil. Pull the handle back towards you making a slit. Remove the shovel.
2. Take a tree from the planting bag or bucket.
3. Place the tree upright against the vertical face with the root collar at ground level, spreading the roots naturally.
4. Holding the tree in position with one hand, use the shovel to push some soil against its roots.
5. Firm the remainder of the soil in place with the heel of your boot to eliminate air pockets.
6. Test the tree for firmness by giving a slight pull.

Assumptions:

- The time required to perform steps 1 to 6 is 20 seconds.
- It takes 60 seconds to dispose of the empty tray, gather a new tray, and move to the new planting site.
- Stock is carried in trays of 24.
- Transplants (2+2) cost $0.50 each.

$$\textbf{Labour Cost}: \$17 \ / \ hr$$

$$* \left[\left(\frac{20 sec/tree}{3600 sec/hr} \right) + \frac{21 \ ft/tree}{3 \frac{ft}{sec} * 3600 sec/hr} + \frac{60 \ sec/tray}{24 trees/tray * 3600 \ sec/hr} \right]$$

$$* \ 100 \frac{trees}{acre} = \$13.93/\text{acre}$$

$$\textbf{Material and supply cost}: \$0.50 \ per \ tree * 100 \ trees \ / \ acre = \$50.00$$

$$\textbf{Total fill planting cost per acre} = \$63.93$$

$$\textbf{Total fill planting cost} = \$63.93 \ / \ acre * 20 \ acres = \$1278.61$$

$$\textbf{Total fill planting cost per tree (on average)} = \frac{\$63.93 \ / \ acre}{100 \ trees \ / \ acre} = \$0.64$$

Option 3: Container Stock

Container stock is grown from seed in containers that encompass the roots. The seedlings are transported to the field in their containers.

1. Push the blade straight into the soil. Remove the shovel.
2. Make a second cut at an angle to the first and remove the wedge of soil.
3. Take a tree from the planting bag or bucket.
4. Place the tree upright against the vertical face with the root collar at ground level spreading the roots naturally.
5. Holding the tree in position with one hand, replace the wedge of soil against its roots.
6. Firm the soil with the heel of your boot to eliminate air pockets.
7. Test the tree for firmness by giving a slight pull.

Assumptions:

- The time required to perform steps 1 to 7 is 20 seconds.
- It takes 60 seconds to dispose of the empty tray, gather a new tray, and move to the new planting site.
- Stock is carried in a multipot #4 container with 96 cells.
- Container stock costs $0.50 each.

$$\textbf{Labour Cost}: \$17 \ / \ hr$$

$$* \left[\left(\frac{20 sec/tree}{3600 sec/hr} \right) + \frac{21 \frac{ft}{tree}}{3 \ ft/sec * 3600 \ sec/hr} + \frac{60 \ sec/tray}{96 trees/tray * 3600 \ sec/hr} \right]$$

$$* \ 100 trees/acre = \$13.05/\text{acre}$$

$$\textbf{Material and supply cost}: \$0.50 \ / \ tree * 100 \ trees \ / \ acre = \$50.00$$

$$\textbf{Total fill planting cost per acre} = \$63.05$$

$$\textbf{Total fill planting cost} = \$63.05 / \ acre * 20 \ acres = \$1260.90$$

$$\textbf{Total fill planting cost per tree (on average)} = \frac{\$63.05 \ / \ acre}{100 \ trees \ / \ acre} = \$0.63$$

Option 4: Wildlings (W+2)

Wildlings are small seedlings pulled from the forest floor. It this scenario, they are planted directly in ground as soon as they are pulled. This option is best suited for fields that are overstocked. A shovel is required and generally follows the slit method used for seedlings:

1. Push the blade straight into the soil. Remove the shovel.
2. Make a second cut at an angle to the first and remove the wedge of soil.
3. Take a tree from the planting bag or bucket.
4. Place the tree upright against the vertical face with the root collar at ground level spreading the roots naturally.
5. Holding the tree in position with one hand, replace the wedge of soil against its roots.
6. Firm the soil with the heel of your boot to eliminate air pockets.
7. Test the tree for firmness by giving a slight pull.

Assumptions:

- It takes 15 seconds to find a suitable wildling.
- It takes 60 seconds to properly pull a seedling from the forest floor.
- It takes 30 seconds to trim some of the root and pre dip wildlings before planting.
- It takes 15 seconds to find a location for the wildling.
- It takes 60 seconds to properly plant the wildling.
- Pre dip costs are negligible per tree

$$\textbf{Labour Cost}: \$17/hr * \frac{180 sec/tree}{3600 sec/hr} * \frac{100 trees}{acre} = \$85.00/\text{acre}$$

$$\textbf{Material and supply cost}: \$0$$

$$\textbf{Total fill planting cost per acre} = \$85.00$$

$$\textbf{Total fill planting cost} = \$85.00 \ / \ acre * 20 \ acres = \$1700$$

$$\textbf{Total fill planting cost per tree (on average)} = \frac{\$85.00 \ / \ acre}{100 \ trees \ / \ acre} = \$0.85$$

Planting (even-aged management in natural stands)

General Planting Cost Assumptions:

- One-eighth of the lot needs to be planted (five acres).
- Stock is planted 6 feet apart on average.
- The worker plants half the seedlings walking away from the truck and the other half walking back towards the truck that is carrying the multi pot seedling trays.

Option 1: Seedlings (2+0) with a dibble or hoe pipe

One of the most common methods for growers planting by hand in Nova Scotia is to use the dibble (or hoe pipe) method. A dibble is solid and pushes dirt into the ground leaving a cone-shaped impression. A hoe pipe cuts and removes an earth plug when pushed into the soil with the foot. Both are done using the following steps:

1. Push the implement vertically into the soil by stepping on the footplate.
2. Remove the implement using a slight twisting motion.
3. Select a seedling from the tray and place it in the hole.
4. Make sure the top of the plug is slightly below the soil level. At least 2/3 of the plug must extract from the multi-pot to be planted.
5. Firm seedling into the soil with forefinger and thumb.

Assumptions:

- The time required to perform steps 1 to 5 is 15 seconds.
- It takes 60 seconds to dispose of the empty tray, gather a new tray, and move to the new planting site.
- Stock is carried in trays of 24.
- Seedlings (2+0) cost $0.60 each.

$$\textbf{Labour Cost}: \$17/hr * \left[\left(\frac{15sec/tree}{3600sec/hr}\right) + \frac{6ft/tree}{3 \ ft/sec * 3600 \ sec/hr} + \frac{60 \ sec/tray}{24trees/tray * 3600 \ sec/hr}\right] * \frac{1210trees}{acre} = \$111.42/\text{acre}$$

$$\textbf{Material and supply cost}: \$0.60/tree * 1210 \ trees/acre = \$726.00$$

$$\textbf{Total planting cost per acre} = \$111.42 + \$726.00 = \$837.42$$

$$\textbf{Total planting cost} = \$837.42/acre * 5 \ acres = \$4187.10$$

$$\textbf{Total planting cost per tree (on average)} = \frac{\$837.42/acre}{1210 \ trees/acre} = \$0.69$$

Option 2: Transplants (2+2) with shovel (slit method)

The slit method uses a shovel or spade and generally follows these steps:

1. Push the blade straight into the soil. Pull the handle back towards you making a slit. Remove the shovel.
2. Take a tree from the planting bag or bucket.
3. Place the tree upright against the vertical face with the root collar at ground level, spreading the roots naturally.
4. Holding the tree in position with one hand, use the shovel to push some soil against its roots.
5. Firm the remainder of the soil in place with the heel of your boot to eliminate air pockets.
6. Test the tree for firmness by giving a slight pull.

Assumptions:

- The time required to perform steps 1 to 6 is 20 seconds.
- It takes 60 seconds to dispose of the empty tray, gather a new tray, and move to the new planting site.
- Stock is carried in trays of 24.
- Transplants (2+2) cost $0.50 each.

$$\boldsymbol{Labour\ Cost}: \$17\ /\ \boldsymbol{hr} * \left[\left(\frac{20 sec/tree}{3600 sec/hr}\right) + \frac{6\ ft/tree}{3 ft/sec * 3600 sec/hr} + \frac{60\ sec/tray}{24 trees/tray * 3600\ sec/hr}\right] * 1210 \frac{trees}{acre} = \$139.99/\text{acre}$$

$$\boldsymbol{Material\ and\ supply\ cost}: \$0.50\ per\ tree * 1210\ trees/acre = \$605.00$$

$$\boldsymbol{Total\ planting\ cost\ per\ acre} = \$139.99 + \$605.00 = \$744.99$$

$$\boldsymbol{Total\ planting\ cost} = \$744.99/acre * 5\ acres = \$3724.95$$

$$\boldsymbol{Total\ planting\ cost\ per\ tree\ (on\ average)} = \frac{\$744.99/acre}{1210\ trees/acre} = \$0.62$$

Option 3: Container Stock

Container stock is grown from seed in containers that encompass the roots. The seedlings are transported to the field in their containers.

1. Push the blade straight into the soil. Remove the shovel.
2. Make a second cut at an angle to the first and remove the wedge of soil.
3. Take a tree from the planting bag or bucket.

4. Place the tree upright against the vertical face with the root collar at ground level spreading the roots naturally.
5. Holding the tree in position with one hand, replace the wedge of soil against its roots.
6. Firm the soil with the heel of your boot to eliminate air pockets.
7. Test the tree for firmness by giving a slight pull.

Assumptions:

- The time required to perform steps 1 to 7 is 20 seconds.
- It takes 60 seconds to dispose of the empty tray, gather a new tray, and move to the new planting site.
- Stock is carried in a multipot #4 container with 96 cells.
- Container stock costs $0.50 each.

$$\boldsymbol{Labour\ Cost}: \$17/hr$$

$$* \left[\left(\frac{20 sec/tree}{3600 sec/hr} \right) + \frac{6 \frac{ft}{tree}}{3\ ft/sec * 3600\ sec/hr} + \frac{60\ sec/tray}{96 trees/tray * 3600\ sec/hr} \right]$$

$$* 1210\ trees/acre = \$129.28/\text{acre}$$

$$\boldsymbol{Material\ and\ supply\ cost}: \$0.50\ /\ tree * 1210\ trees\ /\ acre = \$605.00$$

$$\boldsymbol{Total\ planting\ cost\ per\ acre} = \$129.28 + \$605.00 = \$734.28$$

$$\boldsymbol{Total\ planting\ cost} = \$734.28/acre * 5\ acres = \$3671.40$$

$$\boldsymbol{Total\ planting\ cost\ per\ tree\ (on\ average)} = \frac{\$734.28\ /\ acre}{1210\ trees\ /\ acre} = \$0.61$$

Option 4: Wildlings (W+2)

Wildlings are small seedlings pulled from the forest floor. It this scenario, they are planted directly in ground as soon as they are pulled. This option is best suited for fields that are overstocked. A shovel is required and generally follows the slit method used for seedlings:

1. Push the blade straight into the soil. Remove the shovel.
2. Make a second cut at an angle to the first and remove the wedge of soil.
3. Take a tree from the planting bag or bucket.
4. Place the tree upright against the vertical face with the root collar at ground level spreading the roots naturally.
5. Holding the tree in position with one hand, replace the wedge of soil against its roots.
6. Firm the soil with the heel of your boot to eliminate air pockets.
7. Test the tree for firmness by giving a slight pull.

