

# Vertical Farming Case Study

---

Published by Alberta Agriculture, Forestry and Rural Economic Development

Vertical Farming Case Study

Published by Alberta Agriculture, Forestry and Rural Economic Development

7000 – 113 Street

Edmonton, Alberta

Canada T6H 5T6

Prepared by Serecon Inc.

Date of Publication April 2021

Copyright © 2020 Government of Alberta.

This publication is issued under the Open Government Licence – Alberta (<http://open.alberta.ca/licence>). Please note that the terms of this licence do not apply to any third-party materials included in this publication.

This project is funded by the Government of Canada and the Government of Alberta through the Canadian Agricultural Partnership.

---

# Table of Contents

<b>1.0 EXECUTIVE SUMMARY</b> .....	<b>1</b>
<b>2.0 INTRO TO VERTICAL FARMING</b> .....	<b>3</b>
<b>3.0 MARKET ANALYSIS</b> .....	<b>6</b>
3.1 INTRODUCTION .....	6
3.2 TRADE .....	6
3.3 SEASONALITY OF IMPORTS .....	9
3.4 CONSUMER TRENDS .....	9
3.5 FORECASTED DEMAND .....	10
3.6 MARKET ASSESSMENT .....	11
3.7 LOCAL MARKET .....	11
3.8 MARKET ACCESS .....	12
3.8.1 Local Retailers and Restaurants.....	12
3.8.2 Co-operatives.....	12
3.8.3 Wholesalers .....	12
3.8.4 Major Supermarket Distributors.....	12
3.8.5 Direct Sales.....	12
3.9 QUALITY CONTROL AND REGULATION.....	13
3.10 QUALITY CONTROL .....	13
3.11 FOOD SAFETY REGULATIONS.....	14
3.12 SUMMARY.....	14
<b>4.0 VERTICAL FARMING MODELS</b> .....	<b>15</b>
4.1 OVERVIEW.....	15
4.2 LARGE-SCALE OPERATIONS.....	15
4.2.1 Industrial Warehouse (Racks).....	16
4.2.2 LED Grow Lights .....	16
4.2.3 Cultivation Area.....	17
4.2.4 Containerized (Rotating Platforms).....	18
4.2.5 LED Grow Lights .....	19
4.2.6 Cultivation Area.....	19
4.3 SMALL-SCALE OPERATIONS .....	20
4.3.1 Red Shipping Container (Racks) .....	21
4.3.2 LED Grow Lights .....	22
4.3.3 Cultivation Area.....	21
4.3.4 Blue Shipping Container (Racks).....	22
4.3.5 LED Grow Lights .....	22
4.3.6 Cultivation Area.....	22
4.3.7 Green Shipping Container (Hanging Racks) .....	22
4.3.8 LED Grow Lights .....	24
4.3.9 Cultivation Area.....	24
4.3.10 Summary.....	25
<b>5.0 OPERATIONS ANALYSIS</b> .....	<b>26</b>
5.1 OVERVIEW.....	26
5.2 OPERATING COSTS.....	26
5.2.1 Cost of Goods Sold (COGS) .....	26
5.2.2 Labour .....	27
5.2.3 Freight .....	29
5.2.4 Lease .....	30
5.2.5 Municipal Tax.....	30
5.2.6 Overhead and Other Operating Costs.....	30

---

5.3 CAPITAL COSTS .....	31
5.3.1 Capital Expenditure.....	31
5.3.2 Equipment Costs.....	32
5.3.3 Land Costs.....	32
5.3.4 Other Capital Costs.....	33
5.3.5 Summary.....	33
<b>6.0 FINANCIAL ASSESSMENT .....</b>	<b>35</b>
6.1 OVERVIEW.....	35
6.2 ASSUMPTIONS.....	35
6.2.1 Production and Pricing Benchmarks .....	35
6.2.2 Direct Sales.....	36
6.2.3 Wholesale Sales.....	37
6.2.4 Critical Cost Assumptions Impacting Model.....	37
6.2.5 Breakeven Analysis.....	37
6.2.6 Summary.....	37
<b>7.0 CONCLUSION .....</b>	<b>37</b>

## List of Tables

Table 1: Alberta Greenhouse Vegetable Trade Balance (Quantity).....	6
Table 2: Canada Greenhouse Vegetable Trade Balance (MT).....	7
Table 3: Estimated Provincial Demand for Vegetables - Alberta.....	11
Table 4: Representative Vertical Farms .....	15
Table 5: Packaging Costs.....	27
Table 6: Employee Requirements.....	28
Table 7: Labour Cost for Large-Scale Warehouse Operation.....	29
Table 8: Vehicle Lease Rates.....	30
Table 9: Building Costs by Representative Vertical Farm.....	32
Table 10: Equipment Costs – Blue Shipping Container (Racks).....	32
Table 11: Operating Cash .....	33
Table 12: Yield Estimates by Vertical Farm Type.....	36
Table 13: Commodity Sales by Package Size .....	36
Table 14: Pricing Schedule by Package Size and Commodity .....	36
Table 15: Wholes Prices.....	37

## List of Figures

Figure 1: Layout of Simulated Multi-Floor Vertical Farm.....	4
Figure 2: Lettuce Production Canada.....	7
Figure 3: HS Code 121190 Imports (MT) into Canada .....	8
Figure 4: Microgreens.....	8
Figure 5: Trends in Fruit and Vegetable Consumption.....	10
Figure 6: Large Indoor Vertical Farming Operation (example).....	16
Figure 7: Diagram with Grow Lights and Drivers .....	17
Figure 8: Propagation Trays and Plastic Grow Beds.....	18
Figure 9: Example of Building Design.....	18
Figure 10: Example of Rotating Grow Beds .....	19
Figure 11: Example of a Static Horizontal Shipping Container.....	21
Figure 12: Image of Hanging Vertical Farm (Inside Container).....	23
Figure 13: Birds Eye Perspective (Hanging Vertical Farm – Shipping Container).....	23
Figure 14: Germination Station (Nursery Area) .....	24
Figure 15: Hanging Polystyrene Plant Panels.....	25

## Glossary

**Canadian International Merchandise Trade Database (CIMTD):** Database offers detailed trade data using the Harmonized System (HS) classification of goods (based on the 6-digit commodity level).

**Cooperatives:** Also known as “Horticulture Associations”, are organizations dedicated to promoting and distributing Alberta-grown produce.

**Cost of Goods Sold (COGS):** The cost of products or raw materials included in production.

**Cost of Production (COP):** The sum of the cost of the resources that were required to produce something.

**Cultivation Area:** A separate area used for cultivating the first stage of plant growth before being transplanted.

**Direct Sales:** Sales made by the vertical farming producer directly to the end customer, without going through a wholesaler and retailer.

**Grow Bed:** The shallow plastic “bed” in which the propagation trays are floating in the hydroponic/aeroponic system. The leafy greens are produced in the grow bed with LED lights suspended above.

**HVAC System:** Stands for heating, ventilation and air conditioning.

**LED Driver:** An LED driver regulates the power required for an LED or array of LEDs. LEDs are low energy, lighting devices with a long lifespan and low energy consumption, hence the requirement for specialized power supplies.

**Light Emitting Diode (LED):** Is a semiconductor light source that emits light when current flows through it.

**Microgreen:** the shoots of salad vegetables such as arugula, Swiss chard, mustard, beetroot, etc., picked just after the first leaves have developed.

**Propagation Trays:** The tray that holds the growing leafy greens. It is typically suspended in a grow bed.

**Retail Prices:** Retail prices are the prices that the customers buying goods at retail outlets pay.

**Salvage Value:** salvage value is the estimated resale value of an asset at the end of its useful life.

**Thermal Runaway:** Thermal runaway occurs in situations where an increase in temperature changes the conditions in a way that causes a further increase in temperature, often leading to a destructive result.

**Turnkey Vertical Farming Operation:** Equipment suppliers pre-build the entire operation and deliver it to the site. This is slightly different for the Large-Scale operation (which is quoted as a pre-built operation), but for the remaining turnkey vertical farming operations they come pre-built with all equipment.

**Useful Life:** The useful life of an asset is an accounting estimate of the number of years it is likely to remain in service for the purpose of cost-effective revenue generation.

**Wholesale Prices:** the cost of a good sold by a wholesaler. The wholesaler will usually charge a price somewhat higher than they paid to the producer, and the retailer who purchases the goods from the wholesaler will increase the price again when they sell the good in their store.

# 1.0 Executive Summary

The following document defines and outlines a series of different, representative models, each with distinctive, identifiable economic elements, and shows the financial results from an economic comparison. The models are based on recognizable examples and quotes from suppliers that are currently available in Alberta and Western Canada. The following document reflects the “turnkey” vertical farming systems currently available in Alberta.

The vertical farming assessment is not a business plan or a detailed guideline on building a vertical farming operation from scratch. As a result, it does not provide any conclusions on the viability of vertical farming as an industry itself. On the other hand, it provides a detailed economic assessment of the current turnkey systems being marketed to in Alberta and Canada.

The document begins with a brief introduction to vertical farming, an overview of the market for leafy green vegetables in Canada and Alberta, a detailed description of the five chosen representative vertical farming models, an operational analysis of the inputs used in the model, and finishes with a financial analysis and conclusion.

While there are beginning to be a number of turnkey vertical farming equipment suppliers, verifying the costs and revenues provided by these companies is complex. All costs that were able to be verified with independent research have been verified, however, much of the proprietary LED light technology, LED drivers, and other specific technology prebuilt into the systems does not have equivalency elsewhere. Therefore, information such as annual electricity consumption and yield estimates were taken from the equipment suppliers. Data supplied by the equipment suppliers was verified where possible, and additional costs of production (COP) information was added where missing. Investors are cautioned, especially those interested in the small-scale containerized operations, to review cash flow statements from equipment suppliers and have a third party review the financials. Much of the financial information available on vertical farms is missing key cost elements including the cost of own labour, repairs and maintenance, marketing fees, freight, business licenses, taxes and debt payments, among various other cost factors that are critical to generating a realistic picture of the financial viability of these operations. This assessment and the accompanying spreadsheet model are a first step towards including the key cost elements into the assessment process so that investors can better understand the financial viability of these operations under real-world assumptions.

For this work five representative turnkey vertical farming operations were selected, which represent the options that are currently available to investors in Alberta. The five models include two large-scale operations and three small-scale shipping container operations. The company details of the equipment suppliers have been removed from the document for the sake of confidentiality.

The two large-scale operations differ significantly in their capital requirements and size, while the three shipping container operations are similar in size and scale. The

smallest investment assessment in this document requires a capital expenditure of roughly \$150,000 and the largest is upwards of \$20 million. Clearly, the target audience of the former is small-scale producers, potentially looking to supplement income with an additional business opportunity, whereas the largest operation is targeted at investment funds and professional investors that would likely be looking to hire professionals to run the entire operation. A clear breakdown of each operation can be found here: [Vertical Farming Models](#) (page 20).

One of the critical assumptions made for the modelling is the marketing approach for the vertical farming operation. It was found that in order for any of the vertical farming operations to be economically viable, the majority of produce sales had to be sold at higher than wholesale prices, i.e. marketed direct to consumers at retail prices rather than compete with other suppliers on the wholesale market. This document will demonstrate how vertical farming operations need to hit large direct to consumer sales targets if they are to be profitable. If they do not and end up selling produce at wholesale prices, they are not able to compete with greenhouse produced vegetables. The [Financial Assessment](#) section of this document provides a breakdown of the approximate sales targets each respective vertical farming operation has to make in order to meet targeted rates of return. One overarching conclusion from this process is that the larger operations have to make considerable direct to consumer sales in order to be profitable.

The two large-scale operations reviewed for this assessment may produce the volume required to supply grocery stores (either directly or through cooperatives, i.e. wholesalers), the prices received would not be high enough to support the large-scale vertical farming businesses without direct sales to consumers. Small-scale operations are the same, but to a lesser extent. While the small-scale operations would not have the scale necessary to supply larger grocery stores or cooperatives, they would find most of their sales through the restaurant industry and through farmer's markets. However, like the large-scale operations, they require considerable direct sales to consumers to be profitable.

The main conclusion this work will demonstrate is that while investing in vertical farming appears to be growing momentum and has the potential to offer innovative ways to feed a growing population, investors are encouraged to do their own due diligence prior to investing in the sector. Some of the operations outlined in this assessment offer very a good return on investment, but they also require highly advanced marketing plans that will allow the business to market direct to consumers.



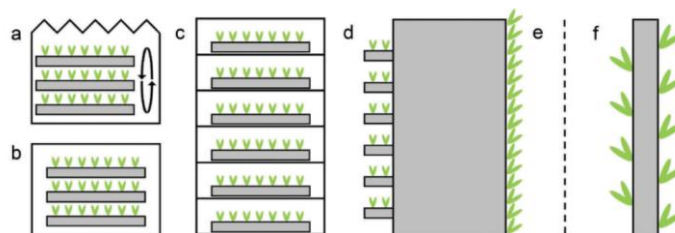
## 2.0 Intro to Vertical Farming

One of the original motivations behind vertical farming arose out of the idea that agricultural production is experiencing increased pressure to generate larger yields as the global population rises and demand for food increases. In recent years it has increasingly been driven in North America by a combination of advances in technology – which have decreased the cost of indoor production and made the concept feasible – and increasing demand for “free-from,” locally produced goods, among other factors. In the Alberta context, indoor vertical farming operations have begun to crop up in the regions surrounding Edmonton and Calgary, where the operations are supplying the local population centres with fresh leafy green vegetables.

Vertical farming can be broadly divided into two main categories, those comprising multiple levels/rows of growing platforms/units, and those where the operation is located on a vertical surface such as on rooftops (Beacham, Vickers & Monaghan, 2019). This assessment focuses on the design of the vertical growing operation itself rather than where it is located, other than to account for the cost of leasing the physical space to run the operation (whether that is an industrial warehouse or an empty lot). In theory, pre-fabricated units could be placed wherever the grower had suitable space, which may in fact be on the rooftop of a building; however, it does not change the economic assessment of the unit itself other than to account for the cost to lease the space.

There are numerous different theoretical styles of vertical farms. Beacham, Vickers and Monaghan (2019) define the following six models that have working operations.

- a) multiple levels of horizontal growing surfaces located in glasshouses with level rotation incorporated
- b) Controlled environment (CE) facilities;
- c) Multi-floor towers, where each level is isolated from the surrounding levels;
- d) The use of balconies for crop production using stacked horizontal growing surfaces;
- e) Vertical growing surface include green walls, which can be positioned on the side of buildings and other vertical surfaces;
- f) Cylindrical growth units with vertical arrangements of plants.

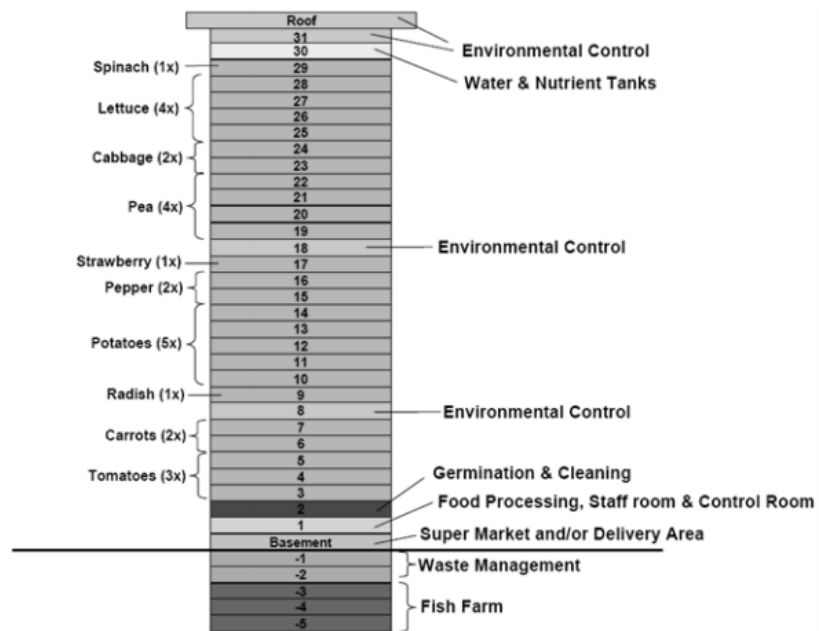


Source: Beacham, Vickers and Monaghan (2019)

While each of the six models defined by the authors have a use for growing crops, the list of feasible options for the Alberta climate is reduced to vertical farming variations of the controlled environment facilities. A controlled environment facility differs from a glasshouse because it does not allow natural light to pass through. Glasshouses with the incorporation of rotating platforms (option a), is feasible and currently being used in Alberta, but this assessment will not be focusing on greenhouse operations.

The multi-floor tower option (option c) will also not be incorporated into this study. This option is simply a variation of the controlled environment facility that incorporates multiple floors. A multi-floor facility would need to be purpose built rather than incorporating pre-existing industrial warehouse space, which appears to be a limiting factor. Adenaueer and Allee (2014) provide a detailed overview of ongoing research into simulated multi-floor vertical farming tower in Berlin, Germany (**Error! Reference source not found.**). The ongoing simulation work is being conducted by the German Aerospace Center (DLR) in Bremen, Germany. The authors suggest that the investment costs required for such as facility adds up to just under \$300 million CAD (€200 million).

**Figure 1: Layout of Simulated Multi-Floor Vertical Farm**



Source: Banerjee and Allee (2014). Up, Up and Away! The Economics of Vertical Farming

While the multi-floor facility is still very much a theoretical concept, the use of single floor, controlled environment facilities are cropping up across Canada and Alberta. There are multiple examples of controlled environment facilities in both Calgary and Edmonton, and real world data has been used for the assessment of this type of facility.

Going beyond warehouse-style large-scale industrial operations, the remaining vertical farming operations in Alberta are of the turnkey variety. These are containerized variations of the controlled environment facility. Options on the market include variations of the stacked horizontal growing surfaces, green walls, and a third option which was not defined by Beacham, Vickers and Monaghan (2019). One company is offering a technology that incorporates rotating platforms (i.e. long stainless steel growing tubs) housed within shipping containers.

## 3.0 Market Analysis

### 3.1 Introduction

Research into the vertical farming sector in Alberta suggests that lettuce, basil and microgreens are the most commonly produced leafy green vegetables in the emerging vertical farming sector. The LED light technology being developed is ideally suited to growing leafy greens and these three commodities are commonly grown at this time.<sup>1</sup> All of these commodities have been increasing in demand, especially basil and microgreens, and they offer vertical farming producers an opportunity to take over some of the high value market for fresh leafy green vegetables currently being captured by imports and greenhouse production.

The following market overview section sources reliable Statistics Canada data on lettuce trade and production numbers. Data on basil and microgreens provides an overview of the size of the market by drawing on the available information. However, given the lack of reliable reporting for basil and microgreens by Statistic Canada, the information is less certain. It relies on publications and other sources for its information.

### 3.2 Trade

Alberta is a net importer of leafy green vegetables, primarily due to the climate. A competitor to vertical farming operations is the emerging greenhouse industry in Alberta. Alberta is also a net importer of all greenhouse vegetables. The trade balance for Alberta is shown in **Error! Reference source not found.** The values listed below are for greenhouse vegetables directly imported into Alberta from another country. Inter-provincial shipments are not included in imports.

**Table 1: Alberta Greenhouse Vegetable Trade Balance (Quantity)**

(Metric Tonnes)

	2014	2015	2016	2017
Total Exports	333,149	415,945	701,322	437,360
Total Imports	18,054,533	20,654,942	25,332,438	22,552,872
<b>Trade balance</b>	<b>(17,721,384)</b>	<b>(20,238,997)</b>	<b>(24,238,997)</b>	<b>(22,115,512)</b>

Source: Economics of Production and Marketing Greenhouse Crops in Alberta ([2017](#))

With respect to vegetables, the United States and Mexico are Canada's primary trade partners. Over the last 10 years, Mexico has increased its greenhouse vegetable production and has started advancing into U.S. and Canadian markets. Mexico has changed its greenhouse production from seasonal to year-round. Canadian greenhouse producers are also beginning to establish greenhouses in the southern United States to ensure they have year-round product. In this way, there is considerable competition for vertical farming from traditional greenhouse

<sup>1</sup> The vertical farming industry is working on developing the ability to grow tomatoes, strawberries and other horticulture products, but they are not commonly produced at this time. The LED light technology and growing system is well suited to leafy greens.

operations. Even more so because greenhouses are beginning to incorporate LED lighting and other aspects that allow them to incorporate both sunlight and artificial light.

Regarding lettuce production, Canada is currently large net importer (**Error! Reference source not found.**). The main two sources of imports for Canada are the United States (California) and Mexico. Much of the produce comes from greenhouse operations.

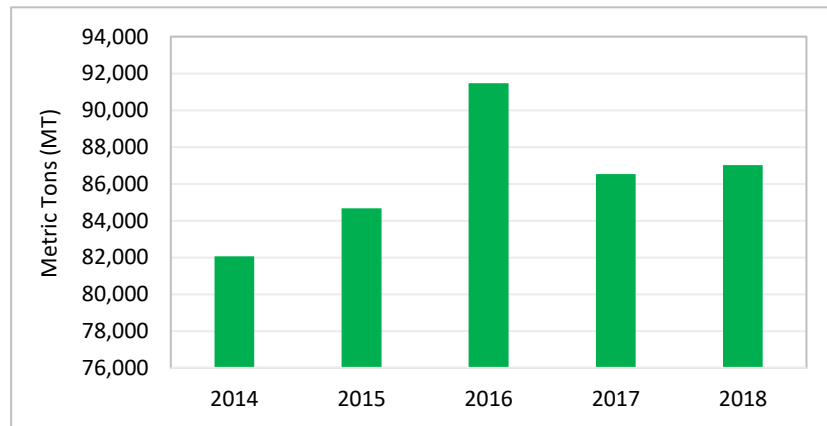
**Table 2: Canada Greenhouse Vegetable Trade Balance (MT)**

	2013	2014	2015	2016	2017
Lettuce	-418	-247	-284	-317	-374

Source: [Statistical Overview of the Canadian Greenhouse Vegetable Industry, 2017](#)

Canada produced 87 million kg of fresh lettuce in 2018 (**Error! Reference source not found.**). Much of Canada’s lettuce production comes from the large greenhouse sectors in southern Ontario and British Columbia.

**Figure 2: Lettuce Production Canada**

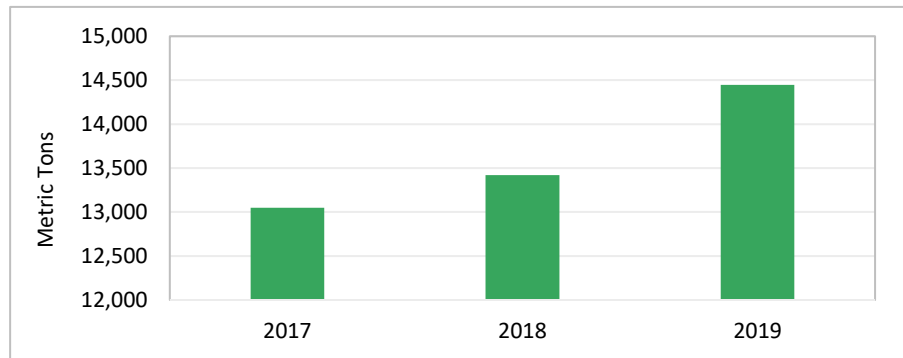


Source: AAFC

Basil production and area planted is not tracked by Statistics Canada, making it more difficult to estimate market size. While import statistics for basil are technically tracked through Canadian International Merchandise Trade Database (CIMTD), the level of aggregation means that it is lumped in with various other plants, making the import numbers uncertain. The aggregated category (HS Code: 121190<sup>2</sup>) for basil shows a 5% year-on-year growth in imports for the past ten years, totaling 13,500 metric tonnes (MT) in 2018 (\$101 million) (**Error! Reference source not found.**).

<sup>2</sup> 121190 - Plants, parts, seeds & fruits, nes, f perfumery/pharm/insect/fung/sim,fr/chd/frz/dr

**Figure 3: HS Code 121190 Imports (MT) into Canada<sup>3</sup>**



Source: Canadian International Merchandise Trade Database (CIMTD)

A [consumer survey](#) by Alberta Agriculture and Forestry found that in Edmonton 32% of households surveyed stated that there was unmet demand for fresh or dried basil in the city. This is the second highest amongst the list of vegetables in the survey. A similar [study](#) by Alberta Agriculture and Forestry conducted for on the Calgary market found that basil stood well above any other vegetables in popularity and unmet demand. Therefore, there appears to be unmet demand for basil in the province of Alberta.

Market research shows demand for fresh leafy greens on the rise, driven in part by demand for fresh and local products by higher-income consumers in Canada.<sup>4</sup> Regarding microgreens, recent studies on the market suggest that it will peak in North America within the next 10 years.<sup>5</sup> However, the market appears to be growing at this time. There is an opportunity to potentially take way market share from exporters in areas like California. However, the size of the market for microgreens remains unclear.

**Figure 4: Microgreens**



Source: The Canadian Organic Grower

<sup>3</sup> "Basil Imports" includes everything within HS Code: 121190.

<sup>4</sup> USDA GAIN Report CA19022

<sup>5</sup> Sylvain Charlebois (2017) Microgreens with Big Potential. ([link](#))

### 3.3 Seasonality of Imports

The seasonality of vegetable importation should be considered to fully understand market supply and competition for emerging vertical farming businesses. Typically, Canadian greenhouses have not operated year-round, which consequently leads to interruptions in supply. It is expected that imports are the highest during these interruptions, but consideration should be given to the quantity of imports in peak supply months. These interruptions in supply may offer an opportunity for indoor vertical farming operations. If imports exist during peak supply months, it may be an indication that there is room in the market for these imports to be replaced by domestic production.

### 3.4 Consumer Trends

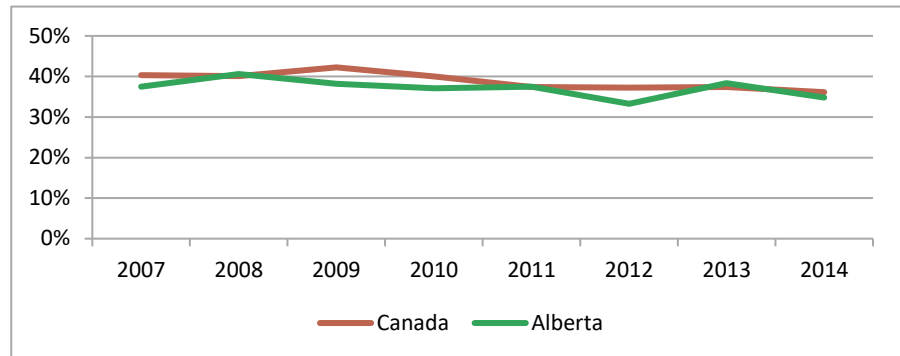
Considerable research has been conducted on the trends that may be expected for vegetable consumption. In the face of health concerns with respect obesity, dietary fiber, general good health, and vegetarianism, there would be an expectation that vegetable consumption is increasing. However, recent Statistics Canada research (2017) has shown a 5 per cent drop in consumption between 2015 and 2017. The latest statistics show that 28.6 per cent of Canadians aged 12 and older reported that they consumed fruits and vegetable five or more times per day. This rate has been decreasing since consumption peaked in 2009 at 45.6 per cent.<sup>6</sup> Another recent study found that between 2004-2015 Canadian total consumption of vegetables and fruits dropped by 13%. However, analysis of subgroups in the same study found that consumption of dark green vegetables (e.g. raw spinach or romaine lettuce) is increasing.<sup>7</sup> The study finds that consumption of starchy vegetables such as potatoes has decreased, but consumption of fresh leafy greens has grown in the last decade. This trend corroborates the findings in Alberta from the consumer surveys completed by Alberta Agriculture, Forestry and Rural Economic Development in [Edmonton](#) and [Calgary](#), which finds unmet demand for herbs like basil.

Limited data is available through Statistics Canada on fruit and vegetable consumption in Alberta. Figure 6 shows variability in the percentage of the population ages 12 and older who consume fresh fruit and vegetables five or more times per day. Compared to the Canadian average, fewer Albertans consume these products regularly. Also, of note is the downward trend for both Alberta and Canada. However, as has been noted above, total vegetable consumption may be decreasing, but subgroups such as fresh leafy greens appear to be increasing.

---

<sup>6</sup> [Fruit and Vegetable Consumption, 2017](#)

<sup>7</sup> Tugault-Lafleur, C., N., Black, J., L. (2019). Differences in the Quantity and Types of Foods and Beverages Consumed by Canadians between 2004 and 2015. *Nutrients*:11, 526; doi:10.3390/nu11030526

**Figure 1: Trends in Fruit and Vegetable Consumption**


Source: Statistics Canada, CANSIM 105-0501

Note: consumption refers to 5 times or more per day (% of the population aged 12 and older)

A previous study found that approximately 75 per cent of Canadians surveyed claim that a product “Made in Canada” influences their likelihood of buying a product<sup>8</sup>. The second highest influence comes from products that are branded as “local.” Both of these consumer trends favor greater demand for domestically produced vegetables.

Another incentive for retailers to buy local is that locally grown produce has a greater shelf life than imported product.<sup>9</sup> When fruits and vegetables are harvested locally, they do not spend as much time on a truck where it can be exposed to changing temperature environments.<sup>10</sup> Less time in transit means more time on shelf and subsequently less waste. The ability to source locally grown produce can add two to four days to shelf life. Although locally grown produce is increasing in popularity, price still trumps locations when purchasing vegetables.

### 3.5 Forecasted Demand

In the development of a new vertical farming operations in Alberta, and in the selection of crops to produce, a useful step is to establish the current consumption of different vegetables, and where possible, make projections on what the demand may be over the next few years.

Future vegetable demand is impacted by a number of factors, but the most important are any expected change in the per capita disappearance, and the change in population. In 2019, Alberta’s population growth accelerated for a second consecutive year to 1.6%, and it is projected to continue growing. According to Statistics Canada, the rate of population growth is expected to be highest in Alberta among all provinces over the next 25 years.

<sup>8</sup> [The B.C. Organic Market](#)

<sup>9</sup> Watada, A., E., Qi, L. (1999). *Quality of fresh-cut produce*. *Postharvest Biology and Technology* 15: 201 – 205. PII:S0925-5214(98)00085-4

<sup>10</sup> Nunes, M., C., N., Emond, J., P., Rauth, M., Dea, S., Chau, K., V. (2009). *Environmental conditions encountered during typical consumer retail display affect fruit and vegetable quality and waste*. *Postharvest Biology and Technology* 51: 232–241. doi:10.1016/j.postharvbio.2008.07.016



The growth in per capita demand is impacted by a variety of factors, the most important of which are disposable income, as well as trends in obesity, immigration, and demographics such as age and cultural mix.

### 3.6 Market Assessment

The vertical farming vegetable market can be observed from two different points of view: local and international. The local market consists of customers and competitors that exist in the same geographical region where products can easily be transported by land. The international market consists of customers and competitors that exist in another country. Due to the limited size of the vertical farming sector in Alberta and across North America, and the similarities with the greenhouse sector, this marketing section will include greenhouses in the overview of the local and international markets.

### 3.7 Local Market

According to United States Department of Agriculture (USDA) Agricultural Marketing Resource Center (AgMRC) data from 2018, 25.8 pounds of lettuce are being consumed on an annual basis by the average consumer in the United States.<sup>11</sup> The growing popularity of prepackaged, ready-to-eat salad greens contributed to the rise in availability of fresh lettuce products. It can be reasonably assumed that Canadians and Americans have similar consumption habits. Anecdotal evidence suggests that herb consumption (including basil) per capita in the North America has been growing, but no clear per capita numbers are available at this time. **Error! Reference source not found.** below shows the estimated demand for lettuce in Alberta based on the USDA per capita consumption estimates.

**Table 3: Estimated Provincial Demand for Vegetables - Alberta**

	Lettuce	
	Total	Per capita
Estimated Consumption (lbs)	58,000,000	25.8
Estimated Consumption (kg)	26,300,000	11.7

Source: Alberta Economic Dashboard, USDA AgMRC<sup>12</sup>

The provincial supply of vegetable comes from local producers, inter-provincial transfers, or international imports. Unfortunately, inter-provincial transfers are not tracked. Therefore, it cannot be determined what quantity is transferred into the province from other provinces. Vegetable supply is comprised of both greenhouse and field production.

Overall, there appears to be room in the market for additional production, especially during the winter. Price and quality of product will likely determine success in accessing the market. Further research could be conducted to determine market availability. Interviewing vegetable co-operatives and wholesalers would be valuable to determine their demand for increased production.

<sup>11</sup> [Commodities and Products: Lettuce \(2018\)](#)

<sup>12</sup> [Commodities and Products: Lettuce \(2018\)](#)

## 3.8 Market Access

Gaining market access is critical for securing buyers for products from these vertical farming operations. There are a couple of market outlets that could be considered for the vertical farming product. Some of these outlets include local retailers, co-operatives, wholesalers, and major grocery distribution centers as well as direct-to-consumer sales.

### 3.8.1 Local Retailers and Restaurants

Local retailers in nearby small communities and farmers' markets as well as direct sales to restaurants are avenues that could be utilized to sell product. There are a number of benefits that would result from the construction of a local marketplace. One of the main advantages of using a local marketplace as a marketing channel is that it reduces the amount of linkages in the supply chain. By reducing the number of linkages in the supply chain, a greater portion of the producer to retail margin is retained by the producer. In this case, the greenhouse could make large margins on the product that it sells to the marketplace as there are no middlemen or wholesalers handling or redistributing the product. By eliminating these middlemen, the marketplace might also be able to compete with other major retailers in terms of price.

### 3.8.2 Co-operatives

Co-operatives have been established across the province to help smaller producers better market their product. Often times, operations do not produce enough quantity on their own to satisfy major buyers' needs. Instead, growers combine their production and market their product as a larger entity. This aggregation gives smaller producers access to larger markets and greater marketing power.

### 3.8.3 Wholesalers

Wholesalers are similar to co-operatives in that they collect product from smaller producers and sell it in aggregate. The difference between a co-operative and wholesalers is that wholesalers are not always owned by the producers. They are a separate entity in the supply chain and make decisions based on their best interests. Some of the wholesalers that are present in Alberta include Sunfresh Farms, Star Produce and Gordon Food Service.

### 3.8.4 Major Supermarket Distributors

Major supermarket distributors include Loblaws, Sobeys, and Costco. These distributors need access to large quantities of vegetables that are reliably produced year-round. Vertical farming operations would need to be well-established and trusted before these distributors will engage in an agreement. This is likely not the marketing channel that will be targeted from the beginning by anything but the largest vertical farming operations in this assessment.

### 3.8.5 Direct Sales

Opportunities for direct sales include sales through online platforms such as Amazon Grocery, home delivery (SPUD, The Organic Box, etc.), and farmers' markets. Direct sales offer the vertical farming producer the opportunity to generate retail prices for their leafy greens. However, there is considerable administrative work involved with marketing direct to consumers.

### 3.9 Quality Control and Regulation

Forming business relationships with vegetable buyers is a significant milestone in the success of a vertical farming operation. The keys to maintaining this relationship are to produce safe, high quality vegetables that are reliably supplied. If quantity or quality were to dwindle or degrade, it could put the business relationship at risk. In order to maintain the quality of vegetables, growing guidelines and legislation are set out to ensure that quality parameters are met.

#### 3.10 Quality Control

In order to consistently supply safe, high quality vegetables, it is important to implement Standard Operating Procedures (SOPs) to maintain the desired quality status.

The *CanadaGAP Food Safety Manual for Greenhouse Product* is an on-farm food safety program developed by the Canadian Horticultural Council.<sup>13</sup> This program has applicable SOPs for the vertical farming sector as well. The program was intended to identify the potential sources of biological, chemical, and physical hazards for horticultural products from the production site through to shipping. It outlines Good Agricultural Practices (GAPs) that are recommended to ensure safe and high-quality food. Each individual producer has different greenhouse structures, products, and production methods. Therefore, a cookie-cutter type SOP cannot be applied to every operation. GAPs are practices that are outlined to give direction on where contaminations may occur. The manual is available online for greenhouse producers to print out and use to establish on-farm food safety practices.

The manual outlines a “To Do List” of items to inspect to prevent contamination of product. The areas outlined can be summarized into the below points:

- Inspection, cleaning, repair, and maintenance of the handling, storage, sorting, packaging, grading, and growing facilities.
- Application and storage of synthetic fertilizers, manure, and agricultural chemicals used in the production of vegetables.
- Supply of water for the plants and disposal of wastewater.
- Cleanliness of equipment, gloves, and hands is an important procedure to limit the spread of disease.
- Visitor policy for biosecurity reasons.
- Employee training procedures to ensure that outlined SOPs are adhered to.
- Setting out protocols in the case of emergencies or contaminations to prevent further losses.

Adhering to GAP’s is an important marketing characteristic that can help improve trust in the quality of production. For a more detailed description of GAP’s refer to the On-Farm Food Safety Greenhouse Manual.

<sup>13</sup> [On-Farm Food Safety Greenhouse Manual](#)

### 3.11 Food Safety Regulations

Food safety regulations are established to protect Canadians and instill trust in the food that is publicly available. Vertical farming operators need be aware and adhere to legislation that applies to their operation. Failure to comply with legislation could lead to fines, and consequently loss of buyers.