Assumptions:

- It takes 15 seconds to find a suitable wildling.
- It takes 60 seconds to properly pull a seedling from the forest floor.
- It takes 30 seconds to trim some of the root and pre dip wildlings before planting.
- It takes 15 seconds to find a location for the wildling.
- It takes 60 seconds to properly plant the wildling.
- Pre dip costs are negligible per tree

$$\boldsymbol{Labour\ Cost}: \$17/hr * \frac{180sec/tree}{3600sec/hr} * \frac{100trees}{acre} = \$85.00/\text{acre}$$

$$\boldsymbol{Material\ and\ supply\ cost}: \$0$$

$$\boldsymbol{Total\ fill\ planting\ cost\ per\ acre} = \$85.00$$

$$\boldsymbol{Total\ fill\ planting\ cost} = \$85.00\ /\ acre * 20\ acres = \$1700$$

$$\boldsymbol{Total\ fill\ planting\ cost\ per\ tree\ (on\ average)} = \frac{\$85.00\ /\ acre}{100\ trees\ /\ acre} = \$0.85$$

Planting (plantations)

Time Factors:

- **Planting techniques** – There are many different planting techniques such as the slit, wedge, Wifsta hoe, and dibble methods. Each technique takes a slightly different amount of time.
- **Number of seedlings carried** – The more seedlings that can be carried at a time, the fewer trips are required back to the road to refill on seedlings, and more time can be spent on planting.
- **Spacing of roads** – Interplanting can be done quicker with less travelling back and forth to the road if spacing is narrower.
- **Spacing of trees –** Trees that are spaced further apart require more time walking which means less time is available for interplanting.
- **Worker's Ability –** Some workers can work faster and more effectively than others. For planting, their ability is likely based on experience, training, age, and physical condition.
- **Tools Used** – Different planting tools have pros and cons depending on the terrain, seedling, and operator's preference. A mechanical tree planter will have a much higher rate of planting.

General Planting Cost Assumptions:

- One quadrant of the 40-acre lot is planted using 6' x 6' spacing (square 10-acre block).
- 12,100 trees will be planted (110 rows x 110 trees/row) to fill a 10-acre block with 6' x 6' spacing.
- Seedlings (2+0) cost $0.60 each.

Option 1: Checkboard design by range pole method

This method is the most labour-intensive of the three options. It requires at least three poles, one on each end of the planting area and at least one pole in between. After planting the first tree, the planter moves the pole over to the next row, returns to the first row, and proceeds to plant in a straight line towards the remaining range poles, moving them over to the next row once they get there.

Another option with a similar amount of effort is the steel tape method. It involves using steel tape to measure desired spacing, stake off rows, and placing sawdust for sites to plant trees.

Assumptions:

- For a 10-acre square block, five poles are used (one pole every 22 trees).
- It takes 5 minutes to place the starting poles and get supplies ready.
- It takes 30 seconds to move a pole from one row to the next.
- It takes 25 seconds to plant a tree using the hoe pipe method.
- It takes 60 seconds to dispose of the empty tray, gather a new tray, and move to the new planting site.
- Stock is carried in trays of 24.

$$\boldsymbol{Labour\ Cost}: \$17\ /\ hr * \left[\left(\frac{25 sec/tree}{3600 sec/hr}\right) + \frac{6 ft/tree}{3\ ft/sec * 3600\ sec/hr} + \frac{60\ sec/tray}{24 trees/tray * 3600\ sec/hr} + \frac{30\ sec/pole}{22 trees/pole * 3600\ sec/hr}\right] * 1210\ trees/acre = \$176.35/\text{acre}$$

$$\boldsymbol{Setup\ Labour\ Cost}: \frac{\$17}{hr} * \frac{5\ mins}{60\ \frac{mins}{hr}} * \frac{1}{10\ acres} = \$0.14/\text{acre}$$

$$\boldsymbol{Material\ and\ supply\ cost}: \$0.60/tree * 1210\ trees/acre = \$726.00$$

$$\boldsymbol{Total\ planting\ cost\ per\ acre} = \$176.35 + \$726.00 + \$0.14 = \$902.49$$

$$\boldsymbol{Total\ planting\ cost} = (\$902.49\ /\ acre * 10\ acres) = \$9024.92$$

$$\boldsymbol{Total\ planting\ cost\ per\ tree\ (on\ average)} = \frac{\$902.49\ /\ acre}{1210\ trees\ /\ acre} = \$0.75$$

Option 2: Checkboard design by tractor

There are a few approaches to use a tractor, but they all involve a tractor driving a straight line up and down the field then across the field to create a checkerboard pattern. The tractor can use its wheel width, metal bars attached to the three-point hitch, or chains to identify the spacing.

Assumptions:

- The tractor drives and average of 10km/h to mark the rows
- It takes 10 seconds for the tractor to turn around and prepare for the next row
- The tractor used an attachment on the three-point hitch so it can make two new rows on each pass (one row is tracked over an old row for alignment).
- 55 vertical passes and 55 horizontal passes are required by the tractor.
- It takes 25 seconds to plant a tree using the hoe pipe method.
- It takes 60 seconds to dispose of the empty tray, gather a new tray, and move to the new planting site.
- Stock is carried in trays of 24.

$$\textbf{Labour Cost}: \$17\ /\ hr$$

$$* \left[\left(\frac{25 sec/tree}{3600 sec/hr} \right) + \frac{6 \frac{ft}{tree}}{3\ ft/sec * 3600\ sec/hr} + \frac{60\ sec/tray}{24 trees/tray * 3600\ sec/hr} \right]$$

$$* \ 1210 trees/acre = \$168.56/\text{acre}$$

$$\textbf{Setup Labour Cost}: \$17/hour * \frac{110\ passes * 0.2\ km/pass}{10\ \ km/hr} * \frac{1}{10\ acres} = \$3.74/\text{acre}$$

$$\textbf{Material and supply cost}: \$0.60/tree * 1210\ trees/acre = \$726.00$$

$$\textbf{Total planting cost per acre} = \$168.56 + \$726.00 + \$3.74 = \$898.30$$

$$\textbf{Total planting cost} = (\$898.30\ /\ acre * 10\ acres) = \$8983.00$$

$$\textbf{Total planting cost per tree (on average)} = \frac{\$898.30\ /\ acre}{1210\ trees\ /\ acre} = \$0.74$$

Option 3: Row design with mechanical tree planter

Row planting only measures the field in one direction and maintains spacing between rows, but the spacing between trees is more erratic. This type of design is ideal for the use of mechanical tree planters, which will plant thousands of trees per day.

Assumptions:

- The tractor drives and average of 10km/h to mark the rows
- It takes 10 seconds for the tractor to turn around and prepare for the next row
- The tractor used an attachment on the three-point hitch so it can make two new rows on each pass (one row is tracked over an old row for alignment).
- 55 passes are required by the tractor
- It takes 10 seconds between planting trees
- One operator is required to drive the tractor while another worker needs to plant the tree

Stock is stored on the tractor, so no additional time is required to gather or dispose of trays.

$$\textbf{Labour Cost}: \$17\ /\ hr * \frac{10 sec/tree}{3600 sec/hr} * 2 * \ 1210\ trees/acre = \$114.28/\text{acre}$$

$$\textbf{Setup Labour Cost}: \$17/hr * \frac{55\ passes * 0.2\ km/pass}{10\ km/hr} * \frac{1}{10\ acres} = \$1.87/\text{acre}$$

$$\textbf{Material and supply cost}: \$0.60\ /\ tree * 1210\ trees\ /\ acre = \$726/acre$$

$$\textbf{Total planting cost per acre} = \$114.28 + \$726.00 + \$1.87 = \$842.15$$

$$\textbf{Total planting cost} = (\$842.15\ /\ acre * 10\ acres) = \$8421.50$$

$$\textbf{Total planting cost per tree (on average)} = \frac{\$842.15\ /\ acre}{1210\ trees\ /\ acre} = \$0.70$$

Spraying

Spraying pesticides is an essential component of growing quality Christmas trees. Pesticides are used to manage weeds, insects, and disease and may be applied multiple times a year or once every few years.

Time Factors:

- **Volume of pesticide spray needed** – The most obvious time factor is how much spraying is required for the year. This depends on the volume of weeds, insects, and disease present in a Christmas tree lot and the grower's preference on how to manage it.
- **Spraying technique** – Growers that use a spray shield and take more care to apply the spray to each tree will take more time.
- **Spraying equipment** – Backpack sprayers and mist blowers will use less product but will take more time to get through the entire lot.
- **Nozzle size** – How big the orifice is on a nozzle, measured in L/minute or gal/minute. Increasing the nozzle orifice size increases sprayer output per area.
- **Spray pressure** – The pressure at which the spray mixture is forced through the nozzle orifice, often in bars (metric) or psi (imperial). Increasing pressure increases sprayer output per area.
- **Sprayer speed** – How fast a sprayer travels, in km/hour or m/sec. Increasing speed decreases sprayer output per area.

- **Spray swath** – The effective spray coverage of an individual nozzle set-up (metres or feet). If all other parameters are equal, increasing the spray swath increases sprayer output.
- **Size of tank** – The larger the tank, the less frequently spraying needs to stop to fill up.
- **Spacing of trees** – Trees that are spaced further apart requires more time travelling or walking to spray the same number of trees.
- **Spacing of roads** –The spacing of roads has a direct impact on the efficiency and time required for using tractor-mounted spray equipment.

General Spraying Cost Assumptions:

- Insecticide is required for the full 40 acres.
- Insecticide costs $80/L.
- 100mL of insecticide is required per acre[12].
- The ratio of insecticide to water is 1:10.

Option 1: Backpack hydraulic sprayers

Pesticides can be applied very accurately with the backpack when proper technique and preparation are employed. Using a spray shield can allow growers to apply contact sprays close to young seedlings without damage.

Assumptions:

- It takes 15 seconds to properly apply the spray at each tree.
- Backpack holds 10L.
- It takes 2 minutes to refill backpack and mix in pesticide and water.
- Every tree needs to be sprayed.

$$\boldsymbol{Labour\ Cost}: \$17\ /\ \boldsymbol{hr} * \left[\left(\frac{15 sec/tree}{3600 sec/hr}\right) + \frac{6\ ft/tree}{3\ ft/sec * 3600\ sec/hr} + \frac{120\ sec/backpack * 1.1 L/acre}{10\ L/backpack * 3600\ sec/hr}\right] * 1210 trees/acre = \$172.56/\text{acre}$$

$$\boldsymbol{Material\ and\ supply\ cost}: \$80.00\ /\ L * 0.1 L\ /\ acre = \$8.00$$

$$\boldsymbol{Total\ spray\ cost\ per\ acre} = \$180.56$$

$$\boldsymbol{Total\ spray\ cost} = \$180.56\ /\ acre * 40\ acres = \$7222.38$$

$$\boldsymbol{Total\ spray\ cost\ per\ tree\ (on\ average)} = \frac{\$180.56\ /\ acre}{1210\ trees\ /\ acre} = \$0.15$$

[12] This value is meant for demonstration purposes to calculate a cost and is not a recommendation. See disclaimer in the first section of the report for more information.

Option 2: Backpack mist blowers

This type of sprayer is best suited for insecticides or fungicides. When applying suspension type sprays, follow the same procedure outlined in the backpack hydraulic section, with these additional points: The greatest drawback for herbicide applications is the variation of swath width. Bearing this in mind, keep swaths as narrow as possible (6–8 m), and direct the spray level with the ground. Backpack mist blowers can apply spray much more quickly than backpack hydraulic sprayers.

Assumptions:

- It takes 5 seconds on average to properly apply the spray at each tree.
- Backpack holds 10L.
- It takes 2 minutes to refill backpack and mix in pesticide and water.
- Every tree needs to be sprayed.

$$\boldsymbol{Labour\ Cost}: \$17/\ \boldsymbol{hr} * \left[\left(\frac{5 sec/tree}{3600 sec/hr}\right) + \frac{6\ ft/tree}{3 ft/sec * 3600 sec/hr} + \frac{120\ sec/backpack * 1.1\ L/acre}{10\ L/backpack * 3600\ sec/hr}\right] * 1210 trees/acre = \$115.42/\text{acre}$$

$$\boldsymbol{Material\ and\ supply\ cost}: \$80.00\ /\ L * 0.1 L\ /\ acre = \$8.00$$

$$\boldsymbol{Total\ spray\ cost\ per\ acre} = \$123.42$$

$$\boldsymbol{Total\ spray\ cost} = \$123.42/\ acre * 40\ acres = \$4936.82$$

$$\boldsymbol{Total\ spray\ cost\ per\ tree\ (on\ average)} = \frac{\$123.42\ /\ acre}{1210\ trees\ /\ acre} = \$0.10$$

Option 3: Tractor-mounted sprayer

Operating a boom sprayer in a natural stand is in most cases impossible, yet the development of the boomless nozzle allows us to use this system. Swaths between 6–18 m can be achieved from one cluster of various nozzles (no boom). Modern technology has allowed for extremely accurate GPS guidance systems that can minimize overlap and misses in a field.

Assumptions:

- It takes 10 minutes to prepare, calibrate, and load the sprayer.
- A tractor needs to travel 3.2 km to cover 40 acres.
- A tractor needs to travel at 5km/h to effectively apply spray.
- The tractor's tank can hold enough for one application of the entire 40-acre block.

$$\boldsymbol{Labour\ Cost}: \$17\ /\ \boldsymbol{hr} * \left[\left(\frac{3.2 km}{5\ km/hr}\right) + \frac{10\ minutes}{60\ min/hr}\right] = \$13.71 \text{ for } 40 \text{ acres}$$

$$\textbf{\textit{Material and supply cost}}: \$80.00 \ / \ L * 0.1L \ / \ acre = \$8.00$$

$$\textbf{\textit{Total spray cost per acre}} = \frac{\$13.71}{40} + \$8.00 = \$8.34$$

$$\textbf{\textit{Total spray cost}} = \$8.34 \ / \ acre * 40 \ acres = \$333.71$$

$$\textbf{\textit{Total spray cost per tree (on average)}} = \frac{\$8.34 \ / \ acre}{1210 \ trees \ / \ acre} = \$0.007$$

Option 4: Tractor-mounted mist blower/airblast/cannon sprayer

These sprayers are typically used for fungicide or insecticide applications. They have a larger swath width and can carry a large spray volume, so several acres can be done per tank load.

Tractor mounted airblast sprayers do have some serious drawbacks, including not having the ability to apply product accurately. They are very prone to drift and should only be operated in ideal conditions. When there is no wind, the droplets will stay suspended in the air and can drift offsite. In higher winds, (i.e., 10 km/hour) it can be difficult to get a consistent swath width and product can drift for some distance.

Assumptions:

- It takes 10 minutes to prepare, calibrate, and load the sprayer.
- A tractor needs to travel 3.2 km to cover 40 acres.
- A tractor needs to travel at 5km/h to effectively apply spray.
- The tractor's tank can hold enough for one application of the entire 40-acre block.

$$\textbf{\textit{Labour Cost}}: \$17 \ / \ hr * \left[\left(\frac{3.2km}{5 \ km/hr}\right) + \frac{10 \ minutes}{60 \ min/hr}\right] = \$13.71 \text{ for } 40 \text{ acres}$$

$$\textbf{\textit{Material and supply cost}}: \$80.00 \ / \ L * 0.1L \ / \ acre = \$8.00$$

$$\textbf{\textit{Total spray cost per acre}} = \frac{\$13.71}{40} + \$8.00 = \$8.34$$

$$\textbf{\textit{Total spray cost}} = \$8.34 \ / \ acre * 40 \ acres = \$333.71$$

$$\textbf{\textit{Total spray cost per tree (on average)}} = \frac{\$8.34 \ / \ acre}{1210 \ trees \ / \ acre} = \$0.007$$

Fertilizing

Fertilizing Christmas tree soil helps increase overall Christmas tree productivity. There are two main ways to apply fertilizer: dripline application and field application.

Time Factors:

- **Volume of fertilizer carrying on hand** – The more fertilizer that can be carried at a time, the fewer trips are required back to the road to refill.
- **Spacing of roads** – Fertilizing can be done quicker with less travelling back and forth to the road if spacing is narrower.
- **Spacing of trees –** Trees that are spaced further apart require more time walking which means less time is available for fertilizing.
- **Slope and terrain –** Flatter lots with less brush, stumps, and large rocks are easier to navigate and the worker can walk at a quicker pace.
- **Worker's ability and technique –** Some workers can work faster and more effectively than others. For fertilizing, their ability is likely based on experience, training, age, and physical condition. They may employ different techniques which can alter the amount of time required and the effectiveness of the application.
- **Tools used** – Different fertilizing tools have pros and cons depending on the terrain, age and condition of trees, and operator's preference.

General Fertilizing Cost Assumptions:

- 100 grams of fertilizer is required for a mature tree.
- 1 tonne of 25-5-5 fertilizer costs $700[13].

Option 1: Dripline fertilization with backpack

Many growers choose to manage nutrients on a per tree basis and opt to apply fertilizers around the dripline of individual trees. Fertilizing around the dripline is often cheaper and allows for more efficient use of product, however it requires individual tree evaluation which is challenging to do accurately. Any tree over two feet should be fertilized. The larger the tree, the more fertilizer is required.

Assumptions:

- It takes 5 minutes to blend and create fertilizer ratio (once a day)
- It takes 2 minutes to refill fertilizer backpack.
- It takes 3 seconds to apply fertilizer per tree.
- 10 kgs of fertilizer can be carried in a backpack.

[13] Fertilizer costs can vary significantly and have seen large price increases in the past. Be sure to check current fertilizer prices before using these costs to guide any decisions.

$$\textbf{Labour cost}: \left[\$17/hr * \left[\left(\frac{3sec/tree}{3600sec/hr}\right) + \frac{6ft}{3\frac{ft}{sec} * 3600sec/hr}\right] * 1210trees/acre\right] + \left[\$17 * \left(\frac{5min}{60min/hr} + \left(\frac{\frac{1210trees/acre}{10000g/backpack}}{100g/tree} * \frac{2\ min/backpack}{60min/hour}\right)\right)\right] = \$36.84/\text{acre}$$

$$\textbf{Material and supply cost per acre} = \$700/tonne * 100g/tree * 1210\ trees * \frac{1\ tonne}{1,000,000g}$$
$$= \$84.70$$

$$\textbf{Total fertilizing cost per acre} = \$36.84 + \$84.70 = \$121.54$$

$$\textbf{Total fertilizing cost} = \$121.54/\ acre * 40\ acres = \$4861.71$$

$$\textbf{Total cost per tree (on average)} = \frac{\$121.54\ /\ acre}{1210\ trees\ /\ acre} = \$0.10$$

Option 2: Field fertilization

The standard for fertilization recommendations across the agricultural sector is to manage nutrients across the entire field. Nutrient application on a field basis will improve soil fertility of the entire site over time, which will show benefits such as improved germination and growth for decades. This method is not recommended for most natural stands unless the lot has a great road system.

Assumptions:

- It takes 10 minutes to prepare, calibrate, and load the tractor-mounted blaster.
- A tractor needs to travel 3.2 km to cover 40 acres.
- A tractor needs to travel at 5km/h to effectively apply fertilizer.
- 20% more fertilizer is required compared to dripline fertilization.

$$\textbf{Labour Cost}: \$17\ /\ hr * \left[\left(\frac{3.2km}{5\ km/hr}\right) + \frac{10\ minutes}{60\ min/hr}\right] = \$13.71\ \textbf{for 40 acres}$$

$$\textbf{Material and supply cost per acre}: \$700/tonne * 120g/tree * 1210\ trees * \frac{1\ tonne}{1,000,000g}$$
$$= \$101.64$$

$$\textbf{Total fertilizing cost per acre} = \frac{\$13.71}{40} + \$101.64 = \$101.98$$

$$\textbf{Total fertilizing cost} = \$101.98/acre * 40\ acres = \$4079.31$$

$$\textbf{Total fertilizing cost per tree (on average)} = \frac{\$101.98\ /\ acre}{1210\ trees\ /\ acre} = \$0.08$$

Shearing

Shearing is a proven way of increasing the quality and quantity of saleable Christmas trees in balsam fir stands. It controls tree form and promotes foliage density, the most important characteristic determining tree grade and value. Many injuries and growth abnormalities can be treated by appropriate shearing practices, which prevent serious deformities and tree loss. Proficiency increases with experience and practice.

Time Factors:

- **Size of Tree** – With all other factors the same, larger trees require more time to shear. Larger trees over eight feet tall may require long-handled shears that take much more time to use and likely aren't carried on hand while going through the lot so may require another trip back to the truck.
- **Tree abnormalities/deformities** – With all other factors the same, trees with more abnormalities and deformities require more time to shear. Where conditions cannot be corrected by shearing within an acceptable time, skip shearing and cull the tree.
- **Uneven density and symmetry** – With all other factors the same, trees with less density and symmetry require more time to shear and may even require hand pruners to remove part of or entire branches from dense sections if their length and density interfere with the tree's symmetry and uniformity.
- **Spacing –** Trees that are spaced further apart require more time walking which means less time is available for shearing.
- **Slope and Terrain –** It is not only the distance, but the speed of the shearer walking from tree to tree will determine how much time they can spend shearing versus walking during the day. Flatter lots with less brush, stumps, and large rocks are easier to navigate and the shearer can walk at a quicker pace.
- **Shearer's Ability –** Possibly the most critical factor for a quick and quality shearing is the ability of the shearer. Their ability is likely based on experience, training, age, and condition.
- **Tools Used** – Another important factor that will affect the time required to shear is the tool being used. A mechanical shearing machine is most often quicker than two-handled shears. The quality and maintenance of the tool will also play a role in the speed and quality of shearing.

General Shearing Cost Assumptions:

- 60% of trees in the lot require shearing (29040 trees).
- Since all trees are in one lot, there is no time allocated to sanitize.

Option 1: Two-handled shears

Two-handled shears enable to worker to accurately shear all parts of the tree that are within reaching distance. There is less danger of injury with two-handled shears which is why many growers choose this tool.