Relevant regulations are dependent on where and how the product is being marketed. Selling directly to the consumer will have different regulations than selling to a wholesale buyer. Producers need to be aware that they must abide by both provincial and federal legislation in the production of food. Municipal requirements must also be considered prior to construction as some may be subject to an environmental impact review. Prospective investors in vertical farming are advised to refer to the following sources for more information on regulations:

- [Federal Legislation](#)
- [Provincial Legislation](#)
- [Safe Food for Canadians Act \(SFCR\)](#)

A detailed handbook of the new regulations in SFCR has been provided by the Canadian Food Inspection Agency (CFIA) and can be accessed [here](#). The handbook is intended for food businesses who need to comply with new SFCR regulations. The SFCR generally applies to food for human consumption (including ingredients) that is imported, exported, or inter-provincially traded for commercial purposes. It also applies to the slaughter of food animals from which meat products to be exported or inter-provincially traded. Some of the traceability, labelling and advertising, and grading provisions also apply to intra-provincially traded foods.

### 3.12 Summary

The market for Alberta grown vertically farmed vegetables shows promise as there continues to be strong imports of fresh vegetables. Seasonally, July and August are the months where vegetable supply is at its greatest and prices are generally at their lowest. Despite peak production, Canada import fresh vegetables year-round. Therefore, there still appears to be room in the market for more domestic production.

Per capita vegetable consumption appears to be plateauing, but a recent population boom and projected future growth will increase the aggregate demand for vegetables in Alberta.

Securing and maintaining a buyer of vertical farming products is critical to the feasibility of the operation. Ideally, the vertical farm would market the majority of its product through direct to consumer sales with a smaller percent being sold to cooperatives at wholesale prices. Maintaining business relationships, product safety, quality, and reliable supply are critical for the longevity of the business.

This section provided a general overview of the market for lettuce, basil and microgreens. The market for lettuce is clearly defined and there is clearly a gap in local production. The market for basil and microgreens in Alberta is less clearly defined given the lack of data on these products. However, anecdotal reports suggest that demand is growing rapidly and there appears to be an opportunity to supply the market locally.

# 4.0 Vertical Farming Models

## 4.1 Overview

Real world data has been provided by vertical farming equipment suppliers and used for the following vertical farming models. As the technology is just emerging, the level of data available is limited at this time. More importantly for the assessment, the limited number of suppliers means that data must be taken at face-value from the suppliers. With the greenhouse industry, for example, there is enough publicly available research that allows for industry standards with regard to energy use per square metre or expected yields for certain plant varieties in a given location. With vertical farming this is not the case. Each equipment supplier has their own patented LED light technology and there is no way short of performing trials to independently verify the yield estimates provided by the manufacturer. Therefore, the vertical farming options used for this assessment rely completely on the variables provided by the equipment suppliers themselves.

The names of the individual vertical farming technology providers have been kept anonymous at the request of the suppliers. Where diagrams and/or images are included, they have been taken from other similar operations to demonstrate the type of technology, but the exact photos supplied to by the companies are not used in this assessment.

As described in the industry analysis section of this document, there are a few available vertical farming options on the market at this time. Out of the options available to producers, some can be considered larger-scale industrial agricultural operations, and some are smaller-scale, designed to target a different market segment. Five different representative vertical farming models have been selected and divided into large-scale and small-scale operations. This selection represents the vertical farming technology that is commercially available on the market in western Canada at this time (**Error! Reference source not found.**). The following section will provide a brief overview of the selected representative models.

**Table 4: Representative Vertical Farms**

<p><b>Large-Scale Vertical Farms</b></p> <ul style="list-style-type: none"> <li>Industrial Warehouse (Racks)</li> <li>Containerized (Rotating Platforms)</li> </ul> <p><b>Small-Scale Vertical Farms</b></p> <ul style="list-style-type: none"> <li>Red Shipping Container (Racks)</li> <li>Blue Shipping Container (Racks)</li> <li>Green Shipping Container (Hanging Panels)</li> </ul>
---

## 4.2 Large-Scale Operations

A large-scale operation is defined in this assessment as anything larger than a vertical farming operation housed within a single shipping container. Two representative models fit this definition in this assessment. The first is a large-scale operation that consists of multiple levels of grow-beds stacked on steel shelving filling a large warehouse. The second is large-scale operation consisting of groups

of steel containers built up in unison to form a larger system. The characteristic that sets the second large-scale operation apart from the other small-scale containerized operations is that it is designed to work in minimum groupings of 14 units. In other words, while the second large-scale representative model uses shipping containers, they are not designed to work as single units, they are purpose built to be used in larger-scale vertical farming operations.

4.2.1 Industrial Warehouse (Racks)

Industrial warehouse vertical farming operations are built on a large industrial scale, require considerable labour (employees), use large amounts of electricity and require large capital expenditure upfront (example shown in **Error! Reference source not found.**). Some leading vertical farms of this design in North America include [AeroFarms](#), [Bowery Farming Inc](#), and [Plenty](#). However, there are examples of similar warehouse vertical farms in Edmonton and Calgary.

Error! Reference source not found.: **Large Indoor Vertical Farming Operation (example)**



Source: aerofarms.com

Note: Image is an example of a similarly designed vertical farm.

The data source used for this work comes from a large-scale vertical farming equipment supplier in Western Canada. The large scale operation consists of a 3000-bed vertical farming operation housed in an 80,000ft<sup>2</sup> warehouse.

#### 4.2.2 LED Grow Lights

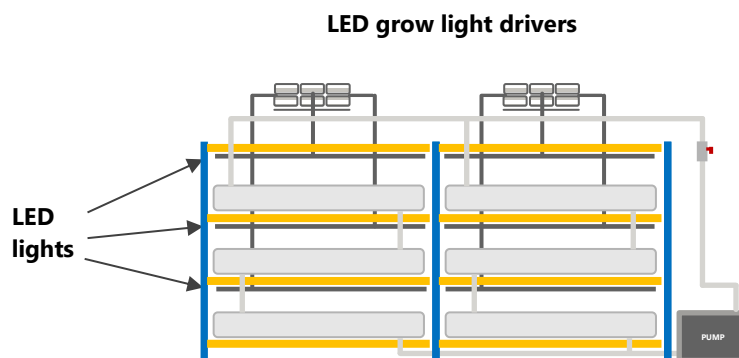
The warehouse vertical farm uses 6 LED grow lights (8 ft) per grow bed. Each grow light requires 1 driver (housed in an Extrusion) and located on top of the grow racks.

LED drivers are electrical circuits used to control the forward voltage ( $V_f$ ) of high-powered LED lights with temperature changes. The drivers work in unison with LED lights. As temperature increases, the forward voltage of the LED decreases, causing the LED to draw more current. The LED will continue to get hotter and draw more current until the LED burns itself out, this is also known as Thermal Runaway. The LED driver is a self-contained power supply which has outputs that are matched to the electrical characteristics of the LEDs. This helps avoid thermal runaway as the constant current LED driver compensates for the changes in the forward voltage while delivering a constant current to the LED.



The LED lights are hung in rows of six above each grow bed with electrical cables running up to the drivers on top of the grow racks (Figure 2). The equipment manufacturer consulted for this representative vertical farm produces their own LED lights at a factory in China. The equipment supplier has been developing the lights for ten years and they make up a significant per cent of the overall cost of setting up a facility. The LED grow lights and drivers account for roughly half the total equipment cost.

**Figure 2: Diagram with Grow Lights and Drivers**



Source: Depiction by author.

The LED lights for the warehouse vertical farming operation consumes approximately 616,000 kW of electricity per month. At a rate of \$.10/kWh it costs the producer just under \$740,000 in electricity per year to run the LED lights for the facility.

#### 4.2.3 Cultivation Area

The cultivation area can be visualized as long rows of steel racks (**Error! Reference source not found.**) separated by walkways in a warehouse environment. The representative vertical farm has 16 ft high steel racks with a steel walkway halfway



up. The steel racks are coated with food grade paint to avoid mold and mildew buildup during the growth cycle.

Each shelf on the steel racks holds a plastic grow tub with LED lights suspended above. The plastic grow beds are 4 ft by 8 ft and the propagation trays are 2 ft x 4 ft, meaning that a total of four propagation trays would be used per grow bed (Figure 3). The trays are typically modified by the vertical farming operation so that they will hold more plants per square inch. The system uses a soil-less hydroponic system (other than the grow plugs). The piping for the facility is all pre-cut and shipped to the building site for assembly. The facility uses 2-inch white PVC piping, ozone generators, water pumps, propagation trays and grow beds.

**Figure 3: Propagation Trays and Plastic Grow Beds**



*Note: Above images are examples of similar products.*

4.2.4 Containerized  
 (Rotating  
 Platforms)

The second large-scale representative vertical farm uses pre-built containers that incorporate rotating grow bed technology. The units come pre-built in sets of a minimum of 14 containers. There are examples of this style operation in Alberta, housed in both conventional steel buildings and under domed tent-like structures (Figure 4).<sup>14</sup>

Unlike with the warehouse style vertical farming, where the operation can easily be housed within a leased industrial building, this style vertical farm requires land preparation. Purchased industrial land has been incorporated into the economic model as well as the necessary land preparation including pouring a cement pad. The cost of building a domed structure (Figure 4) to house the operation is included.

**Figure 4: Example of Building Design**



<sup>14</sup> Similar to what is offered by the company Econoline (Storage Building).

Source: <https://cubicfarms.com/>

Note: example image of similar technology.



#### 4.2.5 LED Grow Lights

This system incorporates fewer LED light fixtures per square foot of growing area because the grow platforms rotate, i.e. they share the light. The lights are located at the top of the shipping container and the grow beds move along tracks that allow the plants to have timed access to light (Figure 5). The LED grow lights have drivers and other timing mechanisms that come pre-built in each container.

**Figure 5: Example of Rotating Grow Beds**



Source: [Seedstock.com](https://www.seedstock.com)

Note: Image is an example and does not represent the exact technology used by the equipment supplier worked with for this assessment.

The LED lights for the 14-shipping container system consumes approximately 72,800 kW of power per month. At a rate of \$.10/kWh it costs the producer just under \$90,000 in electricity per year to operate the facility. This is in line with the electricity consumption per shipping container for the small-scale operations in this assessment (e.g. \$6,500 per year).

#### 4.2.6 Cultivation Area

The one key differentiating factor between this technology and the following small-scale operations is that the 40-foot containers are custom built using stainless steel rather than conventional shipping containers. This may not be an important factor to consider in the initial years of operation, but as time goes on the use of fertilizer and water within a regular steel structure may cause rusting that prematurely wears out the investment.

Each individual container (14 in total) has 240 grow trays with automated hydroponic watering systems that are timed and supply water and nutrients when needed. Everything including temperature, humidity, CO<sub>2</sub>, and airflow are all automated and programmable. In addition, the conveyor system brings the trays of crops to the producer at the entrance to the shipping container, so there is no need to move back and forth within the unit to harvest the crops.

### 4.3 Small-Scale Operations

For this work, a small-scale vertical farming operation is defined as anything that can be used as a single unit, i.e. a 40-foot shipping container. There are a growing number of companies across North America that have started to offer turnkey shipping container vertical farming operations. They pre-build the units and ship them to the customer with everything needed to get started growing leafy greens.

The capital expenditure and technology vary by product, but the fundamental aspects of the units are similar: they all have a growing area with some form of grow beds, either florescent or LED grow lights, circulating pumps, nutrient tanks, a separate cultivation chamber or area, and various forms of technology to assist the grower. The first two containerized options vary in their projected productivity and the initial equipment costs (start-up costs) and the third in the unique design of the growing area itself as well as the way the LED lights are arranged to maximize growing area within the container. Given the prevalence of the shipping containers with a simple design of shelving on either side of one central walkway, this assessment compares the financials of two different operations that incorporate similar designs but at significantly different capital expenditure requirements. The third option shows the financials for what can be considered a more innovative design and what can be expected going forward as the technology becomes more competitive.

Most of the containerized options on the market are built in pre-insulated shipping containers. New, insulated shipping containers have a market price of roughly \$5000 to \$6000. Therefore, at a price range of between \$135-\$200K for the finished shipping containers with all the additional racks, lights and other equipment necessary for growing plants, there appears to be considerable markup with the finished products. However, as it is a new technology and the price of the lights and other specialty equipment has few, if any, comparisons on the market, it is difficult to determine the actual markup.

The shipping containers also have numerous add-ons that can increase the finished price considerably. For instance, suppliers offer custom paint, showroom display cabinets, educational courses, software applications, a year's supply of seeds and fertilizers (at a high markup), and a long list of other additional items that a

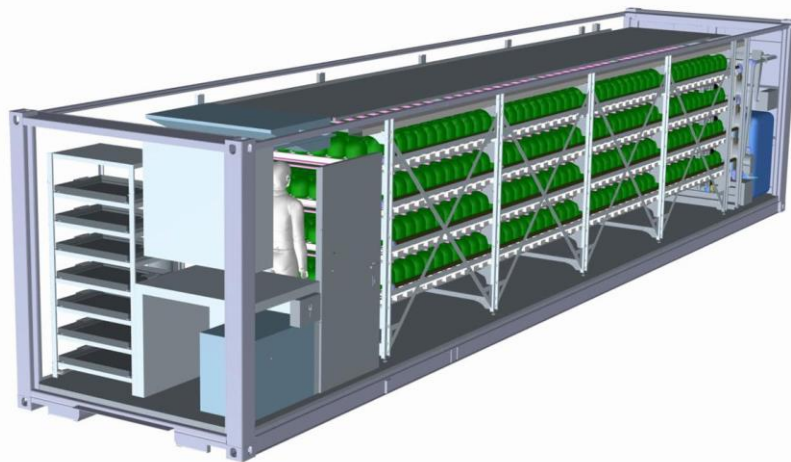
purchaser can add to their finished shipping container. These costs add up quickly and can increase the overall cost of the equipment by \$10,000 to \$30,000.

Finally, the equipment suppliers market these systems as being low maintenance and requiring no more than 20-21.5 hours of labour per week. The assumption has been maintained throughout the assessment of 20 hours per week based on the recommendations of the technology providers. However, depending on the marketing plan of the small-scale producer, this assumption may be open for debate. The reality for a small producer, the target market of these systems, is that they are going to be fulfilling the responsibility of the grower, marketer and delivery person, unless they are willing to hire additional labour, which the cash flow generated from these grow systems will not support.

#### 4.3.1 Red Shipping Container (Racks)

Many companies are offering variations of this model. The basic layout of the operation is relatively straightforward. Slightly used insulated shipping containers are modified into turnkey vertical farms (or new shipping containers at an additional cost of between \$5000 and \$10,000 on top of the regular price). The system generally consists of a walkway down the center with shelves on either side (either PVC or steel) holding grow beds with LED lights suspended above (Figure 6). Somewhere within the unit (generally at the beginning near the doors) the water tanks, pumps, HVAC units, etc. are housed. There is also an allocated space for a cultivation area, i.e. where the plants are started prior to being transplanted to the larger grow beds.

**Figure 6: Example of a Static Horizontal Shipping Container**



Source: <https://www.bridgeverticalfarming.co.uk/farmpro-container.php>

Note: Image is an example from a similar style vertical farming operation.

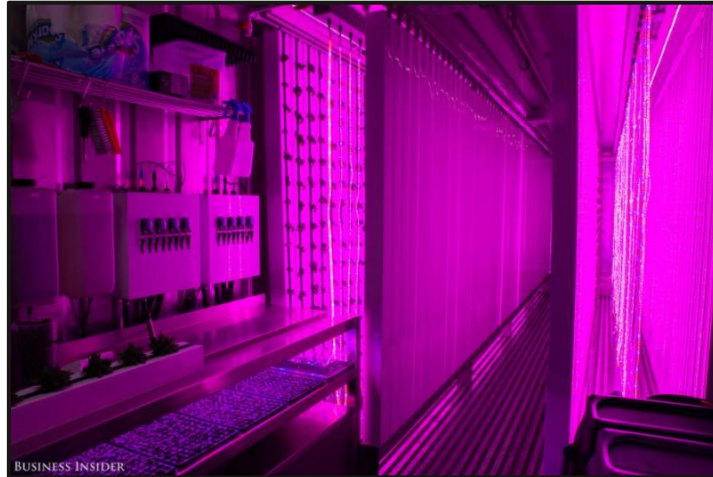
Most of the turnkey system providers also supply a software and application package that is used to run the vertical farm. This allows the user to monitor the system. Some other key attributes of this style vertical farm, especially for the Canadian climate, are a separate "control room" at the entrance with a non-

	structural wall, which serves as a cold-weather entryway that buffers the grow environment from cold weather outside upon entering.
4.3.2 LED Grow Lights	The first shipping container option (Red Shipping Container (Racks)) comes with 277 LED lights in addition to three florescent lights to illuminate the central walkway. The system consumes around 6 kW/hr at a rate of 14 hours/day. This equates to 30,660 kW per year or approximately \$3,000 in LED lighting costs. However, the small closed unit shipping container generates considerable heat, costing roughly \$600 to \$1000 per year to cool. The unit has a mini-split AC unit (10.5 kW) that is used to cool the environment. The exhaust fans and circulating pumps are anticipated to cost another \$1000 in electricity per year to operate. Total electricity costs for the year of approximately \$6,600 for this shipping container.
4.3.3 Cultivation Area	The cultivation area is a relatively simple design with grow beds stacked on shelves on either side of a central walkway. There are six shelves on each side running the length of the shipping container, making for a total of 12 shelves in all. The shelves are built using PVC piping.
4.3.4 Blue Shipping Container (Racks)	While in many aspects the Blue Shipping Container are similar to the Red Shipping Container, it comes at a much higher capital expenditure requirement. This makes for an interesting comparison of the financials.
4.3.5 LED Grow Lights	While each equipment supplier offers a variation in design, the representative model used for this assessment comes with a total of 48 high efficiency LED grow lights. This breaks down to two light strips per shelf (four shelves per rack) or eight light strips per rack (six racks total in the unit). The electrical system uses 100 A, 240-volt single phase power (optional three-phase power option) as well as the option of either adding a backup generator and/or solar power. <sup>15</sup> Power consumption (includes HVAC, circulation pumps and other system requirements as well as light) averages 104-111 kWh/day, with peak load running at 646-946 kW. Total electricity costs for the year of approximately \$7,200 for this shipping container.
4.3.6 Cultivation Area	The cultivation area consists of six grow racks with four shelves (grow beds) each, and an additional cultivation site. This allows the grower to have 1,800 planting sites and 1,200 seeding sites. The spacing between the shelves is 20 inches (shelf-to-shelf). Each shelf holds 5 trays that are bonded together in a row and plumbed for irrigation. There is a total of 120 trays in one shipping container unit. General information provided by the manufacturer suggests that their system can produce 23,000 mature plants annually. Further consultation with the manufacturer suggests that the system can produce 1,830 kg of basil and 4,400 kg of lettuce per year.
4.3.7 Green Shipping Container (Hanging Racks)	The following variation to the shipping container vertical farm differs in its design of the growing racks and LED lights. Unlike the relatively simple design of the static horizontal system described above, the hanging vertical farming design has tracks in

<sup>15</sup> The quoted price and data used for the model did not include solar power or a generator. These would add additional costs of greater than \$20,000 to the capital expenditure requirements.

the ceiling of the container from which plant panels and LED light boards hang (Figure 7).