Assumptions:

- It takes 40 seconds, on average, to shear a tree

$$\textbf{Labour cost}: \$17/hr * \left[\left(\frac{40sec/tree}{3600sec/hr}\right) + \frac{10ft}{3ft/sec*3600sec/hr}\right] * 1210trees/acre * 60\% = \$148.56/\text{acre}$$

$$\textbf{Material and supply cost}: \$0/acre$$

$$\textbf{Total shearing cost per acre} = \$148.56 + \$0 = \$148.56$$

$$\textbf{Total shearing cost} = \$148.56 \ / \ acre * 40 \ acres = \$5942.44$$

$$\textbf{Total cost per tree per year (on average)} = \frac{\$148.56 \ / \ acre}{726 \ trees \ / \ acre} = \$0.20$$

$$\textbf{Total cost per tree (on average)} = \ \$0.20 * 6 = \$1.20$$

Option 2: Shearing Knives

Shearing knives can be a quick and effective way to shear and shape a tree. While care must be taken with the use of any tool, shearing knives especially require training, focused attention, and protective leg and handguards.

Assumptions:

- Trained and skilled operators with shearing knives can shear a tree in 30 seconds.

$$\textbf{Labour cost}: \$17/hr * \left[\left(\frac{30sec/tree}{3600sec/hr}\right) + \frac{10ft}{3ft/sec*3600sec/hr}\right] * 1210trees/acre * 60\% = \$114.28/\text{acre}$$

$$\textbf{Material and supply cost}: \$0/acre$$

$$\textbf{Total shearing cost per acre} = \$114.28 + \$0 = \$114.28$$

$$\textbf{Total shearing cost} = \$114.28 \ / \ acre * 40 \ acres = \$4571.11$$

$$\textbf{Total cost per tree per year (on average)} = \frac{\$114.28 \ / \ acre}{726 \ trees \ / \ acre} = \$0.16$$

$$\textbf{Total cost per tree (on average)} = \ \$0.16 * 6 = \$0.96$$

Option 3: Mechanical shearing machines

Shearing with motor or battery-powered shearing machines will usually yield a tree with exceptional density, however repeated mechanical shearing can produce heavy trees.

Assumptions:

- Trained and skilled operators with mechanical shearing machines can shear a tree in 20 seconds.
- A battery-powered machine is used. The time it takes to replace a dead battery is negligible (i.e., it can be done quickly during breaks).
- The electricity cost for charging a battery is negligible.

$$\textbf{Labour cost}: \$17/hr * \left[\left(\frac{20sec/tree}{3600sec/hr}\right) + \frac{10ft}{3ft/sec*3600sec/hr}\right] * 1210trees/acre * 60\% = \$79.99/\text{acre}$$

$$\textbf{Material and supply cost}: \$0/acre$$

$$\textbf{Total shearing cost per acre} = \$79.99 + \$0 = \$79.99$$

$$\textbf{Total shearing cost} = \$79.99 \ / \ acre * 40 \ acres = \$3199.78$$

$$\textbf{Total cost per tree (on average)} = \frac{\$79.99 \ / \ acre}{726 \ trees \ / \ acre} = \$0.11$$

$$\textbf{Total cost per tree (on average)} = \ \$0.11 * 6 = \$0.66$$

Butt Pruning

Butt pruning to establish a "handle" and a strong bottom whorl are usually combined with the first shearing. The removal of branches near the ground may reduce the incidence of foliage diseases such as needle casts by improving the air circulation with the tree lot.

Shearing for symmetry and taper, whether in wild stands or plantations, is easier when the bottom branches of the Christmas tree have first been determined and the stem butt has been pruned. The exact amount of pruning necessary for a well-formed tree is easier to determine while the tree is standing. Also, pruning assures a more accurate inventory of saleable trees and greatly speeds up the harvesting operation.

Time Factors:

- **Size of Tree** – With all other factors the same, larger trees require more time to butt prune.
- **Amount of Pruning Required** – With all other factors the same, trees with more abnormalities and deformities require more time to shear. Where conditions cannot be corrected by shearing within an acceptable time, skip shearing and cull the tree.
- **Spacing –** Trees that are spaced further apart require more time walking which means less time shearing in the run of a given day.
- **Slope and Terrain –** It is not only the distance, but the speed of the shearer walking from tree to tree will determine how much time they can spend shearing versus walking during the day. Flatter lots with less brush, stumps, and large rocks are easier to navigate and the shearer can walk at a quicker pace.
- **Worker's Ability –** Some workers can work faster and more effectively than others. For butt pruning, their ability is likely based on experience, training, age, and physical condition.

- **Tools Used** – Another important factor that will affect the time required to shear is the tool being used. A mechanical shearing machine is most often quicker than two-handled shears. The quality and maintenance of the tool will also play a role in the speed and quality of shearing.

General Butt Pruning Cost Assumptions:

- 10% of trees a year require butt pruning.
- Butt pruning is not paired with another task (i.e., the worker is only butt pruning, not shearing or grading at the same time).

Option 1: Hand cutters

For this option, pruned branches are cut close to the stem with hand cutters.

Assumptions:

- It takes 45 seconds to properly butt prune a tree.

$$\boldsymbol{Labour\ cost}: \$17/hr * \left[\left(\frac{45sec/tree}{3600sec/hr}\right) + \frac{60ft}{3ft/sec*3600sec/hr}\right] * 1210\ trees/acre * 10\% = \$37.14/\text{acre}$$

$$\boldsymbol{Material\ and\ supply\ cost}: \$0/acre$$

$$\boldsymbol{Total\ butt\ pruning\ cost\ per\ acre} = \$37.14 + \$0 = \$37.14$$

$$\boldsymbol{Total\ butt\ pruning\ cost} = \$37.14\ /\ acre * 40\ acres = \$1485.61$$

$$\boldsymbol{Total\ cost\ per\ tree\ (on\ average)} = \frac{\$37.14\ /\ acre}{121\ trees\ /\ acre} = \$0.31$$

Option 2: Reciprocating saw

For this option, pruned branches are cut close to the stem with a reciprocating saw.

Assumptions:

- Trained and skilled operators with a reciprocating saw can butt prune 20% faster (36 seconds) than hand cutters.
- A battery-powered machine is used. The time it takes to replace a dead battery is negligible (i.e., it can be done quickly during breaks).
- The electricity cost for charging a battery is negligible.

$$\boldsymbol{Labour\ cost}: \$17/hr * \left[\left(\frac{36sec/tree}{3600sec/hr}\right) + \frac{60ft}{3ft/sec*3600sec/hr}\right] * 1210\ trees/acre * 10\% = \$32.00/\text{acre}$$

$$\boldsymbol{Material\ and\ supply\ cost}: \$0/acre$$

$$\boldsymbol{Total\ butt\ pruning\ cost\ per\ acre} = \$32.00 + \$0 = \$32.00$$

$$\textbf{Total butt pruning cost} = \$32.00 \ / \ \textbf{acre} * 40 \ \textbf{acres} = \$1279.91$$

$$\textbf{Total cost per tree (on average)} = \frac{\$32.00 \ / \ \textbf{acre}}{121 \ \textbf{trees} \ / \ \textbf{acre}} = \$0.26$$

Grading

Most grading systems for balsam fir are based on two key factors: density and symmetry. Density refers to the abundance of needles and is influenced largely by the number of branches. This is sometimes described in terms of amount of stem coverage. Most trees require shearing to produce heavy foliage. Trees with the heaviest density receive four or five shearings. Classifications of density are usually heavy, medium, or light. Symmetry is a measure of the evenness, taper, and balance of the tree.

Time Factors:

- **Spacing –** Trees that are spaced further apart require more time walking which means less time is available for grading.
- **Slope and Terrain –** It is not only the distance, but the speed of the shearer walking from tree to tree will determine how much time they can spend shearing versus walking during the day. Flatter lots with less brush, stumps, and large rocks are easier to navigate and the shearer can walk at a quicker pace.
- **Grader's Ability –** Possibly the most critical factor for a quick and quality grading is the ability of the grader. Their ability is based on experience and training.
- **Complexity of Grading System** – Growers that have 20+ different styled flags to differentiate the height and grade of trees will most often take longer than a simpler grading system.
- **Tools and Materials Used** – Growers that use flags that are pre-numbered will save a lot of time over growers that manually count and track the number of each flag used.

General Grading Cost Assumptions:

- 10% of trees are harvested each year and require grading.

Option 1: Grade on stump

Grading a tree on the stump is the method most growers use to document the inventory of trees to be sold for the year. Grading is based on two main factors: quality and height. Most operators use a different colour and/or patterned ribbons to indicate the quality/height combination.

Assumptions:

- It takes 60 seconds to properly measure the height, grade the tree, and tie a ribbon on the tree.
- It costs $5.00 for a numbered flagging tape roll of 250 ($0.02 per flag).

$$\textbf{Labour cost}: \$17/\textbf{hr} * \left[\left(\frac{60\textbf{sec/tree}}{3600\textbf{sec/hr}}\right) + \frac{60\textbf{ft}}{3\textbf{ft/sec}*3600\textbf{sec/hr}}\right] * \ 1210 \ \textbf{trees/acre} * \ 10\% = \$45.71/\text{acre}$$

$$\textbf{Material and supply cost}: \$0.02 \ /\textbf{flag} * 121 \ \textbf{flags/acre} = \$2.42/\textbf{acre}$$

$$\textbf{Total grading cost per acre} = \$45.71 + \$2.42 = \$48.13$$

$$\textbf{Total grading cost} = \$48.13/\textbf{acre} * 40\ \textbf{acres} = \$1925.24$$

$$\textbf{Total cost per tree (on average)} = \frac{\$48.13\ /\ \textbf{acre}}{121\ \textbf{trees}\ /\ \textbf{acre}} = \$0.40$$

Option 2: Grade on stump after shearing

This option is the same process as the option above, except the shearer is the one to grade the trees immediately after shearing. This method saves time since they only must visit the tree once, not twice.

Assumptions:

- It takes 60 seconds to properly measure the height, grade the tree, and tie a ribbon on the tree.
- It costs $5.00 for a numbered flagging tape roll of 250 ($0.02 per flag).
- Walking time is already counted for shearing so it is not double counted here.

$$\textbf{Labour cost}: \$17/hr * \frac{60sec/tree}{3600sec/hr} * 1210trees/acre * 10\% = \$34.28/\text{acre}$$

$$\textbf{Material and supply cost}: \$0.02\ /flag * 121\ flags/acre = \$2.42/acre$$

$$\textbf{Total grading cost per acre} = \$34.28 + \$2.42 = \$36.70$$

$$\textbf{Total grading cost} = \$36.70/\ \textbf{acre} * 40\ \textbf{acres} = \$1468.13$$

$$\textbf{Total cost per tree (on average)} = \frac{\$36.70\ /\ \textbf{acre}}{121\ \textbf{trees}\ /\ \textbf{acre}} = \$0.30$$

Option 3: Grade in Yard

Some growers that do not need to keep track of inventory and have a market for all the trees harvested, such as those that are selling trees to a Co-operative, can cut trees and bring them to the yard for someone to grade.