**Figure 7: Image of Hanging Vertical Farm (Inside Container)**



Source: Business Insider

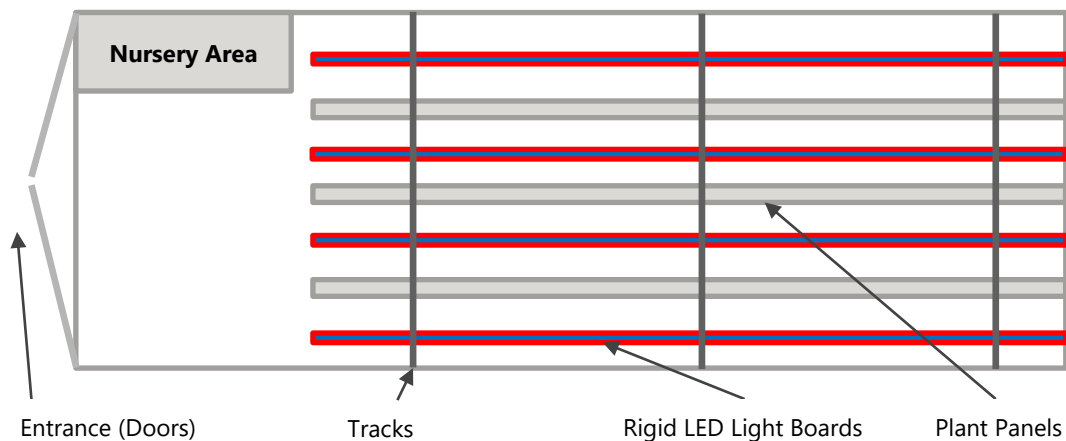
Note: Image above is of Square Roots technology, which varies slightly from the technology supplier we used for this assessment.

The plant panels and rigid LED light boards are hanging suspended from the ceiling on tracks that allow the hanging panels to be shifted to new positions that allow for ease of harvest or ideal growing configuration. Like the above static model, this vertical hydroponic farming system is housed within an insulated, custom-built shipping container (

Figure 8). The outer dimensions of the shipping container are 40 ft long by 8 ft wide by 8.5 ft high.

Figure 8 below shows the layout of the container vertical farm from the top view looking down (ceiling of container removed in diagram).

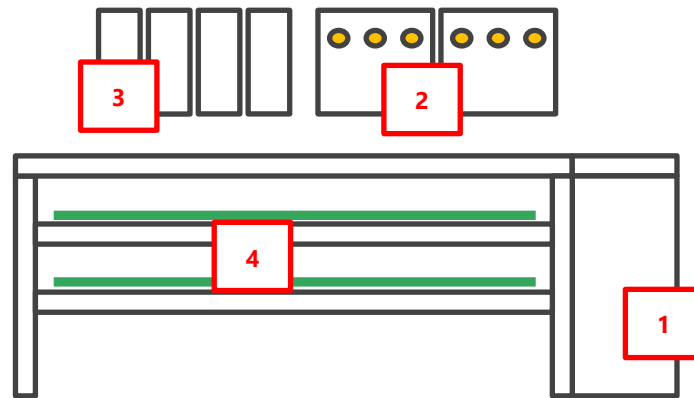
**Figure 8: Birds Eye Perspective (Hanging Vertical Farm – Shipping Container)**



Source: Authors own representation.

The nursery station is located under a 7.5-foot stainless steel table (Figure 9). It consists of two independently controlled seedling troughs that can house up to 4,600 seedlings at once. The plants generally remain in the nursery for the first week of growth. The Germination Station consists of a (1) tank, (2) control panel, (3) nutrient and pH reservoirs, and (4) seed troughs.

**Figure 9: Germination Station (Nursery Area)**



Source: Authors own representation.

#### 4.3.8 LED Grow Lights

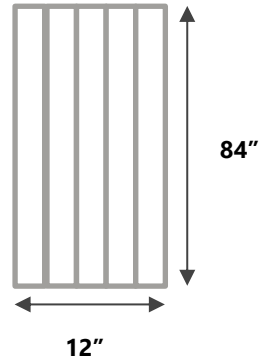
The systems LED light board arrays provide an output on average of 250  $\mu\text{mol}/\text{m}^2\text{s}$ .<sup>16</sup> The system has a total of 120 LED boards which emit a 5:1 red/blue spectrum. Blue and red colours are the most easily absorbed for photosynthesis. Red lights specifically promote stem and leaf growth, while blue light thickens stems and promotes growth of dark green foliage. The 120 LED boards can be further divided into 8 LED boards for the nursery station and 112 LED boards for the cultivation area. The rigid LED light boards hang suspended from the top of the shipping container between each hanging plant panel.

#### 4.3.9 Cultivation Area

The cultivation area of this representative vertical farming operation consists of a 220  $\text{ft}^2$  production space. The area contains 88 plant panels (hanging polystyrene channels - Figure 10) that are 12 inches by 84 inches long and can hold up to 100 plants each. A total of 88 of these plant panels hang in rows lengthwise down the shipping container for a total of 440 combined growing channels.

<sup>16</sup> Units refers to per second and square meter. It is based on the number of photons in a certain waveband per unit of time on a unit of area. There are diminishing returns after 300  $\mu\text{mol}/\text{m}^2\text{s}$

**Figure 10: Hanging Polystyrene Plant Panels**



The representative farm used for the example includes a 36,000 BTU HVAC unit that automatically cools the container<sup>17</sup>, controlled by custom software. The software license and technology are sold by the company and renewed on an annual basis. The software can be controlled by phone or computer. The system also includes a water tank and circulation system to circulate up to 7.12 liters per hour. The unit also controls the humidity of the air and pumps CO<sub>2</sub> as needed to promote photosynthesis.

#### 4.3.10 Summary

In the previous section we have presented background information on the five selected representative vertical farming models. Through careful background research and consultation with industry, we have provided an overview of the different models. We focused the descriptions on key characteristics that differentiate each model including the LED grow lights and the cultivation area. The following section focused on Operations will describe the key operation characteristics of each vertical farming model including the cost elements.

<sup>17</sup> The system has a maximum cooling efficiency of 11.0 energy efficiency ratio (EER).



## 5.0 Operations Analysis

### 5.1 Overview

This section identifies the various components of the operations having a critical impact on the cost to produce: labour, utilities, capacity, freight, capital use, location, overhead, and other operating costs.

It is important to recognize that the assumptions made on operations are considered as part of the scenario analysis that has been conducted and that the sensitivity of financial results to these scenarios will be discussed in the following sections.

### 5.2 Operating Costs

*The assessment considers operating and capital costs separately so that the effect of economies of scale can be assessed. Key cost drivers are identified and quantified and the ones with the most impact on net profitability have been used to drive sensitivity and scenario analyses. This enables a more robust assessment of the potential returns of a facility.*

#### 5.2.1 Cost of Goods Sold (COGS)

Raw materials and packaging are two of the largest costs for the vertical farming operation, no matter the size of the facility. For consistency, the cost of raw materials and the cost of packaging for all the representative models is held constant.

One further assumption focuses on the crop varieties in the model. With regard to lettuce, for the economic model “lettuce” will refer specifically to the butterhead varieties (bibb and Boston lettuce).<sup>18</sup> Butterhead lettuce is a common variety grown in vertical farming operations and has been selected as the example lettuce for the model. In the model, “basil” refers to the Genovese varieties. This is the most common variety of basil and the vertical farming equipment suppliers all had production data available. The last leafy green included in the assessment is microgreens. While the term microgreen is vague, in the following document it loosely refers to young vegetable greens that are approximately 1-3 inches in height falling somewhere between a sprout and a baby green. A microgreen is classified as including the following plant varieties: Brassicaceae (watercress, radish and arugula) and Asteraceae (endive, chicory and radicchio).

While each equipment supplier and vertical farming operation consulted provided different input costs, this assessment estimated input costs at \$6.50/kg produced. Input costs include seeds, rooter cubes, fertilizer, pH balancing chemicals and irrigation water for lettuce, basil and microgreens.<sup>19</sup> Input costs are constant across lettuce, basil and microgreens.




<sup>18</sup> For the purpose of this vertical farming assessment a lettuce variety with production data available across all the vertical farming models was selected. Butterhead lettuce was one of the commonly produced lettuce varieties in the models.

<sup>19</sup> In their work on hydroponic production Uyeda, J., Cox, L. J., Radovich, T. J. (2011) *An Economic Comparison of Commercially Available Organic and Inorganic Fertilizers for Hydroponic Lettuce Production* ([link](#)) find slightly larger input costs than used in



Packaging costs were another factor that varied considerably between the vertical farms consulted for this work and the equipment suppliers. The cost depends on the size of the packaging and the end market, i.e. whether it is being sold wholesale or retail. Lettuce, basil and microgreens are sold in 30 gram (1 oz), 142 gram (5 oz), 200 gram (7 oz), and 300 gram (11 oz) packaging (Table 1). Estimates are based off of consultation with equipment suppliers.

**Table 1: Packaging Costs**

Grams	Ounces	\$/kg	Example	Description
30	1	0.44		Small stiff plastic packaging, typically for marketing herbs such as basil, parsley and cilantro. But this size can also be used for microgreens etc.
142	5	0.44		This is the hard plastic style of packaging used for lettuce and other leafy greens. It is a higher value product.
200	7	0.22		The last two packaging sizes are intended to represent the clear vented poly packaging that is not intended for retail but is to be sold direct to restaurants.
300	11	0.22		

### 5.2.2 Labour

The labour requirements for the different representative vertical farms vary considerably. The two large-scale operations require specialized labour to handle roles such as management, horticulture, administrative, delivery, packaging, etc., whereas the small-scale operations can be operated by a single owner-operator (Table 2). Consultation with the suppliers of small-scale shipping container vertical farms suggest that a 20-hour week is enough labour to maintain the operation.

---

this assessment. Data from the equipment suppliers suggests costs in the range of \$6.50/kg for seeds, trays, substrate and consumables.

**Table 2: Employee Requirements**

	Industrial Warehouse (Racks)	Containerized (Rotating Platforms)	Red Shipping Container (Racks)	Blue Shipping Container (Racks)	Green Shipping Container (Hanging Racks)
Manager	1	1	0	0	0
Marketing Assistant	1	0	0	0	0
VP Finance	1	0	0	0	0
VP Logistics	1	0	0	0	0
Horticulturalists	4	2	0	0	0
Administrative	1	0	0	0	0
Customer service	1	0	0	0	0
Labourer (minimal experience)	40	0	0	0	0
Labourer (medium experience)	12	0	0	0	0
Labourer (high experience level)	4	2	0	0	0
Maintenance	1	0	0	0	0
Drivers	4	2	0	0	0
Packaging	4	0	0	0	0
Training	1	0	0	0	0
Shipping	4	0	0	0	0
Owner Operator	0	0	1	1	1
<b>Total Employees</b>	<b>79</b>	<b>7</b>	<b>1</b>	<b>1</b>	<b>1</b>

For the small-scale operations the assumption is that the owner-operator tends to their shipping container operation when needed, but that a total of 20-hours per week is required. As it can be assumed that many small-scale producers will have another part-time job, the assumption is that the 20-hours dedicated to their vertical farming operation is split up throughout the day and week, i.e. they are likely spending more time tending to their vertical farm on the weekends and in the mornings and evenings during the week. A small-scale operator may average 2-hours per day during the week and then dedicate 10 hours on the weekend to delivery and farmers' markets.

For the large-scale operations, the assumption is that there are two shifts of workers (morning and afternoon) working eight-hour shifts. Taking the warehouse operation as an example (Table 3), there are 40 Level 1 Growers on staff, but only 20 Level 1 Growers are on either the morning or afternoon shift. The same goes for the remaining growers, drivers, packers and warehouse staff. Management, administrative, maintenance, and other staff work a regular eight-hour shift during a typical 9:00 a.m. to 5:00 p.m. workday. Regarding the large-scale containerized operation, the manager works a regular 9:00 a.m. to 5:00 p.m. work schedule and the remaining six staff (horticulturalists, growers, and drivers) are split into a morning and afternoon shift, i.e. there is one grower, one driver and one horticulturalist on each shift.

**Table 3: Labour Cost for Large-Scale Warehouse Operation**

Labour	# of Employees	Wage Rate(\$/hr)	EI, CPP, Benefits (%)	Hours per week	Weeks per year	Annual Cost	Monthly Cost
Manager	1	80	15.1%	40	48	176,766	14,730
Marketing assistant	1	28	15.1%	40	48	61,868	5,156
VP Finance	1	48	15.1%	40	48	106,060	8,838
VP Logistics	1	48	15.1%	40	48	106,060	8,838
Administrative	1	23	15.1%	40	48	50,820	4,235
Horticulturalists	4	48	15.1%	40	48	424,238	35,353
Customer service	1	20	15.1%	40	48	44,191	3,683
Labourer (minimal experience)	40	15	15.1%	40	48	1,325,745	110,479
Labourer (medium experience)	12	18	15.1%	40	48	464,011	38,668
Labourer (high experience level)	4	23	15.1%	40	48	198,862	16,572
Maintenance	1	25	15.1%	40	48	55,239	4,603
Drivers	2	30	15.1%	40	48	265,149	22,096
Packaging	4	15	15.1%	40	48	132,574	11,048
Training	1	25	15.1%	40	48	55,239	4,603
Warehouse Staff	4	18	15.1%	40	48	154,670	12,889
<b>Sum:</b>						<b>3,621,492</b>	<b>301,791</b>

Wages have been input into the model on an hourly basis. Each employee works a 40-hour week for 48 weeks in the year for a total of 1,920 hours per worker. This accounts for vacation days and sickness. Employee wages have an additional 15.1% added to them in the model to account for benefits.

### 5.2.3 Freight

Transportation costs are based on industry standard in greenhouse production which is \$0.20/lb USD (\$0.44/kg USD).<sup>20</sup> This converts to \$0.58/kg CAD at an exchange rate of 1 USD to 1.32 CAD. Freight costs include fuel, licensing and maintenance of the vehicles. A vehicle lease has also been factored into the economic model. Examples of the type of vehicle and accompanying price are in

Table 4: Vehicle Lease Rates

	Vehicle Type (example)	# of \
Industrial Warehouse (Racks)	International Cube Truck	
Containerized (Rotating Platforms)	Ford Transit Van (Large)	
Red Shipping Container (Racks)	Ford Transit Connect (small)	
Blue Shipping Container (Racks)	Ford Transit Connect (small)	
Shipping Container #3 (Hanging LED Panels)	Ford Transit Connect (small)	

<sup>20</sup> Tasgal, P. (2019). *The Economics of Local Vertical and Greenhouse Farming Are Getting Competitive*. [AgFunderNews](#).

**Table 4: Vehicle Lease Rates**

	Vehicle Type (example)	# of Vehicles	mthly Lease
Industrial Warehouse (Racks)	International Cube Truck	2	\$1,500
Containerized (Rotating Platforms)	Ford Transit Van (Large)	1	\$850
Red Shipping Container (Racks)	Ford Transit Connect (small)	1	\$580
Blue Shipping Container (Racks)	Ford Transit Connect (small)	1	\$580
Shipping Container #3 (Hanging LED Panels)	Ford Transit Connect (small)	1	\$580

5.2.4 Lease

As an example, the monthly freight costs and vehicle lease cost the small-scale operations between \$900 and \$1000 on a monthly basis depending on their production. For the two large-scale operations, the combined freight and vehicle costs are closer to \$25,000 and \$6000 for the warehouse and containerized options, respectively.

Consultation with industry reveals that the average asking price for a large industrial space in Calgary, Alberta, is \$7.00/sq. ft (including property tax). The 80,000 sq. ft. warehouse costs the large-scale warehouse vertical farming operation \$560,000 a year in rent and property tax. For the other large scale-operation assessed in this work purchased land is included rather than leased, therefore, it will be accounted for in the Capital Costs section of this document.

The remaining three small-scale vertical farming operations have a monthly lease rate of \$1,000. Given that the shipping container will not require an entire industrial lot it is difficult to determine a suitable space to locate the operation. In the model, the operation would be located on an industrial lot, but it would likely rent a portion of the lot from an existing business. Therefore, the rent is lower than if they had to rent the entire industrial space. Property taxes are included in the rent.

The other large-scale operation (Rotating Platforms) purchases industrial land which is factored in at a later point in this document.

5.2.5 Municipal Tax

As Calgary is the largest market in the province, the model assumes all operations are set up in this location and they use the property tax rates for the city. The total tax rate for non-residential businesses includes the municipal tax rate (0.0177750) and the provincial property tax rate (0.0042467) for a total of 0.0220217.<sup>21</sup>

5.2.6 Overhead and Other Operating Costs

Overhead costs refer to the ongoing expense of operating the vertical farming facility. Unlike other operating expenses such as raw material and labor, overhead is not linked with any cost unit.

Insurance has been factored into the model at a rate of 0.4% of the capital expenditure on equipment for the operation. For example, this works to just under

<sup>21</sup> The Non-Residential property tax rate for the city of Calgary can be found [here](#).

\$70,000 per year for the industrial warehouse vertical farming operation. The insurance for the small-scale containerized vertical farming operations is closer to \$500 per year. An annual cost of \$1000 for a business license has been included, regardless of the size of the operation. Regarding professional fees for accounting and legal, the model budgets \$15,000 for the large industrial warehouse, \$10,000 for the large-scale containerized operation, and \$1000 for each of the small-scale operations.

The requirement for maintaining an office varies depending on the size of the operation. The two large-scale operations require a fully functioning office. For the large warehouse operation, \$1000 per month for office maintenance (computers, copying paper, pens, coffee, etc.) is budgeted, and for the other large-scale operation \$500 per month is allocated, on account of its smaller scale. For the remaining three small-scale vertical farming operations, \$100 per month was budgeted for maintaining an "office space." It is assumed that the small-scale operations maintain an office space in their personal residence, cutting back on the requirement of renting or maintaining additional space.