Assumptions:

- It takes 45 seconds to properly measure the height, grade, and tie a ribbon on the tree.
- It costs $5.00 for a numbered flagging tape roll of 250 ($0.02 per flag).

$$\textbf{Labour cost}: \$17/hr * \frac{45sec/tree}{3600sec/hr} * 1210trees/acre * 10\% = \$25.71/\text{acre}$$

$$\textbf{Material and supply cost}: \$0.02\ /flag * 121\ flags/acre = \$2.42/acre$$

$$\textbf{Total grading cost per acre} = \$25.71 + \$2.42 = \$28.13$$

$$\textbf{Total grading cost} = \$28.13/\ \textbf{acre} * 40\ \textbf{acres} = \$1125.30$$

$$\textbf{\textit{Total cost per tree (on average)}} = \frac{\$28.13 \textit{ / acre}}{121 \textit{ trees / acre}} = \$0.23$$

Harvesting

There are six main harvesting activities when broken down into their components. This section will look at three separately (cutting, dragging, and loading) and the other three together (baling, hauling, and storage) with examples of the different options to get the tasks done.

Cutting

Cutting trees is the "pacemaker" for the entire harvesting operation. Trees can only be baled at the rate they are cut. Usually, a cutter's sole job is to walk through the lot and cut down every tree that is planned to be harvested. Most trees that are ready to be cut are flagged, often based on height and grade. Some operations choose to cut all their trees at once, no matter what grade the tree is. Other operations will cut based on the order they need to fill and will pass over flagged trees to get them another day. Both methods have their pros and cons in terms of quality, sales, and cost efficiencies.

The time it takes to cut a tree is based on many factors such as:

- **Identifying trees to cut** – If ribbons are tied onto trees and are clearly visible, the cutter can identify trees quicker. It may be helpful for graders to tie on the same side and same height of every tree (e.g., facing East five feet off the ground) so the cutter instinctively knows where to look.
- **Spacing** – Spacing, for this example, specifically measures the space between trees to be cut. A well-stocked lot with a 6' x 6' spacing that only has 3% of its lot ready to be harvested will take longer to cut each tree than a 10' x 10' spacing that has 15% of its lot ready to be harvested.
- **Slope and Terrain** – Flatter lots with less brush, stumps, and large rocks are easier to navigate and the worker can walk at a quicker pace.
- **Size of tree –** The thicker the tree, the more time it will take to cut through the stump and ensure a safe landing.
- **Butt pruning –** Trees that are well butt pruned enable the cutter to see rocks and debris near the stump for a safer and quicker cut.
- **Chainsaw –** The model of chainsaw, time to fuel, and time to perform preventative maintenance (or repairs) all factor into the time it takes to cut.

General Cutting Cost Assumptions:

- It takes 15 seconds to identify and cut a tree.
- 10% of trees are harvested each year.
- Chainsaws require $5.00 of fuel and oil per acre.

Option 1: Cut to Order (Natural Stand)

In this scenario, not all trees will be cut at one time. Only certain coloured flags will be cut that fill a certain customers order. This method makes it easier to sort trees in the yard since the sorting is done by the cutter.

Assumptions:

- A block will be walked through twice to cut all marketable trees.

$$\textbf{Labour cost}: \left[\$17/hr * \left[\left(\frac{15sec/tree}{3600sec/hr}\right) + \frac{120ft}{3\ ft/sec * 3600sec/hr}\right] * \ 1210\ trees/acre * \ 5\%\right] * \ 2 = \$31.43/\text{acre}$$

$$\textbf{Material and supply cost}: \$5.00\ per\ acre$$

$$\textbf{Total cutting cost per acre} = \$31.43 + \$5.00 = \$36.43$$

$$\textbf{Total cutting cost} = \$36.43\ /\ acre * 40\ acres = \$1457.06$$

$$\textbf{Total cost per tree (on average)} = \frac{\$36.43\ /\ acre}{121\ trees\ /\ acre} = \$0.30$$

Option 2: Cut All Tagged Trees (Natural Stand)

All tagged trees are cut, and the trees are sorted by size, quality, and/or order in the yard.

Assumptions:

- A block will be walked through once to cut all marketable trees.

$$\textbf{Labour cost}: \$17/hr * \left[\left(\frac{15sec/tree}{3600sec/hr}\right) + \frac{60ft}{3\ ft/sec * 3600\ sec/hr}\right] * \ 1210\ trees/acre * \ 10\% = \$20.00/\text{acre}$$

$$\textbf{Material and supply cost}: \$5.00\ per\ acre$$

$$\textbf{Total cutting cost per acre} = \$20.00 + \$5.00 = \$25.00$$

$$\textbf{Total cutting cost} = \$25.00\ /\ acre * 40\ acres = \$999.94$$

$$\textbf{Total cost per tree (on average)} = \frac{\$25.00\ /\ acre}{121\ trees\ /\ acre} = \$0.21$$

Option 3: Cut Entire Block (plantation/even-aged management)

All tagged trees are cut, and the trees are sorted by size, quality, and/or order in the yard.

Assumptions:

- A block will be walked through once to cut all marketable trees.

$$\textbf{Labour cost}: \frac{\$17}{hr} * \left[\left(\frac{15sec/tree}{3600sec/hr}\right) + \frac{6ft}{3\ ft/sec * 3600\ sec/hr}\right] * \ 1210\frac{trees}{acre} = \$97.14/\text{acre}$$

$$\textbf{Material and supply cost}: \$5.00\ per\ acre$$

$$\textbf{Total cutting cost per acre} = \$97.14 + \$5.00 = \$102.14$$

$$\textbf{Total cutting cost} = \$102.14/acre * 5\ acres = \$510.70$$

$$\textbf{Total cost per tree (on average)} = \frac{\$102.14\ /\ acre}{1210\ trees\ /\ acre} = \$0.08$$

Dragging

Dragging involves taking the cut tree and positioning it on the side of the road so it's ready to be baled. The time it takes to drag a tree is based on many factors such as:

- **Distance to road** – The biggest contributing factor to dragging time is the distance to drag the tree. This is where a road system with roads not spaced far apart is advantageous.
- **Terrain** – The amount of brush, stumps, and debris left between cut trees and the road will reduce the speed of draggers to get the tree to the road. A smooth and clear lot will make the job easier for any dragger.
- **Size of tree** – The larger the tree, the longer it takes to drag to the road. Some large trees may require two people to drag. Some small trees can be dragged two at a time.
- **Slope** – Trees that need to be dragged up hill will take longer and will also wear the dragger out quicker.
- **Strength/condition of dragger** – Dragging is a physically demanding job and can wear down any person, no matter what their strength, size, condition, and experience is. That is why it is important to consider rotating jobs for draggers every few hours.
- **Method of cutting** – If all marketable trees in a block are cut at once, it will be less walking between trees to drag than compared to having to visit that block two or three times when its cut to order.

General Dragging Cost Assumptions:

- Dragging speed is 20% slower than regular walking speed (2.4 feet/second).
- A dragger can only drag one tree at a time.
- The average distance to drag is 50 feet (200 feet spacing between roads).

Option 1: Cut to Order

Draggers must follow the cutters lead. If cutters are only cutting certain coloured flags to fill a certain customers order, the draggers will have fewer trees to drag per block.

Assumptions:

- A block will be walked through twice to cut all marketable trees.
- The average distance to walk from the road to the next tree to be dragged is 130 feet (calculated using Pythagorean's theorem: $\sqrt{50ft^2 + 120ft^2}$).

$$\textbf{Labour cost}: \left[\$17/hr * \left(\frac{50ft}{2.4\ ft/sec * 3600\ sec/hr} + \frac{130ft}{3\ ft/sec * 3600\ sec/hr}\right) * 1210 trees/acre * 5\%\right] * 2 = \$36.66/\text{acre}$$

$$\textbf{Material and supply cost}: \$0$$

$$\textbf{Total dragging cost per acre} = \$36.66 + \$0 = \$36.66$$

$$\textbf{Total dragging cost} = \$36.66\ /\ acre * 40\ acres = \$1466.56$$

$$\textbf{Total cost per tree (on average)} = \frac{\$36.66\ /\ acre}{121\ trees\ /\ acre} = \$0.30$$

Option 2: Cut all tagged trees

Like option 1, draggers follow the cutters lead and drag every cut tree.

Assumptions:

- A block will be walked through once to cut all marketable trees.
- The average distance to walk from the road to the next tree to be dragged is 78.1 feet (calculated using Pythagorean's theorem: $\sqrt{50ft^2 + 60ft^2}$).

$$\textbf{Labour cost}: \$17/hr * \left(\frac{50ft}{2.4\ ft/sec * 3600\ sec/hr} + \frac{78.1ft}{3\ ft/sec * 3600\ sec/hr}\right) * 1210 trees/acre * 10\% = \$26.78/\text{acre}$$

$$\textbf{Material and supply cost}: \$0$$

$$\textbf{Total dragging cost per acre} = \$26.78 + \$0 = \$26.78$$

$$\textbf{Total dragging cost} = \$26.78\ /\ acre * 40\ acres = \$1071.16$$

$$\textbf{Total cost per tree (on average)} = \frac{\$26.78\ /\ acre}{121\ trees\ /\ acre} = \$0.22$$

Option 3: Cut entire block (plantation/even-aged management)

Like the first two options, draggers follow the cutters lead and drag every cut tree.

Assumptions:

- A block will be walked through once to cut all marketable trees.
- The average distance to walk from the road to the next tree to be dragged is 50.4 feet (calculated using Pythagorean's theorem: $\sqrt{50ft^2 + 6ft^2}$).

$$\textbf{Labour cost}: \$17/hr * \left(\frac{50ft}{2.4\ ft/sec * 3600\ sec/hr} + \frac{50.4ft}{3\ ft/sec * 3600\ sec/hr}\right) * 1210\ trees/acre = \$215.03/\text{acre}$$

$$\textbf{Material and supply cost}: \$0$$

$$\textbf{Total dragging cost per acre} = \$215.03 + \$0 = \$215.03$$

$$\textbf{Total dragging cost} = \$215.03\ /\ acre * 5\ acres = \$1075.16$$

$$\textbf{Total cost per tree (on average)} = \frac{\$215.03\ /\ acre}{1210\ trees\ /\ acre} = \$0.18$$

Baling, Hauling, and Storing

Baling is one of the most important operations on a Christmas tree farm since, unlike other activities, it requires a small team of at least three to manage, but also it needs to be managed during a small window of time. Between increased labour and a smaller season, harvest time is known in the industry to be the busiest and most hectic time year-round. That is why it is crucial to be able to complete these activities efficiently and effectively to increase revenue and decrease costs.

Time Factors:

- **Type of baler** – Some balers are more effective and efficient than others.
- **Baler downtime** – Any time spent loading the baler with twine, performing preventative maintenance, repairing the baler, or replacing any parts, is downtime and time not directly spent baling trees.
- **Size of tree** – The larger the tree, both in terms of height and width, the longer it will take to bale.
- **Experience of baler operator** – the baler operator is likely the most crucial position of the harvesting team.
- **Loading speed** – The loading speed is directly correlated to the number of trees near the baler while it is parked.
- **Unloading speed** – Once baled, the tree needs to be removed from the baler for the next tree to start. The quicker the tree is removed from the baler, the quicker the next tree can be baled. One key element to increase the baler efficiency is to move the chains from one tree to the next as quick as possible. If the unloader can perform this task, this can keep the baler operator focused on operating the machine and bale trees quicker.
- **Operating time** – Similar to the loading speed, the operating speed is directly correlated to the number of trees that are located near the baler while it is parked and the distance between trees ready to be baled on the road.