Additional operating costs include maintaining a website, paying for phone, fax and internet, software subscriptions, and in some cases leasing a fax machine. These costs vary depending on the size of the operation. For instance, the small-scale operations have only been allocated \$50 per month to maintain a website, whereas the large-scale operations are expected to have a more complex website at a higher maintenance cost (\$1,500 for the large warehouse operation). The higher cost for the large-scale operations is justified because of their requirement for more direct sales. The large operations must offer a significant percentage of their total sales at retail prices to be economically viable, therefore, a quality website is a must.

## 5.3 Capital Costs

*There are significant capital costs associated with the large-scale vertical farming operations. This is a critical consideration as these costs are essentially sunk once assigned and virtually impossible to recover. As a result, a significant amount of due diligence was conducted on this cost category and the relevant cost drivers.*

### 5.3.1 Capital Expenditure

Capital expenditures include the cost of equipment, delivery, site preparation, land (in some cases), engineering work, and all other costs associated with putting the facility in place. The only operation with purchased land is the large-scale containerized operation, the remaining have been modelled using leased land (Table 5).

**Table 5: Building Costs by Representative Vertical Farm**

	Industrial Warehouse (Racks)	Containerized (Rotating Platforms)	Red Shipping Container (Racks)	Blue Shipping Container (Racks)	Green Shipping Container (Hanging Panels)
Land Purchase	Leased	\$700,000	Leased	Leased	Leased
Site Preparation*	\$400,000	\$150,000	\$10,000	\$10,000	\$10,000
Building	Leased	\$300,000	N/A	N/A	N/A
Equipment	\$17,000,000	\$1,750,000	\$120,000	\$211,500	\$135,000
Delivery	(included)	\$50,000	\$5,000	\$5,000	\$5,000
Installation	\$1,650,000	\$50,000	\$10,000	\$10,000	\$10,000
<b>Total Costs</b>	<b>\$19,050,000</b>	<b>\$2,500,000</b>	<b>\$145,000</b>	<b>\$236,500</b>	<b>\$160,000</b>

\* Site Preparation includes "building analysis" for the warehouse, and all foundation preparation work (grading, excavation, utilities infrastructure, pouring concrete pad, etc.) for the remaining vertical farming operations.

### 5.3.2 Equipment Costs

The cost of equipment for each representative vertical farm has been included in the table above (Table 5). The quotes received from equipment suppliers included the cost of equipment as well as (in most cases) various additional "add-ons." To provide an example, Table 6 shows the equipment cost breakdown for one of the small-scale containerized vertical farming operations. The more "basic-package" was quoted at \$211,540 CAD for FOB delivery to Calgary, Alberta, whereas the quote with additional "add-ons" climbed up to \$227,440 CAD.

**Table 6: Equipment Costs – Blue Shipping Container (Racks)**

System Construction, Parts and Labour	\$101,000
Hydroponic Equipment	\$12,800 per rack (\$76,800 per unit)
Commercial-grade air conditioning	\$5,300
Commercial Water Chiller	\$3,900
Shipping to Calgary, AB	\$2,200
Custom Paint Scheme and Decals	\$2,000
Grow-Out and Onsite Installation	\$5,940
Onsite Training	\$9,700
First Year Growing Materials	\$6,500
<b>Total:</b>	<b>\$211,540</b>
+ Upgrade to "One-Trip" Container	\$9,100
+ Upgrade to Restaurant Racks	\$6,200 for 4 rack upgrades
+ Growing Tray Lids	\$600
<b>Total:</b>	<b>\$227,440</b>

### 5.3.3 Land Costs

As explained above, the only operation with purchased land is the large-scale containerized (rotating platforms). Consultation with the equipment supplier suggests that given the requirements for pouring a concrete pad and creating a

5.3.4 Other Capital Costs

space suitable for holding the built-up container walls and structure in general, it makes more sense for the owner to purchase the land. The price varies across the city of Calgary depending on whether the lot is in the outlying regions or in the inner city, however, a price of \$700,000 has been selected based on recent publications.<sup>22</sup>

The other capital costs associated with getting the vertical farming operations up and running are small in comparison, but they can add up quickly for the producer. For example, a facility requires inputs such as seed, fertilizer, pH balancing chemicals, roter cubes, CO<sub>2</sub> tanks, and to pay the salaries of employees in the case of the larger operations, all prior to generating revenue in the first month. To account for the varying additional costs associated with getting the different sized facilities up and running, operating cash equal to 10% of the facilities equipment costs has been used in the model (Table 7). The operating cash has been factored into the initial requirements for start-up capital.

**Table 7: Operating Cash**

	Operating Cash
Large-Scale: Industrial Warehouse (Racks)	\$1,700,000
Large-Scale: Containerized (Rotating Platforms)	\$175,000
Red Shipping Container (Racks)	\$12,000
Blue Shipping Container (Racks)	\$21,150
Green Shipping Container (Hanging Panels)	\$13,500

5.3.5 Summary

The operations section provided an overview of the operating costs including the Cost of Goods Sold (COGS), labour, utilities, freight, lease, taxes and other overhead. In addition, it covered the capital costs including equipment, land and other costs. There are large differences in the required start-up capital between the large-scale operations and the small-scale shipping container operations.

<sup>22</sup>Steve McLean, specialist with the [Real Estate News Exchange](#) suggests that prices range between \$550,000 to \$1,000,000. In the outer regions of Calgary prices range between \$550,000 and \$750,000 per acre.

## 6.0 Financial Assessment

### 6.1 Overview

This section will present an overview of the financials for operating a vertical farming facility in Alberta. It lists and provides context on each of the key assumptions made in the model and provides a sensitivity analysis on the impacts of each one.

### 6.2 Assumptions

Each of the critical assumptions made in the marketing and operating sections are assessed as part of the analysis. Different scenarios are used to ensure that the model and results are robust. Any critical success factors are discussed in detail in terms of how they might impact financial feasibility. The following assumptions have been made in the model:

- The equity to commercial bank loan rate is 70/30
- Bank of Canada Conventional Rate: 5.19%
- Production schedule:
  - 50% lettuce
  - 40% basil
  - 10% microgreens
- Efficiency of operation begins at 25% and builds 5% per month until maxing out at 95% efficiency for the remainder of the model, i.e. after 13 months the vertical farming operation is running at 95% efficiency
- Inflation is set at 1.5% per year
- Equipment repairs and maintenance are set at 1.5% on an annual basis of the initial equipment costs
- Equipment depreciation is calculated using straight-line depreciation (SLN) with a salvage value of 10% and a useful life of 15 years
- Building depreciation<sup>23</sup> also uses SLN but has a salvage value of 5% (tent structures do not retain value compared with steel buildings) and a useful life of 15 years

#### 6.2.1 Production and Pricing Benchmarks

A production composition of 50% lettuce, 40% basil and 10% microgreens has been used. While microgreens can be sold for a much higher \$/kg rate, basil and lettuce are the vegetables commonly grown at this time in vertical farms in Alberta. These assumptions have been made based on the market assessment and estimations based on demand for lettuce, basil and microgreens.

One of the key factors in the model is the productive capacity of each respective technology. As the technology is relatively new and each supplier has their own LED light configurations and patents, the annual productivity cannot be confirmed via third party research. In other words, the reported yields by the manufacturers have

<sup>23</sup> Building depreciation is only applicable for the rotating platforms vertical farming operation, where the investor builds a structure to hold the operation. In the remaining vertical farming operations, the equipment is the building (containerized) or the operation rents a building.



been used for the estimates in the model. The yield estimates in Table 8 are the yield estimates provided by the equipment manufacturers.<sup>24</sup>

**Table 8: Yield Estimates by Vertical Farm Type**

	Basil	Butterhead Lettuce	Microgreens
Large-Scale: Industrial Warehouse (Racks)	450,000 kg	450,000 kg	450,000 kg
Large-Scale: Containerized (Rotating Platforms)	128,420 kg	78,390 kg	22,830 kg
Red Shipping Container (Racks)	7,080 kg	8,750 kg	8,950 kg
Blue Shipping Container (Racks)	5,320 kg	10,640 kg	10,640 kg
Green Shipping Container (Hanging Panels)	8,130 kg	6,000 kg	8,300 kg

## 6.2.2 Direct Sales

The model allows the user to select the portion of sales that are being sold direct and those that are being sold at wholesale prices. Direct sales have been modelled at retail prices, whereas wholesale prices are much lower.

The following sales by packaging size (Table 9) have been assumed for direct sales (retail prices). The packaging size corresponds with common packaging sizes for retail outlets. Lettuce tends to be packaged in larger units when compared with basil and microgreens.

**Table 9: Commodity Sales by Package Size**

Commodity	30 grams	142 grams	300 grams
Basil	50%	50%	-
Lettuce	-	30%	70%
Microgreens	80%	20%	-

Source: Based on consultation with industry contacts and own estimates.

The following prices by packaging size (Table 10) have been assumed for each crop. Pricing estimates come from a leading vertical farming operation in Alberta.

**Table 10: Pricing Schedule by Package Size and Commodity**

Commodity	30 grams	142 grams	300 grams
Basil	\$2.50	\$4.00	-
Lettuce		\$3.00	\$4.20
Microgreens	\$4.50	\$17.00	-

Source: Based on consultation with industry contacts and own estimates.

<sup>24</sup> Yield estimates are based off those provided by technology suppliers. All the equipment suppliers either provided a spreadsheet model with the annual outputs available or provided reports with estimated yields. The estimates are not verifiable by third parties because each supplier has patents on their LED light technology and much of the necessary data required to verify yield estimates is not provided. In addition, the suppliers of some of the above turnkey operations report yields in units of product rather than weight, which requires estimation as to the kilograms per unit produced (varies by product). Given the large differences in yields between similar technologies (e.g. shipping container systems) we suggest further research is needed to determine actual yields, but short of conducting trials using the technology there is no way to determine yield more accurately at this time.

### 6.2.3 Wholesale Sales

While wholesale prices for lettuce and basil are more readily available, there is nothing directly comparable to produce from vertical farming. There are commodity prices for vegetables produced in traditional farming operations and greenhouses as well as organic products. However, vertically farmed produce can expect to receive a higher premium given its quality and freshness. The following wholesale prices have been used in the model (Table 11):

**Table 11: Wholes Prices**

Commodity	Price
Basil	\$15.00/kg
Lettuce	\$14.00/kg
Microgreens	\$20.00/kg

### 6.2.4 Critical Cost Assumptions Impacting Model

While all assumptions are critical to the evaluation of the model, there is more weight given to variables that have the most significant impact on the profitability of a vertical farming business.

The variable input costs in the model include the following inputs: rooter cubes, fertilizer, pH balancing chemicals and irrigation water.<sup>25</sup> A variable input costs of \$6.50 per kg of production has been used in the model.

The following income and municipal rates have been used in the model:

Income taxes:

- Large Business (>\$500,000 revenue)
  - Federal (net) tax rate: 15%
  - Provincial corporate tax rate: 8%
- Small Business (Canadian-based corporation) (<\$500,000 revenue)
  - Federal (net) tax rate: 9%
  - Provincial corporate tax rate: 2%

Municipal Rate: 0.0220217

### 6.2.5 Breakeven Analysis

The breakeven analysis has been completed for the following five vertical farming operations:

- Large-Scale: Industrial Warehouse (Racks)
- Large-Scale: Containerized (Rotating Platforms)
- Red Shipping Container (Racks)
- Blue Shipping Container (Racks)
- Green Shipping Container (Hanging Panels)

The breakeven analysis assumes a production scenario for each vertical farming operation that generates an internal rate of return of 10%. To hit the 10% IRR target,

<sup>25</sup> Estimates inflated from a study by Uyeda, J., Cox, L. J., and Radovich, T. J. (2011) titled *An Economic Comparison of Commercially Available Organic and Inorganic Fertilizers for Hydroponic Lettuce Production*.

each model has to generate a certain target of direct sales to consumers at retail prices.

**Large-Scale: Industrial Warehouse (Racks):**

All else being equal, the largest operation modelled in this analysis generates an internal rate of return (IRR) of 10% under the configuration of 92% direct sales at retail prices. This requires the operation to sell 7,940 kg of lettuce, basil and microgreens per week at retail prices. This configuration requires considerable direct sales to consumers through online marketing or through delivery. Under this configuration the large-scale warehouse operation generates a ten-year average return on equity (ROE) of 13.0% and a return on total assets of 10.3%.<sup>26</sup> Average ROE as of January 2020 for industry in the United States is 13.63%.<sup>27</sup> The payback period on the initial capital expenditure of \$14.7 million is 5.5 years and the Net Present Value (NPV) is \$6.4 million, under the assumption that net income is discounted at the borrowing rate (5.19% per year).

Invested Capital (Equity)	\$14,665,000
Total Capital Expenditure	\$20,950,000
Net Present Value (10 yrs.)	\$6,390,049
Internal Rate of Return (IRR)	10.8%
<b>Ratios</b>	<b>10 yr. average</b>
Return on Equity	13.0%
Return on Total Assets	10.3%
Debt Ratio	21.7%

Income Statement		Large-Scale: Industrial Warehouse (Racks)									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
Opening Balance	1,700,000	475,158	3,350,694	6,333,525	9,382,582	12,500,573	15,671,026	18,931,652	22,264,309	25,668,354	
<b>Total Revenue</b>	<b>10,189,631</b>	<b>18,461,633</b>	<b>18,822,458</b>	<b>19,106,744</b>	<b>19,395,324</b>	<b>19,688,262</b>	<b>19,985,625</b>	<b>20,287,479</b>	<b>20,593,892</b>	<b>20,904,933</b>	
<b>Expenses</b>											
Total COGS	1,649,998	2,989,476	3,047,904	3,093,938	3,140,668	3,188,103	3,236,255	3,285,134	3,334,751	3,385,117	
Total Payroll Expenses	3,651,052	3,706,196	3,762,173	3,818,995	3,876,676	3,935,227	3,994,663	4,054,997	4,116,242	4,178,411	
Total General Expenses	2,244,120	3,706,196	3,174,696	3,224,514	3,273,377	3,340,490	3,371,699	3,422,884	3,476,571	3,529,366	
EBITDA	2,644,462	8,647,401	8,837,685	8,969,297	9,104,603	9,224,442	9,383,009	9,524,465	9,666,329	9,812,038	
Total Expenses	11,414,474	15,586,097	15,839,628	16,057,687	16,277,334	16,517,809	16,724,999	16,954,823	17,189,847	17,426,718	
<b>Net Income</b>	<b>(1,224,842)</b>	<b>2,875,537</b>	<b>2,982,831</b>	<b>3,049,057</b>	<b>3,117,990</b>	<b>3,170,453</b>	<b>3,260,626</b>	<b>3,332,656</b>	<b>3,404,045</b>	<b>3,478,215</b>	
Closing Balance	475,158	3,350,694	6,333,525	9,382,582	12,500,573	15,671,026	18,931,652	22,264,309	25,668,354	29,146,569	

Ratios										
Return on Equity	-12%	23%	20%	18%	16%	15%	14%	13%	12%	11%
Return on Total Assets	-7%	16%	15%	14%	13%	12%	11%	11%	10%	10%
Debt Ratio	37%	32%	28%	25%	22%	19%	17%	14%	13%	11%
Total Assets	\$ 16,455,158	18,310,694	20,273,525	22,302,582	24,400,573	26,551,026	28,791,652	31,104,309	33,488,354	35,946,569
Total Liabilities	\$ 6,101,171	5,907,571	5,703,680	5,488,953	5,262,812	5,024,651	4,773,831	4,509,679	4,231,487	3,938,509
Equity	\$ 10,353,987	\$ 12,403,124	\$ 14,569,845	\$ 16,813,630	\$ 19,137,761	\$ 21,526,375	\$ 24,017,822	\$ 26,594,630	\$ 29,256,867	\$ 32,008,061

Sales	
Weekly direct to consumer sales	7,940 kg
Weekly wholesale sales	690 kg

<sup>26</sup> ROE is calculated by dividing the annual net income by the annual equity value. Equity equals total assets minus total liabilities. Total assets = land + buildings – accumulated depreciation on buildings + machinery – accumulated depreciation on machinery + accumulated cash. Total liabilities long term debt, with an annual interest rate of 5.19% over a period of 15 years.

<sup>27</sup> New York University Stern School of Business publishes ROE statistics for the United States by sector. Data has been updated as of January 2020.

**Large-Scale: Containerized (Rotating Platforms):**

Configuring the second largest vertical farming operation to generate an IRR of 10% requires 63% direct sales at retail kg of lettuce, basil and microgreens per week at retail prices and 660 kg at wholesale prices. This configuration requires far fewer direct sales to consumers than the largest vertical farming operation in order to achieve an IRR of 10%.

As lettuce only makes up 50% of the production schedule for the vertical farming operation, at a weekly demand of 0.224 kg<sup>28</sup> (225 g) the vertical farming operation would need to supply the per capita lettuce demand requirements of nearly 2,500 individuals:

$$1,122 \text{ kg}_{\text{wkly sales}} \times 50\%_{\text{lettuce prod.}} = 561 \text{ kg}_{\text{wkly lettuce sales (direct to consumer)}}$$

$$561 \text{ kg} \div 0.224 \text{ kg} = 2,500 \text{ direct to consumer sales}$$

Making a further assumption that much of the lettuce sales are going to two person households, the vertical farm will need to make 1,250 lettuce sales per week at a farmers’ market or through home delivery (or online sales platform). A remaining 1,122 kgs of basil and microgreens would also need to be sold in the same manner, with the remaining 660 kgs going at wholesale prices (restaurants, grocery stores, etc.).

Under this configuration the large-scale containerized operation generates a ten-year average return on equity (ROE) of 11.8% and a return on total assets of 9.5%. The payback period on the initial capital expenditure of \$2.22 million is 6 years and the Net Present Value (NPV) is \$873,000, under the assumption that net income is discounted at the borrowing rate (5.19% per year).