The efficiency of hauling trees that are baled from the field to the storage location is based on the following factors:

- **Size of wagon and positioning of trees** – The goal of the operator should be to fit as many trees on the wagon as possible without causing any damage to the trees. The more trees on the wagon, the fewer trips are required between the storage location and the field.
- **Speed of tractor (or truck)** – The faster the vehicle hauling the trailer can travel between the field and storage location, the more time employees will have to load and unload trees (and not be paid to travel with the vehicle).
- **Placement of trees** – How baled trees are positioned on the side of the road has a direct impact on the speed of loading wagons. If the unloader from the baling crew has time, they should consider piling baled trees to make it easier for the hauling crew to pick up.
- **Distance between lot and storage** – The greater the distance between the lot and storage, the more time is spent travelling, with empty and full wagons, instead of loading/unloading trees.
- **Distance between trees on road** – The greater the distance between trees on the road, the more driving and getting on and off the tractor is required, which takes more time to haul the same number of trees. A lower density of baled trees often occurs when there is a large amount of spacing between trees or fewer trees are harvested from the lot.
- **Loading speed of operator** – The quicker the operator can load trees on the wagon, the more trees that can be loaded in a day, and the lower the cost of loading per tree.

General Baling, Hauling, and Storage Cost Assumptions:

- Harvest production is 121 trees/acre.
- The cost of a tube of twine is $12.
- There is 6750 ft of twine on a tube.
- On average, 30 ft of twine is required per tree.
- It takes 60 seconds to replace a tube of twine.
- The cost of fuel for the baler per acre is $1.
- The cost of fuel for the tractor per acre is $5.
- Average distance between block and storage (yard) is 225 metres (this assumes a square 40-acre block with the storage at one end of the block).

Option 1: Three-person Baling Crew with one Hauler

With efficient spacing and trees small enough for one person to handle, a baling crew of three people seems to be the most cost-efficient. The first person carries the trees from roadside to the baler, the second person operates the baler, and the third person unloads the baled tree and places it roadside. This process allows the baler to be baling trees with the shortest amount of waiting time between trees as possible. The fourth person is solely responsible for hauling baled trees from the side of the road to the storage area.

Assumptions:

- Tree spacing, space between roads, and the percentage of trees cut allow for a baling crew to stop and bale 20 trees continuously before travelling down the road for the next stop.
- Cutters are cutting all trees at one time in each block.

- It takes 30 seconds for the baling crew to bale one tree.
- It takes 30 seconds to move baler from one stop to the next and get everything ready before starting to bale again.
- The wagon can hold 80 baled trees.
- It takes 20 seconds to load a baled tree on the wagon.
- It takes 20 seconds to move wagon from one stop to the next.
- It takes 30 seconds to unload and store a baled tree.
- It takes, on average, 1 minute and 21 seconds for the tractor and wagon to travel between blocks and yard (0.225km / 10km/hour).

$$\textbf{Labour cost for baling}: 3 * \$17/hr * \left[\left(\frac{30sec/tree}{3600sec/hr}\right) + \left(\frac{30sec/trees/stop}{3600\ sec/hr * 20trees/stop}\right) + \left(\frac{60\ sec/twine\ replacement}{3600\ sec/hr * 225\ trees/twine\ replacement}\right)\right] * 121trees/acre = \$54.45/\text{acre}$$

$$\textbf{Material and supply cost}: \left(\frac{30ft/tree}{6750ft/tube} * 121\ trees/acre * \frac{\$12}{tube}\right) + \$5.00\ tractor\ fuel/acre + \$1.00\ baler\ fuel/acre = \$12.45\ per\ acre$$

$$\textbf{Total baling cost per acre} = \$54.45 + \$12.45 = \$66.91$$

$$\textbf{Total baling cost} = \$66.91\ /\ acre * 40\ acres = \$2676.27$$

$$\textbf{Total baling cost per tree} = \frac{\$66.91\ /\ acre}{121\ trees\ /\ acre} = \$0.55$$

$$\textbf{Labour cost for hauling \& storing}: \$17/hr * \left[\left(\frac{20sec/tree}{3600sec/hr}\right) + \left(\frac{20\ sec/tree/stop}{3600\ sec/hr * 20trees/stop}\right) + \left(\frac{30sec/tree}{3600sec/hr}\right) + \left(\frac{81\ sec/tree/trip}{3600\ sec/hr * 80trees/trip}\right)\right] * 121\ trees/acre = \$29.72/\text{acre}$$

$$\textbf{Material and supply cost}: \$5.00 fuel/acre = \$5.00\ per\ acre$$

$$\textbf{Total hauling and storing cost per acre} = \$29.72 + \$5.00 = \$34.72$$

$$\textbf{Total hauling and storing cost} = \$34.72\ /\ acre * 40\ acres = \$1388.78$$

$$\textbf{Total hauling and storing cost per tree} = \frac{\$34.72\ /\ acre}{121\ trees\ /\ acre} = \$0.29$$

$$\textbf{Total baling, hauling, and storing cost} = \$2676.27 + \$1388.78 = \$4065.04$$

$$\textbf{Total baling, hauling, and storing cost per acre} = \$66.91 + \$34.72 = \$101.63$$

$$\textbf{Total baling, hauling, and storing cost per tree} = \frac{\$101.63 \text{ / acre}}{121 \text{ trees / acre}} = \$0.84$$

Option 2: Four-person Crew with the Baler attached to a wagon/truck

Some operations pair hauling and baling activities together to limit the double-handling and traveling of equipment. The roles might look something like this:

- Baler loader
- Baler operator
- Baler unloader
- Wagon/flatbed loader

For this to work, the grower needs a truck and large flatbed with the ability to haul a baler behind and a solid road system to allow for large (and long) equipment to navigate. The challenge to this approach is balancing the work so employees are not idle but are also doing value-add work. For example, the wagon loader must wait for trees to come of the baler before loading the wagon. The other consideration is the entire crew needs to unload the wagon, so the baler is not running for long stretches of time.

Assumptions:

- Tree spacing, space between roads, and the percentage of trees cut allow for a baling crew to stop and bale 20 trees continuously before travelling down the road for the next stop.
- Cutters are cutting all trees at one time in each block.
- It takes 30 seconds for the baling crew to bale one tree and load it on the wagon.
- It takes 30 seconds to move baler from one stop to the next and get everything ready before starting to bale again.
- The wagon can hold 80 baled trees.
- In 30 seconds, the team of 4 can unload and store four baled trees.
- It takes, on average, 1 minute and 21 seconds for the tractor and wagon to travel between blocks and yard (0.225km / 10km/hour).

$$\textbf{Labour cost}: 4 * \$17/hr * \left[\left(\frac{30sec/tree}{3600sec/hr}\right) + \left(\frac{30\ sec/tree/stop}{3600\ sec/hr * 20trees/stop}\right) + \left(\frac{60\ sec/twine\ replacement}{3600\ sec/hr * 225trees/twine\ replacement}\right) + \left(\frac{7.5sec/tree}{3600sec/hr}\right) + \left(\frac{\frac{81\ sec/tree/trip}{trip}}{3600\ sec/hr * 80trees/trip}\right)\right] * 121trees/acre = \$92.06/\text{acre}$$

$$\textbf{Material and supply cost}: \left(\frac{30ft/tree}{6750ft/tube} * 121trees/acre * \$12/tube\right) + \$5.00\ tractor\ fuel/acre + \$1.00\ baler\ fuel/acre = \$12.45\ /\ acre$$

$$\textbf{Total baling cost per acre} = \$92.06 + \$12.45 = \$104.51$$

$$\textbf{Total baling cost} = \$104.51 \ / \ \textbf{acre} * 40 \ \textbf{acres} = \$4180.54$$

$$\textbf{Total baling cost per tree} = \frac{\$104.51 \ / \ \textbf{acre}}{121 \ \textbf{trees} \ / \ \textbf{acre}} = \$0.86$$

Option 3: Baling in the Yard

A third option for baling is to bale after the trees are hauled from the lot and into the storage area. There is a big advantage of the baler being able to run non-stop – it does not need to be transported between trees, instead the trees are transported to the balers. However, hauling trees that are not baled take up a lot more space on a wagon and can potentially harm the tree with extra dragging and transportation.

Assumptions:

- The wagon can hold 40 trees (versus 80 baled trees).
- A three-person crew can load, bale, unload, and store without needing to move the baler (haulers bring the trees to them).
- It takes 30 seconds for the baling crew to bale one tree.
- The baler operator only runs the baler and fills it with trees.
- It takes, on average, 1 minute and 21 seconds for the tractor and wagon to travel between blocks and yard (0.225km / 10km/hour).
- It takes 20 seconds to load a tree on the wagon.
- It takes 20 seconds to move wagon from one stop to the next.
- It takes 15 seconds to unload a tree from the wagon.

$$\textbf{Labour cost for baling and storing}: 3 * \$17/hr * \left[\left(\frac{30sec/tree}{3600sec/hr}\right) + \left(\frac{60sec/twine\ replacement}{3600sec/hr * 225trees/twine\ replacement}\right)\right] * 121\ trees/acre = \$51.88/\text{acre}$$

$$\textbf{Material and supply cost}: \left(\frac{30ft/tree}{6750\ ft/tube} * 121\ trees/acre * \$12/tube\right) + \$1.00\ baler\ fuel/acre = \$7.45\ per\ acre$$

$$\textbf{Total baling and storing cost per acre} = \$51.88 + \$7.45 = \$59.34$$

$$\textbf{Total baling and storing cost} = \$59.34 \ / \ \textbf{acre} * 40 \ \textbf{acres} = \$2373.42$$

$$\textbf{Total baling cost per tree} = \frac{\$59.34 \ / \ \textbf{acre}}{121 \ \textbf{trees} \ / \ \textbf{acre}} = \$0.49$$

$$\textbf{Labour cost for hauling}: \$17/hr$$
$$* \left[\left(\frac{20 sec/tree}{3600 sec/hr}\right) + \left(\frac{20\ sec/tree/stop}{3600\ sec/hr * 20 trees/stop}\right) + \left(\frac{15 sec/tree}{3600 sec/hr}\right) + \left(\frac{81\ sec/tree/trip}{3600\ sec/hr * 40 trees/trip}\right)\right] * 121 \frac{trees}{acre} = \$21.73/\text{acre}$$

$$\textbf{Material and supply cost}: \$5.00 fuel/acre = \$5.00\ /\ acre$$

$$\textbf{Total hauling cost per acre} = \$21.73 + \$5.00 = \$26.73$$

$$\textbf{Total hauling cost} = \$26.73\ /\ acre * 40\ acres = \$1069.08$$

$$\textbf{Total hauling cost per tree} = \frac{\$26.73\ /\ acre}{121\ trees\ /\ acre} = \$0.22$$

$$\textbf{Total baling, hauling, and storing cost} = \$2373.42 + \$1069.08 = \$3442.50$$

$$\textbf{Total baling, hauling, and storing cost per acre} = \$59.34 + \$26.73 = \$86.06$$

$$\textbf{Total baling, hauling, and storing cost per tree} = \frac{\$86.06\ /\ acre}{121\ trees\ /\ acre} = \$0.71$$

Loading

Once the trees are baled and organized in the yard, they need to be loaded onto trucks to be shipped to retail lots.

Time Factors:

- **Size and ability of crew** – Some workers can work faster, more effectively, and more collaboratively than others. Depending on the equipment involved, size of trees, and size of trailer, there is often an optimal sized crew that is small enough that nobody is standing around or getting in each other's way but big enough, so no one is getting overworked and getting done quickly.
- **Size of trailer** – The larger the trailer, the longer it will take to fill.
- **Size of trees** – The larger the tree, the more time it will take to load. Larger trees will also take up more room on the trailer so it will full up more quickly.
- **Equipment** – Different types of equipment can make loading faster and easier such as loading with a truck with a grapple or loading trees by elevator.
- **Positioning of Trees** – The arrangement of trees on the truck changes how much time is required to load and position that tree but also changes how quickly the truck will fill.

Option 1: Loading by Hand

The crew does not have any equipment and are carrying the trees onto the truck.

Assumptions:

- A crew of five loaders.
- A tree is being loaded onto the truck at a rate of 1 tree every 10 seconds.

$$\textbf{Labour Costs (per acre)}: 5 * \$17/hr * 121\ trees/acres * \frac{10sec/tree}{3600sec/hr} = \$28.57$$

$$\textbf{Material and Supply Costs (per acre)}: \$0$$

$$\textbf{Total loading cost per acre} = \$28.57 + \$0 = \$28.57$$

$$\textbf{Total loading cost} = \$28.57\ /\ acre * 40\ acres = \$1142.78$$

$$\textbf{Total loading cost per tree} = \frac{\$28.57\ /\ acre}{121\ trees\ /\ acre} = \$0.24$$

Option 2: Loading with Elevator

With an elevator, fewer workers are required to move trees onto the truck.

Assumptions:

- A crew of three loaders.
- A tree is being loaded onto the truck at a rate of 1 tree every 10 seconds.
- The cost of fuel to run the elevator is negligible.

$$\textbf{Labour Costs (per acre)}: 3 * \$17/hr * 121\ trees/acres * \frac{10sec/tree}{3600sec/hr} = \$17.14$$

$$\textbf{Material and Supply Costs (per acre)}: \$0$$

$$\textbf{Total loading cost per acre} = \$17.14 + \$0 = \$17.14$$

$$\textbf{Total loading cost} = \$17.14\ /\ acre * 40\ acres = \$685.67$$

$$\textbf{Total loading cost per tree} = \frac{\$17.14\ /\ acre}{121\ trees\ /\ acre} = \$0.14$$

Option 3: Loading with a Truck and Grapple

A log (or similar) truck with a grapple can make loading a much easier task with fewer loaders required.

Assumptions:

- A crew of two loaders.
- A tree is being loaded onto the truck at a rate of 1 tree every 10 seconds.
- The cost of fuel to run the truck and grapple is negligible.

$$\textbf{\textit{Labour Costs}}\ (\textbf{\textit{per acre}}): 2 * \$17/hr * \ 121\ trees/acres * \frac{10sec/tree}{3600sec/hr} = \$11.43$$

$$\textbf{\textit{Material and Supply Costs}}\ (\textbf{\textit{per acre}}): \$0$$

$$\textbf{\textit{Total loading cost per acre}} = \$11.43 + \$0 = \$11.43$$

$$\textbf{\textit{Total loading cost}} = \$11.43\ /\ acre * 40\ acres = \$457.11$$

$$\textbf{\textit{Total baling cost per tree}}\ = \frac{\$11.43\ /\ acre}{121\ trees\ /\ acre} = \$0.09$$

Mowing (plantation)

There are three major benefits of mowing in Christmas tree stands: reduction of fire hazard by keeping weed growth vegetative, reduction of habitat for rodent populations, and reduction in brush populations. Mowing between rows is a common practice where herbicides are applied in bands down rows of trees. Mowing allows the maintenance of stable ground cover between rows of trees, which helps to control soil erosion on sloping lands. It also provides an aesthetic and practical soil cover in plantations where customers cut their own trees in choose-and-cut operations.

Assumptions:

- Mowing is required 10 times a year.
- It takes 30 minutes to mow an acre.
- It takes 3L of fuel for an hour of mowing.
- Gas prices are $1.30/L.

$$\textbf{\textit{Labour Cost}}: \$17\ /\ hr * 10\ times/year\ * 0.5hr/acre = \$85/\text{acre}$$

$$\textbf{\textit{Material and supply cost}}: \$1.30\ /\ L * 0.5\ hrs\ /\ acre\ * 3L/acre\ * 10\ times/year = \$19.50/acre$$

$$\textbf{\textit{Total mowing cost per acre}} = \$85 + \$19.50 = \$104.50$$

$$\textbf{\textit{Total mowing cost}} = (\$104.50\ /\ acre * 40\ acres) = \$4180.00$$

$$\textbf{\textit{Total planting cost per tree}}\ (\textbf{\textit{on average}}) = \frac{\$104.50\ /\ acre}{1210\ trees\ /\ acre} = \$0.09$$

Appendix D – Workshop Workbook

Introduction (10 minutes)

The three overarching objectives of the Christmas Tree Council of Nova Scotia's (CTCNS) 2018 strategic plan were to:

1. increase the profitability for NS Christmas Tree Producers,
2. increase the number of growers in the industry and the number of Christmas trees produced, and
3. increase the overall quality of the product.

This cost of production report is meant to positively affect all three. With representative data, current producers can see how their profitability compares. The report will also give those that may be interested in becoming a producer a better view into the costs, barriers to entry, and opportunities.

Your Name	
Name of your farm	
Farm Address	
How many lots do you have?	
If you know the PIDs of those lots, please list them here.	
What style of lots do you have? (i.e., natural regeneration, natural regeneration with interplanting, plantation, other)	
What do you believe is your spacing of trees or stocking density (e.g., 6ft x 6ft spacing, 900 stems/acre, 2000 trees/hectare)?	
How much land is used to produce Christmas trees? (Acres or hectares)	
How much of that land is occupied by Christmas trees?	
How many Christmas trees did you **harvest** last year?	
How many Christmas trees did you **sell** last year?	

How many Christmas trees do you plan on selling this year?	

Calendar of Activities (15 minutes)

Objectives

- Understand (at a high-level) the duration of activities required of a Christmas Tree Farm.
- Compare Christmas Tree Farms to identify similarities, differences, and opportunities.
- Spark discussion about when the best time is to complete each activity.
- Give you a full year's view of what it takes to operate a Christmas Tree Farm.

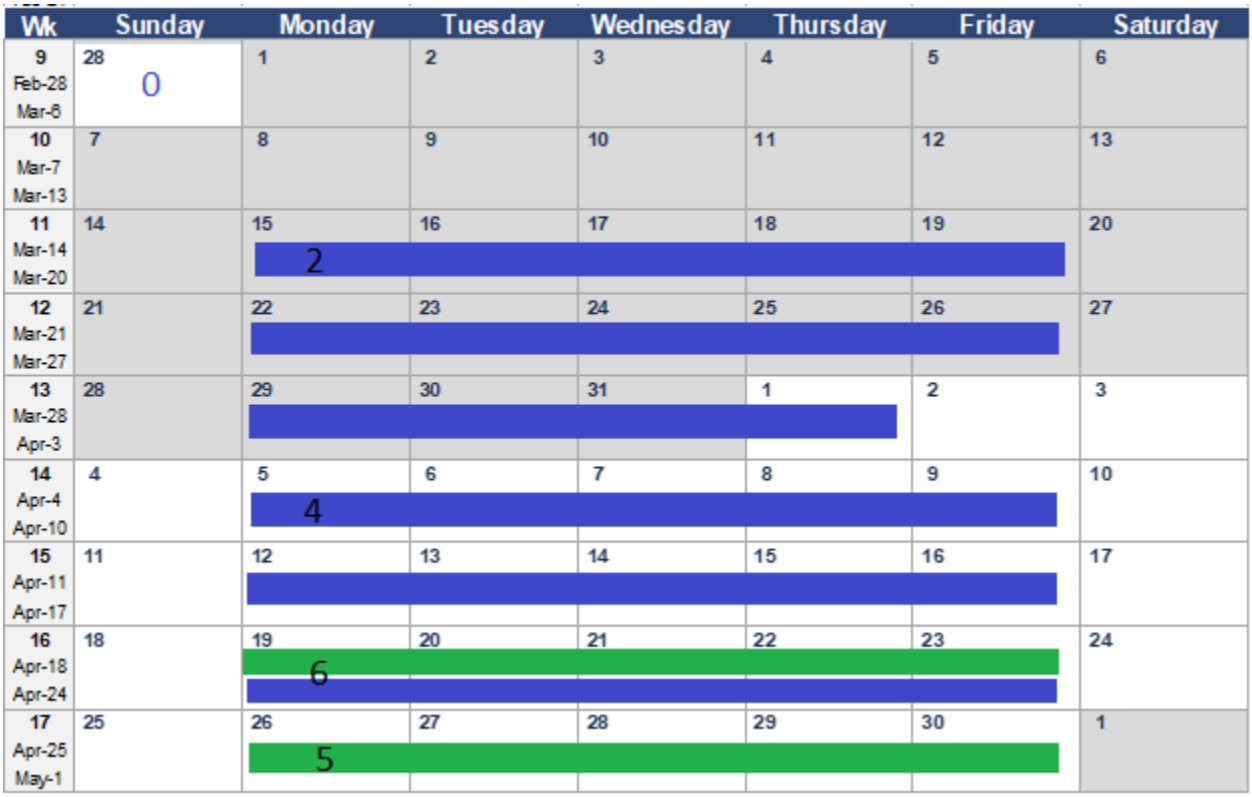
Instructions

- Colour in the days for 2021 based on your planned activities for this year. If you (or your staff) are working full-time on holidays or weekends, colour them in. If those are days off (including the offseason), leave those days blank.
    - Leave blank – days you (or your staff) are not working more than 7 hours a day.
    - Blue – Shearing
    - Green – Planting
    - Brown – Crop Management (e.g., under pruning)
    - Orange – Spraying/Fertilizing
    - Red – Harvesting
    - Purple – Administrative
    - Pink – Other (e.g., building roads, clearing land, etc.)
- If half the staff are doing what type of activity, and the other half are doing another type, use two colours for those days (see example).
- Write the number of paid staff (full-time equivalents or FTEs) as it changes through the year. For example, if you have no staff working starting January 3rd, 2021, write "0" in that block. As soon as you plan to have staff start working this year, write the number of staff on that date. As more staff start working through the year, or if there is a planned decrease of staff, write the new numbers of FTEs whenever the number changes.

Assumptions

- Only count Christmas Tree Farming activities. If you have other crops, livestock, or sources of income, do not include that effort or those activities in the calendar.
- Count what most employees are doing at that time. If you a large farm with many employees that might be splitting activities, focus on the activities that are taking the most time/effort.
- If you conduct activities that don't fit in the list above, feel free to write in notes.
- Note on the calendar if/when workdays get extended and how long the working day is.