Invested Capital (Equity)	\$2,222,500
Total Capital Expenditure	\$3,175,000
Net Present Value (10 yrs.)	\$872,903
Internal Rate of Return (IRR)	10.3%
<b>Ratios</b>	<b>10 yr. average</b>
Return on Equity	11.8%
Return on Total Assets	9.5%
Debt Ratio	20.6%

<sup>28</sup> Using the USDA per capita lettuce consumption statistics:  $11.70_{\text{kg per year}} \div 52.14_{\text{wks}} = 0.224_{\text{week}} \frac{\text{kg}}{\text{week}}$  per capita

Income Statement		Large-Scale: Containerized (Rotating Platforms)									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
Opening Balance	175,000	16,537	436,064	871,124	1,315,885	1,770,974	2,232,855	2,709,724	3,197,360	3,695,433	
Total Revenue	1,557,252	2,821,438	2,876,581	2,920,028	2,964,131	3,008,900	3,054,345	3,100,476	3,147,305	3,194,840	
<b>Expenses</b>											
Total COGS	341,030	617,879	629,956	639,470	649,128	658,933	668,885	678,987	689,243	699,653	
Total Payroll Expenses	525,716	533,656	541,716	549,898	558,203	566,634	575,192	583,880	592,699	601,650	
Total General Expenses	268,244	533,656	386,041	392,274	398,114	407,935	409,590	415,711	422,410	428,725	
EBITDA	422,262	1,290,833	1,318,869	1,338,386	1,358,684	1,375,398	1,400,677	1,421,898	1,442,953	1,464,812	
Total Expenses	1,715,715	2,401,911	2,441,521	2,475,267	2,509,042	2,547,019	2,577,476	2,612,840	2,649,231	2,685,692	
Net Income	(158,463)	419,527	435,060	444,761	455,089	461,881	476,869	487,636	498,073	509,148	
Closing Balance	16,537	436,064	871,124	1,315,885	1,770,974	2,232,855	2,709,724	3,197,360	3,695,433	4,204,581	

Ratios										
Return on Equity	-9%	21%	18%	16%	15%	13%	12%	11%	11%	10%
Return on Total Assets	-6%	14%	13%	12%	12%	11%	10%	10%	9%	9%
Debt Ratio	35%	30%	27%	23%	20%	18%	16%	14%	12%	10%
Total Assets	\$ 2,642,537	2,938,064	3,249,124	3,569,885	3,900,974	4,238,855	4,591,724	4,955,360	5,329,433	5,714,581
Total Liabilities	\$ 924,640	895,300	864,400	831,858	797,586	761,492	723,480	683,448	641,287	596,886
Equity	\$ 1,717,896	\$ 2,042,764	\$ 2,384,724	\$ 2,738,027	\$ 3,103,388	\$ 3,477,363	\$ 3,868,243	\$ 4,271,912	\$ 4,688,146	\$ 5,117,695

Sales		
Weekly direct to consumer sales	1,122	kg
Weekly wholesale sales	659	kg

### Red Shipping Container (Racks):

Configuring the first small-scale shipping container vertical farming operation to generate an IRR of 10% requires 43% direct sales at retail prices. This requires the operation to sell 67 kg of lettuce, basil and microgreens per week at retail prices and 89 kg at wholesale prices.

Lettuce only makes up 50% of the production schedule for the vertical farming operation. At a weekly demand for lettuce of 0.224 kg (225 g) the operation would need to supply the per capita lettuce demand requirements of nearly 150 individuals:

$$67 \text{ kg}_{\text{wkly sales}} \times 50\%_{\text{lettuce prod.}} = 34 \text{ kg}_{\text{wkly lettuce sales (direct to consumer)}}$$

$$34 \text{ kg} \div 0.224 \text{ kg} = 150 \text{ direct to consumer sales}$$

The vertical farm will need to make 75 lettuce sales per week to households of two at a farmers' market or through home delivery (or online sales platform). However, basil and microgreen sales also need to be accounted for in the calculation. Meaning that the operation must sell 34 kgs of basil and microgreens direct to consumers at retail prices, and a further 89 kgs (total lettuce, basil and microgreens) per week at wholesale prices.

Invested Capital (Equity)	\$109,900
Total Capital Expenditure	\$157,000
Net Present Value (10 yrs.)	\$46,061
Internal Rate of Return (IRR)	9.9%
<b>Ratios</b>	
	<b>10 yr. average</b>
Return on Equity	12.4%
Return on Total Assets	10.7%
Debt Ratio	25.7%

Income Statement		Small Scale: Red Shipping Container (Racks)									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
Opening Balance	12,000	(19,935)	4,046	29,225	54,767	81,010	106,392	134,398	163,136	192,288	
Total Revenue	119,129	215,838	220,057	223,381	226,754	230,179	233,656	237,185	240,767	244,403	
<b>Expenses</b>											
Total COGS	29,681	53,776	54,827	55,655	56,495	57,349	58,215	59,094	59,986	60,892	
Total Payroll Expenses	53,463	54,270	55,090	55,922	56,766	57,624	58,494	59,378	60,274	61,185	
Total General Expenses	43,027	54,270	48,965	49,901	50,517	52,715	51,450	52,095	53,080	53,746	
EBITDA	(7,041)	59,512	61,176	61,903	62,975	62,492	65,497	66,618	67,426	68,580	
Total Expenses	151,064	191,858	194,877	197,839	200,512	204,797	205,650	208,447	211,615	214,497	
Net Income	(31,935)	23,980	25,180	25,542	26,243	25,382	28,005	28,738	29,152	29,906	
Closing Balance	(19,935)	4,046	29,225	54,767	81,010	106,392	134,398	163,136	192,288	222,194	

Ratios										
Return on Equity	-69%	38%	31%	25%	22%	18%	17%	16%	14%	13%
Return on Total Assets	-35%	22%	20%	18%	16%	14%	14%	13%	12%	11%
Debt Ratio	50%	41%	34%	29%	24%	21%	18%	15%	13%	11%
Total Assets	\$ 92,065	108,046	125,225	142,767	161,010	178,392	198,398	219,136	240,288	262,194
Total Liabilities	\$ 45,722	44,272	42,744	41,134	39,440	37,655	35,775	33,796	31,711	29,515
Equity	\$ 46,343	\$ 63,774	\$ 82,482	\$ 101,633	\$ 121,570	\$ 140,737	\$ 162,623	\$ 185,340	\$ 208,577	\$ 232,679

Sales	
Weekly direct to consumer sales	67 kg
Weekly wholesale sales	89 kg

### Blue Shipping Container (Racks)

Configuring the second small-scale containerized vertical farming operation to generate an IRR of 10% requires 55% direct sales at retail prices. This requires the operation to sell 90 kg of lettuce, basil and microgreens per week at retail prices and 73 kg at wholesale prices.

Lettuce only makes up 50% of the production schedule for the vertical farming operation. At a weekly demand for lettuce of 0.224 kg (225 g) the operation would need to supply the per capita lettuce demand requirements of nearly 150 individuals:

$$90 \text{ kg}_{\text{wkly sales}} \times 50\%_{\text{lettuce prod.}} = 45 \text{ kg}_{\text{wkly lettuce sales (direct to consumer)}}$$

$$45 \text{ kg} \div 0.224 \text{ kg} = 200 \text{ direct to consumer sales}$$

The vertical farm will need to make 100 lettuce sales per week to households of two at a farmers' market or through home delivery (or online sales platform). Basil and microgreen sales also need to be accounted for in the calculation. Meaning that the operation must sell 45 kgs of basil and microgreens direct to consumers at retail prices, and a further 73 kgs (total lettuce, basil and microgreens) per week at wholesale prices.

The Red and Blue shipping container examples presented here show the difference that the start up capital expenditure requirement makes on the output. In order to achieve an IRR of 10%, the Blue Shipping Container operation must sell an additional 23 kg per week direct to consumers at retail prices.

Invested Capital (Equity)	\$ 180,355
Total Capital Expenditure	\$ 257,650
Net Present Value (10 yrs.)	\$ 72,555
Internal Rate of Return (IRR)	10.1%

Ratios	10 yr. average
Return on Equity	13.0%
Return on Total Assets	10.5%
Debt Ratio	23.0%

Income Statement		Small Scale: Blue Shipping Container (Racks)									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
Opening Balance	21,150	(8,653)	27,509	65,282	103,734	143,210	182,154	224,052	267,020	310,745	
Total Revenue	135,790	246,026	250,834	254,623	258,468	262,372	266,335	270,358	274,441	278,586	
Expenses											
Total COGS	31,123	56,389	57,491	58,359	59,241	60,136	61,044	61,966	62,902	63,852	
Total Payroll Expenses	53,463	54,270	55,090	55,922	56,766	57,624	58,494	59,378	60,274	61,185	
Total General Expenses	45,752	54,270	52,570	53,561	54,234	56,490	55,282	55,987	57,032	57,759	
EBITDA	5,453	83,544	85,684	86,780	88,227	88,123	91,515	93,027	94,232	95,790	
Total Expenses	165,594	209,864	213,061	216,170	218,992	223,429	224,436	227,389	230,716	233,760	
Net Income	(29,803)	36,162	37,773	38,453	39,476	38,943	41,899	42,968	43,725	44,826	
Closing Balance	(8,653)	27,509	65,282	103,734	143,210	182,154	224,052	267,020	310,745	355,572	

Ratios		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Return on Equity		-26%	26%	23%	20%	18%	16%	15%	14%	13%	12%
Return on Total Assets		-16%	17%	16%	15%	14%	13%	12%	12%	11%	11%
Debt Ratio		40%	34%	30%	26%	23%	20%	17%	15%	13%	11%
Total Assets	\$	188,747	210,809	234,482	258,834	284,210	309,054	336,852	365,720	395,345	426,072
Total Liabilities	\$	75,034	72,653	70,146	67,505	64,724	61,795	58,710	55,462	52,040	48,437
Equity	\$	113,712	138,155	164,336	191,329	219,487	247,259	278,142	310,259	343,305	377,635

Sales		Year 1	Year 2
Weekly direct to consumer sales		90 kg	
Weekly wholesale sales		73 kg	

### Green Shipping Container (Hanging Panels):

Configuring the third small-scale shipping container vertical farming operation to generate an IRR of 10% requires 48% direct sales at retail prices. This requires the operation to sell 65 kg of lettuce, basil and microgreens per week at retail prices and 71 kg at wholesale prices.

Lettuce only makes up 50% of the production schedule for the vertical farming operation. At a weekly demand for lettuce of 0.224 kg (225 g) the operation would need to supply the per capita lettuce demand requirements of nearly 150 individuals:

$$65 \text{ kg}_{\text{wkly sales}} \times 50\%_{\text{lettuce prod.}} = 33 \text{ kg}_{\text{wkly lettuce sales (direct to consumer)}}$$

$$33 \text{ kg} \div 0.224 \text{ kg} = 145 \text{ direct to consumer sales}$$

The vertical farm will need to make 73 lettuce sales per week to households of two at a farmers' market or through home delivery (or online sales platform). Basil and microgreen sales also need to be accounted for in the calculation. Meaning that the operation must sell 33 kgs of basil and microgreens direct to consumers at retail prices, and a further 73 kgs (total lettuce, basil and microgreens) per week at wholesale prices.

Invested Capital (Equity)	\$ 129,150
Total Capital Expenditure	\$ 184,500
Net Present Value (10 yrs.)	\$ 63,449
Internal Rate of Return (IRR)	11.0%
<b>Ratios</b>	<b>10 yr. average</b>
Return on Equity	13.2%
Return on Total Assets	10.9%
Debt Ratio	24.0%

Income Statement	Small Scale: Green Shipping Container (Hanging Panels)									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Opening Balance	14,500	(16,156)	12,415	42,324	72,700	103,886	134,322	167,491	201,507	236,052
<b>Total Revenue</b>	119,381	216,295	220,523	223,853	227,234	230,666	234,150	237,687	241,277	244,921
<b>Expenses</b>										
Total COGS	26,012	47,128	48,049	48,775	49,512	50,260	51,019	51,789	52,572	53,366
Total Payroll Expenses	53,463	54,270	55,090	55,922	56,766	57,624	58,494	59,378	60,274	61,185
Total General Expenses	43,310	54,270	49,097	50,036	50,654	52,854	51,591	52,238	53,225	53,894
EBITDA	(3,404)	66,484	68,286	69,121	70,302	69,929	73,046	74,281	75,205	76,477
Total Expenses	150,037	187,724	190,614	193,477	196,048	200,231	200,980	203,671	206,732	209,505
<b>Net Income</b>	(30,656)	28,571	29,908	30,377	31,186	30,435	33,170	34,016	34,545	35,415
Closing Balance	(16,156)	12,415	42,324	72,700	103,886	134,322	167,491	201,507	236,052	271,467

Ratios	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Return on Equity	-47%	33%	28%	23%	20%	17%	16%	15%	13%	12%
Return on Total Assets	-26%	21%	19%	17%	16%	14%	14%	13%	12%	11%
Debt Ratio	45%	38%	32%	27%	23%	20%	17%	15%	13%	11%
Total Assets	\$ 119,177	138,082	158,324	179,034	200,553	221,322	244,825	269,174	294,052	319,800
Total Liabilities	\$ 53,731	52,026	50,231	48,339	46,348	44,251	42,042	39,715	37,265	34,685
Equity	\$ 65,446	\$ 86,056	\$ 108,093	\$ 130,694	\$ 154,205	\$ 177,071	\$ 202,783	\$ 229,458	\$ 256,786	\$ 285,115

Sales		
Weekly direct to consumer sales	65	kg
Weekly wholesale sales	71	kg

### 6.2.6 Summary

The printouts above provide the scenario in which each vertical farming operation are able to pay back the initial investment in under 6 years and demonstrate internal rates of return of 10% or over on invested capital. The key variable to focus on is the direct sales requirements. The model used to generate these outputs has been created to divide the sales from the facility into high value direct to consumer sales and much lower value sales at wholesale prices.

Only selling through traditional marketing channels available for primary producers (wholesale buyers), none of the vertical farming operations are economically viable. Producing leafy green vegetables indoors is costly. Compared with conventional farming and greenhouse operations, growing plants indoors without sunlight comes at a cost. Grow trays, substrate (rooter cubes), pH balancing chemicals, and other inputs amount to roughly \$6.50/kg of production. The large-scale operations need to market an incredible amount of their produce as direct sales (using retail prices) to be viable. However, even at 100% direct sales (retail prices), investors in the largest-scale vertical farming operation generates a 16.2% IRR, and the Red Shipping Container operation generates an 82.1% IRR.

For comparability across all the vertical farming operations, the assumption of 80% direct sales to consumers is shown in the table below. This allows the reader to compare the five vertical farming options using the same consumer sales target.



	Industrial Warehouse (Racks)	Containerized (Rotating Platforms)	Red Shipping Container (Racks)	Blue Shipping Container (Racks)	Green Shipping Container (Hanging Panels)
Invested Capital (Equity)	\$14,665,000	\$2,222,500	\$109,900	\$180,355	\$129,150
Total Capital Expenditure	\$20,950,000	\$3,175,000	\$157,000	\$257,650	\$184,500
Net Present Value (10 yrs.)	-\$2,573,358	\$3,205,215	\$634,095	\$460,230	\$585,224
Internal Rate of Return (IRR)	1.4%	23.4%	59.3%	33.7%	50.1%
<b>Ratios</b>	<b>10 yr. average</b>				
Return on Equity	10.2%	15.1%	22.5%	18.3%	21.1%
Return on Total Assets	7.7%	12.6%	19.7%	15.6%	18.4%
Debt Ratio	26.6%	16.3%	10.8%	14.6%	11.9%
Direct Sales (kg)	6,904 kg	1,424 kg	124 kg	131 kg	109 kg

The table above demonstrates that if the largest operation in this assessment has slightly lower sales at retail prices the NPV for the investment turns negative, making it a riskier investment than some of the other operations above. The large-scale containerized operation demonstrates a good return on the assumption of 80% direct to consumer sales, but this still requires considerable direct sales. Focusing on the three small-scale shipping container operations, the one with the capable of generating the highest return on investment is the one with the lowest capital expenditure requirement. This demonstrates the necessity of seeking the lowest cost shipping container turnkey system, as different manufacturers have vastly different prices for what is a very similar technology.

## 7.0 Conclusion

The main conclusion that can be drawn from this assessment is that while investing in vertical farming appears to be growing momentum and has the potential to offer innovative ways to feed a growing population into the future, investors are cautioned to do their due diligence prior to investing in a turnkey vertical farming system because not all systems offer the same return on investment. This assessment has taken the first key step towards reducing the information asymmetry surrounding vertical farming.<sup>29</sup> This work has shed some light on the financials of the operations, providing investors a closer look at the systems currently available on the market.

One key takeaway from this work is that the cost of production for vertical farming is higher than traditional field crops and greenhouse production, resulting from the need to power LED lights to grow the crops, meaning that produce from vertical farms cannot compete at wholesale prices. Therefore, vertical farming operations must find a way to market their produce at much higher prices if they are to be profitable. The results show that at a certain level of sales at retail prices (sales direct to consumers), all vertical farming operations can generate a strong net return. However, the results from this assessment also suggest that very large direct sales targets are required for the larger operations.

In order to hit a target internal rate of return (IRR) of 10%, the Large-Scale (Rotating Platforms) vertical farming operation would require direct sales 1,122 kg, and the Large-Scale (Warehouse) operation requires direct sales of 7,940 kg. If the Large-Scale Warehouse operation is forced to shift from selling 1,000 kg per week direct to consumers to the wholesale market (dropping retail sales from 7,940 kg to 6,900 kg) the IRR drops from 10% down to 1%, demonstrating how sensitive the operation is to meeting weekly sales targets. While modelling an operation with an advanced direct to consumer sales element built into the model went beyond the scope of this work, direct sales on the level shown in the model are potentially going to be difficult to achieve without the knowledge and ability to generate direct sales to consumers. Vertical farming operations are not going to be able to compete on the wholesale market with greenhouse produced lettuce, basil and microgreens. For those investors that chose to enter the vertical farming sector now, they are encouraged to develop an advanced marketing plan and ensure that they have access to consumers with a high level of disposable income.

The small-scale vertical farming options that are potentially viable investments for small-scale producers are the Red and Green operations, under the assumptions made when building the model. First of all, an owner/operator could generate an IRR of 10% using these technologies with the assumption that they are meeting their direct sales targets of between 65-67 kg per week. This may be possible, but only under the assumption that the producer is selling on a weekly basis at a farmer's market or some other sales location where they can achieve volume at high

<sup>29</sup> Information asymmetry is a concept in economics where one party (turnkey system suppliers) has better access to information than the other (investors). This creates an imbalance in the power of transactions (market failure).

prices. Other assumptions, such as 20 hours per week for the owner operator to maintain their vertical farming operation in addition to marketing the produce are potentially more open for criticism. Under the assumed configuration, the owner/operator is spending 1-2 hours per weekday tending to the vertical farm and 10-15 hours on the weekend marketing (lining up buyers, delivering and tending to a farmer's market stall, etc.). Adjusting the model so that the small-scale containerized operations require a 40-hour work week makes all of three small scale operations have negative rates of return, meaning that prospective investors (owner/operators) need to be aware of the hours they plan on dedicating to the business prior to investing.

The broad conclusions from this assessment are based on the data used (provided by the turnkey equipment suppliers) and they are not necessarily conclusions on the viability of vertical farming industry itself. The research for this work suggested that there still appears to be considerable potential with vertical farming, especially as LED light technology continues to come down in cost and increase in efficiency. Investors can expect start-up costs to come down as more competition enters the market (suppliers) and LED technology improves (e.g. think of the example of how solar panels came down in price). But prospective investors need to independently verify the information provided by vertical farming equipment suppliers and approach the sector with the understanding that the market available for produce is much different from produce grown in a traditional greenhouse operation. This assessment has shown that the potential returns from vertical farming are very high, however, it has also shown that vertical farming can be a very risky investment if sales targets are not met and a market consisting of high-income consumers is not available in the region.

Drop down menus allow user to select scenario

Small Scale: Red Shipping Container (Racks)	▼
0%	▼
60%	▼

*Orange shaded cells allow the user to alter input variables*

Baseline Inputs
-----------------

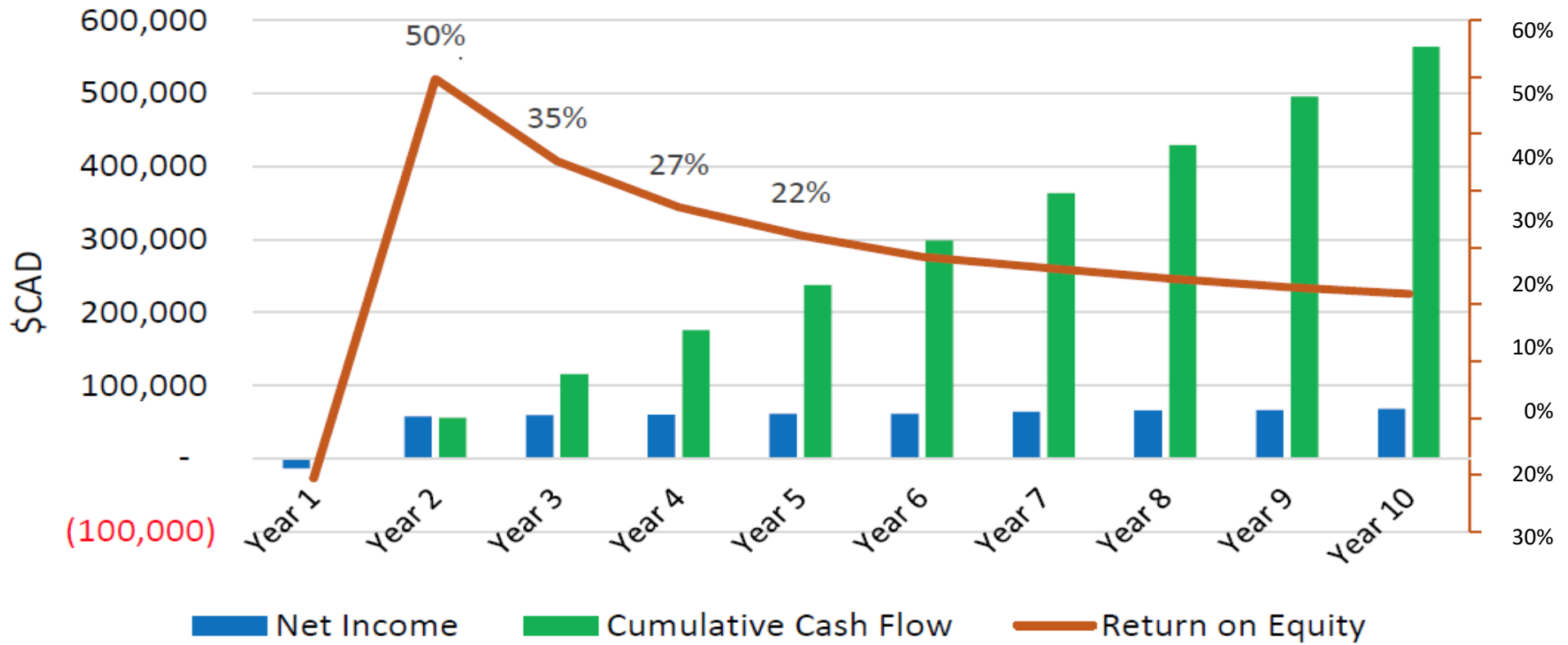
Opening Cash Balance (% of CapEx)	10%	10%
Electricity Cost (\$/kWh)	0.10	\$0.10/kWh
Equity (as percent of CapEx)	70%	70%
Commercial Banking Loan	30%	30%
Basil Production	40%	40%
Lettuce Production	50%	50%
Microgreen Production	10%	10%
Small-Scale Labour (hours per week)	20	20 hrs/week
Small-Scale Labour Wage Rate (\$/hr)	40	\$48/hr

Invested Capital (Equity)	\$109,900
Total Capital Expenditure	\$157,000
Net Present Value (10 yrs.)	\$316,239
Internal Rate of Return (IRR)	34.90%
<b>Ratios</b>	<b>10 Year Average</b>
Return on Equity	18.80%
Return on Total Assets	16.30%
Debt Ratio	15.30%
<b>Weekly Sales</b>	<b>kgs</b>
Direct to Consumer Sales	93
Wholesale Sales	62

Income Statement		Small Scale: Red Shipping Container (Racks)									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
Opening Balance	12,000	(1,365)	56,259	115,738	176,096	237,679	298,933	363,351	429,049	495,718	
Total Revenue	140,536	254,623	259,600	263,520	267,501	271,541	275,642	279,805	284,031	288,321	
<b>Expenses</b>											
Total COGS	29,681	53,776	54,827	55,655	56,495	57,349	58,215	59,094	59,986	60,892	
Total Payroll Expenses	53,463	54,270	55,090	55,922	56,766	57,624	58,494	59,378	60,274	61,185	
Total General Expenses	43,509	54,270	49,858	50,809	51,441	53,655	52,405	53,067	54,068	54,751	
EBITDA	13,883	97,422	99,825	101,134	102,798	102,914	106,528	108,267	109,702	111,493	
Total Expenses	153,901	196,999	200,120	203,163	205,918	210,286	211,224	214,107	217,362	220,333	
Net Income	(13,365)	57,624	59,479	60,358	61,583	61,255	64,418	65,698	66,669	67,988	
Cumulative Cash Flow	(1,365)	56,259	115,738	176,096	237,679	298,933	363,351	429,049	495,718	563,706	

Ratios										
Return on Equity	-21%	50%	35%	27%	22%	18%	16%	15%	13%	12%
Return on Total Assets	-12%	36%	28%	23%	19%	17%	15%	14%	12%	11%
Debt Ratio	41%	28%	20%	16%	12%	10%	8%	7%	6%	5%
Total Assets	110,635	160,259	211,738	264,096	317,679	370,933	427,351	485,049	543,718	603,706
Total Liabilities	45,722	44,272	42,744	41,134	39,440	37,655	35,775	33,796	31,711	29,515
Equity	64,912	115,987	168,994	222,961	278,239	333,278	391,576	451,254	512,007	574,191

## Net Income, Cumulative Cash Flow & Return on Equity



[Contact: Serecon Inc.](#)

Date Printed: 3/312021

**Small Scale: Red Shipping Container (Racks)**

	1	2	3	4
	Jan	Feb	Mar	Apr
Efficiency	25%	30%	35%	40%
Inflation				
<b>REVENUE</b>				
Sales - Produce	5,487	6,593	7,701	8,812
<b>TOTAL REVENUE</b>	<u>5,487</u>	<u>6,593</u>	<u>7,701</u>	<u>8,812</u>
<b>EXPENSES</b>				
<b>Cost of Goods Sold</b>				
Raw Material	1,099	1,320	1,542	1,764
Packaging	60	72	85	97
<b>Total COGS</b>	<u>1,159</u>	<u>1,392</u>	<u>1,626</u>	<u>1,861</u>
<b>Payroll Expenses</b>				
Management	-	-	-	-
Administrative	-	-	-	-
Horticulturalists	-	-	-	-
Other Labour	-	-	-	-
Owner Operator	4,425	4,430	4,436	4,441
<b>Total Payroll Expenses</b>	<u>4,425</u>	<u>4,430</u>	<u>4,436</u>	<u>4,441</u>
<b>General Expenses</b>				
Repairs and Maintenance	150	150	151	151
Variable Utilities	140	169	197	225
Fixed Utilities	8	8	8	8
Disposal	14	17	19	22
Freight Costs	98	118	138	157
Vehicle Lease	580	580	580	580
Insurance	40	40	40	40
Business Licenses	83	83	83	83
Marketing	110	132	154	176
Professional fees	83	84	84	84
Meals and Travel	83	100	117	134
Office Operations	2,000	42	42	42
Website	2,000	50	50	50
Phone, fax, internet	201	201	201	201
Photocopier Lease	-	-	-	-
Lease	1,001	1,003	1,004	1,005
Software Subscription	100	100	100	100
<b>Total General Expenses</b>	<u>6,692</u>	<u>2,876</u>	<u>2,968</u>	<u>3,060</u>
<b>EBITDA</b>	<b>(6,789)</b>	<b>(2,106)</b>	<b>(1,329)</b>	<b>(550)</b>
Taxes				
Income taxes	604	725	847	969

<i>Property Tax</i>	-	-	-	-
Interest Payment	204	203	203	202
Principal Payment	112	113	113	114
Equipment & Building Depreciation	667	667	667	667
<b>TOTAL EXPENSES</b>	<u>13,862</u>	<u>10,406</u>	<u>10,859</u>	<u>11,314</u>
<b>NET INCOME</b>	<u>(8,375)</u>	<u>(3,813)</u>	<u>(3,159)</u>	<u>(2,502)</u>
<b>CASH FLOW</b>				
Opening balance	12,000	3,625	(188)	(3,347)
Net income	(8,375)	(3,813)	(3,159)	(2,502)
<b>Closing cash balance</b>	<u>3,625</u>	<u>(188)</u>	<u>(3,347)</u>	<u>(5,849)</u>



Year 1							
5	6	7	8	9	10	11	12
May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
45%	50%	55%	60%	65%	70%	75%	85%
9,926	11,043	12,162	13,284	14,409	15,537	16,668	18,914
9,926	11,043	12,162	13,284	14,409	15,537	16,668	18,914
1,987	2,211	2,435	2,660	2,885	3,111	3,337	3,787
109	121	134	146	158	171	183	208
2,096	2,332	2,569	2,806	3,043	3,281	3,520	3,995
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
4,447	4,452	4,458	4,464	4,469	4,475	4,480	4,486
4,447	4,452	4,458	4,464	4,469	4,475	4,480	4,486
151	151	151	152	152	152	152	152
254	283	311	340	369	397	426	484
8	8	8	8	8	8	8	8
25	28	31	34	36	39	42	48
177	197	217	237	257	278	298	338
580	580	580	580	580	580	580	580
40	40	40	40	40	41	41	41
83	83	83	83	83	83	83	83
199	221	243	266	288	311	333	378
84	84	84	84	84	84	84	85
151	168	185	202	219	236	253	288
42	42	42	42	42	42	42	42
50	50	50	51	51	51	51	51
202	202	202	202	203	203	203	200
-	-	-	-	-	-	-	-
1,006	1,008	1,009	1,010	1,011	1,013	1,014	1,015
100	100	100	100	100	100	100	100
3,152	3,245	3,338	3,431	3,524	3,618	3,712	3,893
230	1,013	1,798	2,584	3,373	4,163	4,955	6,540
1,092	1,215	1,338	1,461	1,585	1,709	1,833	2,081

-	-	-	-	-	-	-	-
202	201	201	200	200	199	199	198
114	115	115	116	116	117	117	118
667	667	667	667	667	667	667	667
11,770	12,227	12,685	13,144	13,604	14,066	14,528	15,436
(1,844)	(1,184)	(523)	140	805	1,472	2,140	3,477
(5,849)	(7,693)	(8,877)	(9,399)	(9,259)	(8,454)	(6,982)	(4,843)
(1,844)	(1,184)	(523)	140	805	1,472	2,140	3,477
(7,693)	(8,877)	(9,399)	(9,259)	(8,454)	(6,982)	(4,843)	(1,365)

	13	14	15	16	17	18
<b>Year End</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>
	90%	95%	95%	95%	95%	95%
140,536	20,051	21,192	21,218	21,245	21,271	21,298
140,536	20,051	21,192	21,218	21,245	21,271	21,298
28,136	4,014	4,243	4,248	4,253	4,259	4,264
1,545	220	233	233	234	234	234
29,681	4,235	4,476	4,481	4,487	4,492	4,498
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
49,038	4,492	4,497	4,503	4,508	4,514	4,520
53,463	4,492	4,497	4,503	4,508	4,514	4,520
1,815	152	153	153	153	153	153
3,595	513	542	543	544	544	545
99	8	8	8	8	8	8
355	51	54	54	54	54	54
2,511	358	379	379	380	380	380
6,960	580	580	580	580	580	580
484	41	41	41	41	41	41
1,000	83	83	83	83	83	83
2,811	401	424	424	425	425	426
1,008	85	85	85	85	85	85
2,137	305	322	323	323	323	324
2,462	42	42	42	43	43	43
2,555	51	51	51	51	51	51
2,419	204	204	204	204	205	205
-	-	-	-	-	-	-
12,098	1,016	1,018	1,019	1,020	1,021	1,023
1,200	100	100	100	100	100	100
43,509	3,991	4,085	4,089	4,094	4,098	4,102
13,883	7,334	8,134	8,145	8,156	8,167	8,178
15,459	2,206	2,331	2,334	2,337	2,340	2,343

-	-	-	-	-	-	-
2,412	198	197	197	196	196	195
1,378	118	119	119	120	120	121
8,000	667	667	667	667	667	667
<u>153,901</u>	<u>15,905</u>	<u>16,372</u>	<u>16,390</u>	<u>16,408</u>	<u>16,427</u>	<u>16,445</u>
<u>(13,365)</u>	<u>4,146</u>	<u>4,820</u>	<u>4,828</u>	<u>4,836</u>	<u>4,845</u>	<u>4,853</u>
	(1,365)	2,781	7,601	12,430	17,266	22,111
	4,146	4,820	4,828	4,836	4,845	4,853
<u>(1,365)</u>	<u>2,781</u>	<u>7,601</u>	<u>12,430</u>	<u>17,266</u>	<u>22,111</u>	<u>26,963</u>

**Year 2**

19 Jul	20 Aug	21 Sep	22 Oct	23 Nov	24 Dec	Year End
95%	95%	95%	95%	95%	95%	
21,325	21,351	21,378	21,405	21,431	21,458	254,623
21,325	21,351	21,378	21,405	21,431	21,458	254,623

4,269	4,275	4,280	4,285	4,291	4,296	50,977
234	235	235	235	236	236	2,799
4,504	4,509	4,515	4,521	4,526	4,532	53,776

-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
4,525	4,531	4,537	4,542	4,548	4,554	49,779
4,525	4,531	4,537	4,542	4,548	4,554	54,270

154	154	154	154	154	155	1,842
546	546	547	548	548	549	6,514
8	8	8	8	8	8	101
55	55	55	55	55	55	651
381	381	382	382	383	383	4,549
580	580	580	580	580	580	6,960
41	41	41	41	41	41	491
83	83	83	83	83	83	1,000
426	427	428	428	429	429	5,092
85	85	86	86	86	86	1,023
324	325	325	325	326	326	3,872
43	43	43	43	43	43	512
51	51	51	51	51	52	614
205	205	206	206	206	200	2,453
-	-	-	-	-	-	-
1,024	1,025	1,027	1,028	1,029	1,030	12,281
100	100	100	100	100	100	1,200
4,106	4,111	4,115	4,119	4,123	4,121	49,155

8,189      8,200      8,211      8,223      8,234      8,251      97,422

2,346      2,349      2,352      2,355      2,357      2,360      28,009

-	-	-	-	-	-	-
195	194	194	193	193	192	2,339
121	122	122	123	123	124	1,451
667	667	667	667	667	667	8,000
16,464	16,482	16,501	16,519	16,538	16,550	196,999
4,861	4,869	4,877	4,886	4,894	4,908	57,624
26,963	31,824	36,694	41,571	46,457	51,350	
4,861	4,869	4,877	4,886	4,894	4,908	
31,824	36,694	41,571	46,457	51,350	56,259	56,259

Year 3							
25	26	27	28	29	30	31	32
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
95%	95%	95%	95%	95%	95%	95%	95%
21,485	21,512	21,539	21,566	21,593	21,620	21,647	21,674
21,485	21,512	21,539	21,566	21,593	21,620	21,647	21,674
4,301	4,307	4,312	4,318	4,323	4,328	4,334	4,339
236	236	237	237	237	238	238	238
4,538	4,543	4,549	4,555	4,560	4,566	4,572	4,577
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
4,559	4,565	4,571	4,576	4,582	4,588	4,594	4,599
4,559	4,565	4,571	4,576	4,582	4,588	4,594	4,599
155	155	155	155	156	156	156	156
550	550	551	552	552	553	554	554
8	8	8	8	9	9	9	9
55	56	56	56	56	56	56	56
384	384	385	385	386	386	387	387
580	580	580	580	580	580	580	580
41	41	41	41	41	42	42	42
83	83	83	83	83	83	83	83
430	430	431	431	432	432	433	433
86	86	86	86	86	87	87	87
327	327	328	328	328	329	329	330
43	43	43	43	43	43	43	43
52	52	52	52	52	52	52	52
207	207	207	207	208	208	208	208
-	-	-	-	-	-	-	-
1,032	1,033	1,034	1,036	1,037	1,038	1,039	1,041
100	100	100	100	100	100	100	100
4,132	4,136	4,141	4,145	4,149	4,153	4,158	4,162
8,256	8,267	8,279	8,290	8,301	8,312	8,324	8,335
2,363	2,366	2,369	2,372	2,375	2,378	2,381	2,384

-	-	-	-	-	-	-	-
191	191	190	190	189	189	188	188
124	125	125	126	126	127	128	128
667	667	667	667	667	667	667	667
16,575	16,593	16,612	16,631	16,649	16,668	16,687	16,705
4,910	4,919	4,927	4,935	4,943	4,952	4,960	4,968
56,259	61,169	66,087	71,014	75,949	80,893	85,844	90,804
4,910	4,919	4,927	4,935	4,943	4,952	4,960	4,968
61,169	66,087	71,014	75,949	80,893	85,844	90,804	95,772



33	34	35	36	Year End
Sep	Oct	Nov	Dec	
95%	95%	95%	95%	
21,701	21,728	21,755	21,782	259,600
21,701	21,728	21,755	21,782	259,600

37	38
Jan	Feb
95%	95%
21,809	21,837
21,809	21,837

4,345	4,350	4,355	4,361	51,973
239	239	239	239	2,853
4,583	4,589	4,595	4,600	54,827

4,366	4,372
240	240
4,606	4,612

-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
4,605	4,611	4,617	4,622	50,530
4,605	4,611	4,617	4,622	55,090

-	-
-	-
-	-
-	-
4,628	4,634
4,628	4,634

156	157	157	157	1,870
555	556	557	557	6,641
9	9	9	9	102
57	57	57	57	674
388	388	389	389	4,638
580	580	580	580	6,960
42	42	42	42	499
83	83	83	83	1,000
434	435	435	436	5,192
87	87	87	87	1,039
330	330	331	331	3,948
43	43	44	44	519
52	52	52	52	623
209	209	209	200	2,487
-	-	-	-	-
1,042	1,043	1,045	1,046	12,466
100	100	100	100	1,200
4,166	4,171	4,175	4,170	49,858