Example



- "0" shows that nobody is working for the first two weeks in March.
- Starting on March 15th, 2 employees start working (full-time) and their main activity is shearing.
- Nobody is working on the weekends or on April 2nd (Good Friday).
- Starting on April 4th, 4 employees are working, and they are all shearing.
- Starting on April 19th, 6 employees are working, and they are split between shearing and planting.
- Starting on April 26th, 5 employees are working, and they are all planting.

Wk	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 Jan-3 Jan-9	3	4	5	6	7	8	9
2 Jan-10 Jan-16	10	11	12	13	14	15	16
3 Jan-17 Jan-23	17	18	19	20	21	22	23
4 Jan-24 Jan-30	24	25	26	27	28	29	30
5 Jan-31 Feb-6	31	1	2	3	4	5	6
6 Feb-7 Feb-13	7	8	9	10	11	12	13
7 Feb-14 Feb-20	14	15	16	17	18	19	20
8 Feb-21 Feb-27	21	22	23	24	25	26	27
9 Feb-28 Mar-6	28	1	2	3	4	5	6
10 Mar-7 Mar-13	7	8	9	10	11	12	13
11 Mar-14 Mar-20	14	15	16	17	18	19	20
12 Mar-21 Mar-27	21	22	23	24	25	26	27
13 Mar-28 Apr-3	28	29	30	31	1	2	3
14 Apr-4 Apr-10	4	5	6	7	8	9	10
15 Apr-11 Apr-17	11	12	13	14	15	16	17
16 Apr-18 Apr-24	18	19	20	21	22	23	24
17 Apr-25 May-1	25	26	27	28	29	30	1

Wk	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
18 May-2 May-8	2	3	4	5	6	7	8
19 May-9 May-15	9	10	11	12	13	14	15
20 May-16 May-22	16	17	18	19	20	21	22
21 May-23 May-29	23	24	25	26	27	28	29
22 May-30 Jun-5	30	31	1	2	3	4	5
23 Jun-6 Jun-12	6	7	8	9	10	11	12
24 Jun-13 Jun-19	13	14	15	16	17	18	19
25 Jun-20 Jun-26	20	21	22	23	24	25	26
26 Jun-27 Jul-3	27	28	29	30	1	2	3
27 Jul-4 Jul-10	4	5	6	7	8	9	10
28 Jul-11 Jul-17	11	12	13	14	15	16	17
29 Jul-18 Jul-24	18	19	20	21	22	23	24
30 Jul-25 Jul-31	25	26	27	28	29	30	31
31 Aug-1 Aug-7	1	2	3	4	5	6	7
32 Aug-8 Aug-14	8	9	10	11	12	13	14
33 Aug-15 Aug-21	15	16	17	18	19	20	21
34 Aug-22 Aug-28	22	23	24	25	26	27	28
35 Aug-29 Sep-4	29	30	31	1	2	3	4

Wk	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
36 Sep-5 Sep-11	5	6	7	8	9	10	11
37 Sep-12 Sep-18	12	13	14	15	16	17	18
38 Sep-19 Sep-25	19	20	21	22	23	24	25
39 Sep-26 Oct-2	26	27	28	29	30	1	2
40 Oct-3 Oct-9	3	4	5	6	7	8	9
41 Oct-10 Oct-16	10	11	12	13	14	15	16
42 Oct-17 Oct-23	17	18	19	20	21	22	23
43 Oct-24 Oct-30	24	25	26	27	28	29	30
44 Oct-31 Nov-6	31	1	2	3	4	5	6
45 Nov-7 Nov-13	7	8	9	10	11	12	13
46 Nov-14 Nov-20	14	15	16	17	18	19	20
47 Nov-21 Nov-27	21	22	23	24	25	26	27
48 Nov-28 Dec-4	28	29	30	1	2	3	4
49 Dec-5 Dec-11	5	6	7	8	9	10	11
50 Dec-12 Dec-18	12	13	14	15	16	17	18
51 Dec-19 Dec-25	19	20	21	22	23	24	25
52 Dec-26 Jan-1	26	27	28	29	30	31	1

Approximately what percentage of your employees are temporary foreign workers? _____%

Cost of Production Data Points (Survey Questions) – 30 minutes

Assumptions

- Costs associated with general farm overhead like accounting, legal, office, membership fees, and general farm maintenance have not been included due to the variability that exists from situation to situation.

Land

- Do you own or rent your land? _____
- How much is your land worth (per acre/hectare)? _____
- How much do you pay for land tax (per acre/hectare)? _____

Starting or Expanding a Farm

Clearing Land

- To clear land, would you (circle one): Outsource / do with own equipment / do with rented equipment?
- Based on your answer above, about how much do you think it would cost to clear a square 10-acre block? _____

Building Roads

- To build roads, would you (circle one): Outsource / do with own equipment / do with rented equipment?
- How many roads would you put in? _____
- What quality of roads would you put in / what material would you use?

  _____
- Based on your answers above, about how much do you think it would cost to put roads on a square 10-acre block? _____

Preparing Soil

- Briefly explain what you would do to prepare the land/soil for a new block (e.g., take soil samples, plow, fertilize, spray, plant seed)

  _____

  _____
- To prepare soil, would you (circle one): Outsource / do with own equipment / do with rented equipment / Not applicable

Planting

- What spacing would you aim for? _____

- How would you plant? (e.g., dibble, tractor, any other tools/methods)

  _____

Operating a Farm

Business

1. Do you track employee hours worked? _____
2. What employee activities do you track? _____

   _____
3. Do you track how many hours you put into the business? _____
4. What activities do you track for yourself? _____

   _____
5. How do you plan for the year? (e.g., staffing, investing in the business, planting trees, etc.)

   _____

   _____

Planting

6. How did you determine how many trees to plant? _____

   _____
7. Where do you get your seedlings from? _____
8. How much does it cost you for seedlings? _____

Fertilizing

21. Do you fertilize all trees/lots? If not, what trees/lots do you fertilize? _____
22. What type of fertilizer do you use? _____
23. About how much does the fertilizer cost each season? _____

Spraying

18. Do you spray all trees/lots? If not, what trees/lots do you spray? _____

    _____
19. How much spray do you use each season? _____
20. How much does pesticides cost each season? _____

Grading Trees

13. How many different coloured/patterned flags do you use for your Christmas trees? _____
14. What grading system do you use for your trees? _____

Sales

8. Where do you sell your Christmas Trees (Location and/or customer)? _____

   _____
9. How does your target market affect the way you grow and harvest Christmas trees? (e.g., different sizes, shapes, styles, quality, etc.) _____

   _____

10. What effort is spent selling and/or dealing with customers? _____
    _____
    _____

Other Products

10. Do you sell any other products other than Christmas Trees? _____
    a. If yes, what products do you sell? _____
    b. If yes, where do you sell your products? _____
11. If you sell brush or make wreaths, when do you start harvesting brush? _____
12. Do you buy brush? _____

Tools and Equipment (20 minutes)

What tools and equipment do you use? For example: Trucks, tractors, mowers, wagons, trailers, dibbles, backpack sprayers, shears, balers, chainsaws, PPE, etc.

Please indicate the make/model, estimated cost per piece of equipment, and quantity. If you have different models of tractors, trucks, balers, etc., please list each make/model in their own row.

Equipment/Tool	Make and Model	Estimated Cost	Quantity

1. **From the equipment and tools you listed above:**
   - Put a triangle (Δ) next to any piece of equipment you will want to replace or upgrade this year.
   - Put a plus (+) next to any piece of equipment you will want to add to or expand this year (e.g., have two working balers instead of one).
   - Put a minus (-) next to any piece of equipment you are looking to sell or consolidate this year.
   - Put an asterisk next to your favourite piece(s) of equipment.

2. **If money wasn't a limiting factor, what equipment would you buy for your farm this year to be more productive?**

3. **From your perspective, if you were starting a small Christmas Tree Farm from scratch, what tools/equipment would you buy? What tools/equipment would you rent/borrow?**

SWOT Analysis (12 minutes)

	+	-
Internal Factors	Strengths	Weaknesses
External Factors	Opportunities	Threats

Ranking Factors (3 minutes)

1. Rate these factors from high importance to low importance (1 being the most important, 13 being the least important) to what you believe leads to the most profitable farm in the short- and long-term.
   ___ Lot style/Location
   ___ Clearing new land/expanding
   ___ Planting
   ___ Shearing
   ___ Fertilizing
   ___ Spraying for weed control
   ___ Spraying for insect control
   ___ Spraying for disease control
   ___ Grading
   ___ Ground Control / Saw Work
   ___ Harvesting
   ___ Roads
   ___ Office/Administrative functions

2. Rate these factors from high importance to low importance (1 being the most important, 5 being the least important) to what you believe leads to the most profitable farm in the short- and long-term.
   ___ Lot style/Location
   ___ Employees' skills/experience/attitude
   ___ Equipment/machinery
   ___ Crop management (i.e., shearing, planting, harvesting, etc.)
   ___ Marketing and sales

Appendix E – Profit Calculator

Acres of Trees	40
Average Trees/Acre	600
Annual Material Cost	$ 5,000.00
Annual Labour Cost	$ 50,000.00
Annual Fixed Costs	$ 10,000.00
Percent of Trees Harvested	10%

		Height				
	Quality	<6ft	6ft	7ft	8ft	>8ft
Harvest Breakdown	Premium	0%	5%	3%	2%	0%
	#1	0%	10%	20%	10%	0%
	#2	0%	10%	20%	10%	0%
	Bales	10%				
	Unsold	0%				

Market %	Wholesaler	0%
	Retail Outlets	50%
	End Consumer	50%

		Height				
Market Price	Quality	<6ft	6’	7’	8’	>8ft
Wholesaler	Premium	$16	$20	$22	$24	$26
	#1	$14	$18	$20	$22	$24
	#2	$12	$16	$18	$20	$22
	Bales	$5				
Retail Outlets	Premium	$20	$24	$26	$28	$30
	#1	$18	$22	$24	$26	$28
	#2	$16	$20	$22	$24	$26
	Bales	$5				
End Consumer	Premium	$25	$30	$35	$40	$40
	#1	$25	$30	$35	$40	$40
	#2	$20	$25	$30	$35	$35
	Bales	$10				
	Unsold	$0				

Profit	-$ 2,852.00	
Key Performance Indicators		
Revenue	$ 62,148.00	
Expenses	$ 65,000.00	
Stocking	8.5ft x 8.5ft	
Total Trees	24000	
Total Trees Harvested	2400	
Average Revenue per Tree	$ 25.15	
Height	Grade	# of Trees
<6ft	Premium	0
<6ft	#1	0
<6ft	#2	0
6ft	Premium	120
6ft	#1	240
6ft	#2	240
7ft	Premium	72
7ft	#1	480
7ft	#2	480
8ft	Premium	48
8ft	#1	240
8ft	#2	240
>8ft	Premium	0
>8ft	#1	0
>8ft	#2	0
Bales	Bales	240
Unsold	Unsold	0
	Harvested Trees by Grade	
	Premium	240
	#1	960
	#2	960
	Bales	240
	Unsold	0
	Harvested Trees by Height	
	Bales	240
	<6ft	0
	6ft	600
	7ft	1032
	8ft	528
	>8ft	240