157	157
558	559
9	9
57	57
390	390
607	607
42	42
83	83
436	437
87	87
332	332
44	44
52	52
210	210
-	-
1,047	1,049
100	100
4,211	4,216

8,346	8,357	8,369	8,390	99,825
2,387	2,390	2,393	2,396	28,556

8,364	8,375
2,399	2,402

-	-	-	-	-	-	-
187	187	186	185	2,262	185	184
129	129	130	130	1,528	131	132
667	667	667	667	8,000	667	667
16,724	16,743	16,762	16,771	200,120	16,827	16,846
4,977	4,985	4,993	5,011	59,479	4,983	4,991
95,772	100,749	105,734	110,727		115,738	120,721
4,977	4,985	4,993	5,011		4,983	4,991
100,749	105,734	110,727	115,738	115,738	120,721	125,711

28%

228%

\$ 6,443.62

Year 4							
39	40	41	42	43	44	45	46
Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
95%	95%	95%	95%	95%	95%	95%	95%
21,864	21,891	21,919	21,946	21,974	22,001	22,029	22,056
21,864	21,891	21,919	21,946	21,974	22,001	22,029	22,056
4,377	4,383	4,388	4,394	4,399	4,405	4,410	4,416
240	241	241	241	242	242	242	242
4,618	4,623	4,629	4,635	4,641	4,647	4,652	4,658
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
4,640	4,646	4,651	4,657	4,663	4,669	4,675	4,681
4,640	4,646	4,651	4,657	4,663	4,669	4,675	4,681
157	158	158	158	158	158	159	159
559	560	561	561	562	563	564	564
9	9	9	9	9	9	9	9
57	58	58	58	58	58	58	58
391	391	392	392	393	393	394	394
607	607	607	607	607	607	607	607
42	42	42	42	42	42	42	42
83	83	83	83	83	83	83	83
437	438	438	439	439	440	441	441
87	88	88	88	88	88	88	88
332	333	333	334	334	335	335	335
44	44	44	44	44	44	44	44
52	53	53	53	53	53	53	53
210	211	211	211	211	212	212	212
-	-	-	-	-	-	-	-
1,050	1,051	1,053	1,054	1,055	1,057	1,058	1,059
100	100	100	100	100	100	100	100
4,220	4,224	4,229	4,233	4,237	4,242	4,246	4,250
8,387	8,398	8,410	8,421	8,432	8,444	8,455	8,467
2,405	2,408	2,411	2,414	2,417	2,420	2,423	2,426

-	-	-	-	-	-	-	-
184	183	183	182	181	181	180	180
132	133	133	134	134	135	136	136
667	667	667	667	667	667	667	667
16,865	16,884	16,903	16,922	16,941	16,960	16,979	16,998
4,999	5,008	5,016	5,024	5,033	5,041	5,050	5,058
125,711	130,711	135,718	140,734	145,759	150,792	155,833	160,883
4,999	5,008	5,016	5,024	5,033	5,041	5,050	5,058
130,711	135,718	140,734	145,759	150,792	155,833	160,883	165,941

47	48	Year End
Nov	Dec	
95%	95%	
22,084	22,111	263,520
22,084	22,111	263,520

49	50	51	52
Jan	Feb	Mar	Apr
95%	95%	95%	95%
22,139	22,167	22,194	22,222
22,139	22,167	22,194	22,222

4,421	4,427	52,758
243	243	2,896
4,664	4,670	55,655

4,432	4,438	4,443	4,449
243	244	244	244
4,676	4,682	4,687	4,693

-	-	-
-	-	-
-	-	-
-	-	-
4,686	4,692	51,294
4,686	4,692	55,922

-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
4,698	4,704	4,710	4,716
4,698	4,704	4,710	4,716

159	159	1,898
565	566	6,742
9	9	104
59	59	695
395	395	4,708
607	607	7,289
42	42	506
83	83	1,000
442	442	5,270
88	88	1,055
336	336	4,007
44	44	527
53	53	633
212	200	2,521
-	-	-
1,060	1,062	12,654
100	100	1,200
4,255	4,247	50,809

159	160	160	160
566	567	568	569
9	9	9	9
59	59	59	59
396	396	396	397
607	607	607	607
43	43	43	43
83	83	83	83
443	443	444	444
89	89	89	89
337	337	337	338
44	44	44	44
53	53	53	53
213	213	213	214
-	-	-	-
1,063	1,064	1,066	1,067
100	100	100	100
4,264	4,268	4,273	4,277

8,478	8,503	101,134
2,429	2,432	28,987

8,501	8,513	8,525	8,536
2,435	2,438	2,441	2,444

-	-	-
179	179	2,180
137	137	1,609
667	667	8,000
<u>17,017</u>	<u>17,023</u>	<u>203,163</u>

<u>5,067</u>	<u>5,088</u>	<u>60,358</u>
--------------	--------------	---------------

165,941	171,008	
5,067	5,088	
<u>171,008</u>	<u>176,096</u>	<u>176,096</u>

-	-	-	-
178	177	177	176
138	138	139	140
667	667	667	667
<u>17,055</u>	<u>17,074</u>	<u>17,094</u>	<u>17,113</u>

<u>5,084</u>	<u>5,092</u>	<u>5,101</u>	<u>5,109</u>
--------------	--------------	--------------	--------------

176,096	181,179	186,271	191,372
5,084	5,092	5,101	5,109
<u>181,179</u>	<u>186,271</u>	<u>191,372</u>	<u>196,481</u>

**Year 5**

53	54	55	56	57	58	59
<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>
95%	95%	95%	95%	95%	95%	95%
22,250	22,278	22,305	22,333	22,361	22,389	22,417
22,250	22,278	22,305	22,333	22,361	22,389	22,417
4,455	4,460	4,466	4,471	4,477	4,482	4,488
245	245	245	245	246	246	246
4,699	4,705	4,711	4,717	4,723	4,729	4,734
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
4,722	4,728	4,733	4,739	4,745	4,751	4,757
4,722	4,728	4,733	4,739	4,745	4,751	4,757
160	160	161	161	161	161	161
569	570	571	571	572	573	574
9	9	9	9	9	9	9
59	60	60	60	60	60	60
397	398	398	399	399	400	400
607	607	607	607	607	607	607
43	43	43	43	43	43	43
83	83	83	83	83	83	83
445	446	446	447	447	448	448
89	89	89	89	89	90	90
338	339	339	340	340	340	341
45	45	45	45	45	45	45
53	53	54	54	54	54	54
214	214	214	215	215	215	216
-	-	-	-	-	-	-
1,068	1,070	1,071	1,072	1,074	1,075	1,076
100	100	100	100	100	100	100
4,281	4,286	4,290	4,295	4,299	4,304	4,308
8,548	8,559	8,571	8,583	8,594	8,606	8,617
2,447	2,451	2,454	2,457	2,460	2,463	2,466

-	-	-	-	-	-	-
176	175	174	174	173	172	172
140	141	142	142	143	143	144
667	667	667	667	667	667	667
17,132	17,151	17,171	17,190	17,209	17,229	17,248
5,118	5,126	5,135	5,143	5,152	5,161	5,169
196,481	201,599	206,725	211,860	217,003	222,155	227,316
5,118	5,126	5,135	5,143	5,152	5,161	5,169
201,599	206,725	211,860	217,003	222,155	227,316	232,485



60	
Dec	Year End
95%	
22,445	267,501
22,445	267,501

61				62				63				64			
Jan		Feb		Mar		Apr									
95%		95%		95%		95%									
22,473	22,501	22,529	22,558												
22,473	22,501	22,529	22,558												

##

4,494	53,555
247	2,940
4,740	56,495

4,499	4,505	4,511	4,516
247	247	248	248
4,746	4,752	4,758	4,764

-	-
-	-
-	-
-	-
4,763	52,068
4,763	56,766

-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
4,769	4,775	4,781	4,787
4,769	4,775	4,781	4,787

162	1,927
574	6,844
9	105
60	716
401	4,779
607	7,289
43	514
83	1,000
449	5,350
90	1,070
341	4,068
45	535
54	642
200	2,556
-	-
1,078	12,846
100	1,200
4,297	51,441

162	162	162	162
575	576	576	577
9	9	9	9
61	61	61	61
401	402	402	403
580	580	580	580
43	43	43	43
83	83	83	83
449	450	451	451
90	90	90	90
342	342	343	343
2,000	45	45	45
-	54	54	54
216	216	217	217
-	-	-	-
1,079	1,081	1,082	1,083
100	100	100	100
6,191	4,294	4,299	4,303

0%

2%

8,645	102,798
2,469	29,425

6,767	8,680	8,692	8,703
2,472	2,475	2,478	2,481

-	-
171	2,095
145	1,695
667	8,000
<u>17,252</u>	<u>205,918</u>

<u>5,194</u>	<u>61,583</u>
--------------	---------------

232,485	
5,194	
<u>237,679</u>	<u>237,679</u>

-	-	-	-
161	160	160	159
155	156	156	157
667	667	667	667
<u>19,161</u>	<u>17,279</u>	<u>17,298</u>	<u>17,318</u>

<u>3,313</u>	<u>5,222</u>	<u>5,231</u>	<u>5,240</u>
--------------	--------------	--------------	--------------

237,679	240,991	246,214	251,445
<u>3,313</u>	<u>5,222</u>	<u>5,231</u>	<u>5,240</u>
<u>240,991</u>	<u>246,214</u>	<u>251,445</u>	<u>256,684</u>

## Year 6

65	66	67	68	69	70	71	72
May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
95%	95%	95%	95%	95%	95%	95%	95%
22,586	22,614	22,642	22,671	22,699	22,727	22,756	22,784
22,586	22,614	22,642	22,671	22,699	22,727	22,756	22,784
4,522	4,527	4,533	4,539	4,544	4,550	4,556	4,562
248	249	249	249	249	250	250	250
4,770	4,776	4,782	4,788	4,794	4,800	4,806	4,812
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
4,793	4,799	4,805	4,811	4,817	4,823	4,829	4,835
4,793	4,799	4,805	4,811	4,817	4,823	4,829	4,835
163	163	163	163	164	164	164	164
578	579	579	580	581	581	582	583
9	9	9	9	9	9	9	9
61	61	62	62	62	62	62	62
403	404	404	405	406	406	407	407
580	580	580	580	580	580	580	580
43	43	43	44	44	44	44	44
83	83	83	83	83	83	83	83
452	452	453	453	454	455	455	456
90	90	91	91	91	91	91	91
343	344	344	345	345	346	346	346
45	45	45	45	45	45	46	46
54	54	54	54	55	55	55	55
217	217	218	218	218	219	219	200
-	-	-	-	-	-	-	-
1,085	1,086	1,087	1,089	1,090	1,091	1,093	1,094
100	100	100	100	100	100	100	100
4,308	4,312	4,317	4,321	4,326	4,330	4,335	4,320
8,715	8,727	8,739	8,751	8,762	8,774	8,786	8,817
2,484	2,488	2,491	2,494	2,497	2,500	2,503	2,506

-	-	-	-	-	-	-	-
158	157	157	156	155	155	154	153
158	158	159	160	160	161	162	162
667	667	667	667	667	667	667	667
17,338	17,357	17,377	17,396	17,416	17,436	17,455	17,456
5,248	5,257	5,266	5,274	5,283	5,292	5,300	5,328
256,684	261,933	267,190	272,455	277,730	283,013	288,304	293,605
5,248	5,257	5,266	5,274	5,283	5,292	5,300	5,328
261,933	267,190	272,455	277,730	283,013	288,304	293,605	298,933

	73	74	75	76	77	78
<b>Year End</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>
	95%	95%	95%	95%	95%	95%
271,541	22,813	22,841	22,870	22,898	22,927	22,956
271,541	22,813	22,841	22,870	22,898	22,927	22,956
54,364	4,567	4,573	4,579	4,584	4,590	4,596
2,985	251	251	251	252	252	252
57,349	4,818	4,824	4,830	4,836	4,842	4,848
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
52,855	4,841	4,847	4,853	4,859	4,865	4,871
57,624	4,841	4,847	4,853	4,859	4,865	4,871
1,956	164	165	165	165	165	165
6,947	584	584	585	586	587	587
107	9	9	9	9	9	9
738	62	63	63	63	63	63
4,851	408	408	409	409	410	410
6,960	580	580	580	580	580	580
522	44	44	44	44	44	44
1,000	83	83	83	83	83	83
5,431	456	457	457	458	459	459
1,087	91	91	92	92	92	92
4,129	347	347	348	348	349	349
2,498	46	46	46	46	46	46
598	55	55	55	55	55	55
2,592	219	220	220	220	220	221
-	-	-	-	-	-	-
13,040	1,095	1,097	1,098	1,100	1,101	1,102
1,200	100	100	100	100	100	100
53,655	4,344	4,348	4,353	4,357	4,362	4,367
102,914	8,810	8,822	8,834	8,846	8,857	8,869
29,869	2,509	2,513	2,516	2,519	2,522	2,525

-	-	-	-	-	-	-
1,886	153	152	151	151	150	149
1,904	163	164	165	165	166	167
8,000	667	667	667	667	667	667
<u>210,286</u>	<u>17,495</u>	<u>17,514</u>	<u>17,534</u>	<u>17,554</u>	<u>17,574</u>	<u>17,594</u>
<u>61,255</u>	<u>5,318</u>	<u>5,327</u>	<u>5,335</u>	<u>5,344</u>	<u>5,353</u>	<u>5,362</u>
	298,933	304,251	309,578	314,913	320,258	325,611
	5,318	5,327	5,335	5,344	5,353	5,362
<u>298,933</u>	<u>304,251</u>	<u>309,578</u>	<u>314,913</u>	<u>320,258</u>	<u>325,611</u>	<u>330,972</u>

**Year 7**

79	80	81	82	83	84	
Jul	Aug	Sep	Oct	Nov	Dec	Year End
95%	95%	95%	95%	95%	95%	
22,984	23,013	23,042	23,071	23,099	23,128	275,642
22,984	23,013	23,042	23,071	23,099	23,128	275,642

4,602	4,607	4,613	4,619	4,625	4,630	55,185
253	253	253	254	254	254	3,030
4,854	4,860	4,866	4,872	4,879	4,885	58,215

-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
4,878	4,884	4,890	4,896	4,902	4,908	53,653
4,878	4,884	4,890	4,896	4,902	4,908	58,494

166	166	166	166	166	167	1,985
588	589	589	590	591	592	7,052
9	9	9	9	9	9	109
63	64	64	64	64	64	760
411	411	412	412	413	413	4,924
580	580	580	580	580	580	6,960
44	44	44	44	44	44	529
83	83	83	83	83	83	1,000
460	460	461	461	462	463	5,513
92	92	92	92	92	93	1,103
350	350	350	351	351	352	4,192
46	46	46	46	46	46	552
55	55	55	55	55	56	662
221	221	222	222	222	200	2,628
-	-	-	-	-	-	-
1,104	1,105	1,106	1,108	1,109	1,111	13,237
100	100	100	100	100	100	1,200
4,371	4,376	4,380	4,385	4,390	4,372	52,405

8,881      8,893      8,905      8,917      8,929      8,964      106,528

2,528      2,531      2,535      2,538      2,541      2,544      30,321

-	-	-	-	-	-	-
148	148	147	146	145	145	1,784
167	168	169	170	170	171	2,005
667	667	667	667	667	667	8,000
17,614	17,634	17,654	17,674	17,693	17,691	211,224
5,371	5,379	5,388	5,397	5,406	5,437	64,418
330,972	336,343	341,722	347,111	352,508	357,914	
5,371	5,379	5,388	5,397	5,406	5,437	
336,343	341,722	347,111	352,508	357,914	363,351	363,351



Year 8							
85	86	87	88	89	90	91	92
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
95%	95%	95%	95%	95%	95%	95%	95%
23,157	23,186	23,215	23,244	23,273	23,302	23,331	23,361
23,157	23,186	23,215	23,244	23,273	23,302	23,331	23,361
4,636	4,642	4,648	4,654	4,659	4,665	4,671	4,677
255	255	255	255	256	256	256	257
4,891	4,897	4,903	4,909	4,915	4,921	4,928	4,934
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
4,914	4,920	4,927	4,933	4,939	4,945	4,951	4,957
4,914	4,920	4,927	4,933	4,939	4,945	4,951	4,957
167	167	167	167	168	168	168	168
592	593	594	595	595	596	597	598
9	9	9	9	9	9	9	9
64	65	65	65	65	65	65	66
414	414	415	415	416	416	417	417
580	580	580	580	580	580	580	580
44	45	45	45	45	45	45	45
83	83	83	83	83	83	83	83
463	464	464	465	465	466	467	467
93	93	93	93	93	93	93	93
352	353	353	353	354	354	355	355
46	46	46	47	47	47	47	47
56	56	56	56	56	56	56	56
223	223	223	224	224	224	224	225
-	-	-	-	-	-	-	-
1,112	1,113	1,115	1,116	1,118	1,119	1,120	1,122
100	100	100	100	100	100	100	100
4,399	4,403	4,408	4,413	4,417	4,422	4,427	4,431
8,953	8,966	8,978	8,990	9,002	9,014	9,026	9,038
2,547	2,550	2,554	2,557	2,560	2,563	2,566	2,570

-	-	-	-	-	-	-	-
144	143	142	142	141	140	139	139
172	173	173	174	175	176	176	177
667	667	667	667	667	667	667	667
17,734	17,754	17,774	17,794	17,814	17,834	17,854	17,875
5,424	5,433	5,441	5,450	5,459	5,468	5,477	5,486
363,351	368,775	374,207	379,649	385,099	390,558	396,027	401,504
5,424	5,433	5,441	5,450	5,459	5,468	5,477	5,486
368,775	374,207	379,649	385,099	390,558	396,027	401,504	406,990

93	94	95	96		97	98
Sep	Oct	Nov	Dec	Year End	Jan	Feb
95%	95%	95%	95%		95%	95%
23,390	23,419	23,448	23,478	279,805	23,507	23,536
23,390	23,419	23,448	23,478	279,805	23,507	23,536
4,683	4,689	4,694	4,700	56,019	4,706	4,712
257	257	258	258	3,075	258	259
4,940	4,946	4,952	4,958	59,094	4,965	4,971
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
4,964	4,970	4,976	4,982	54,463	4,988	4,995
4,964	4,970	4,976	4,982	59,378	4,988	4,995
168	169	169	169	2,015	169	170
598	599	600	601	7,158	601	602
9	9	9	9	110	9	9
66	66	66	66	783	66	67
418	418	419	419	4,999	420	420
580	580	580	580	6,960	607	607
45	45	45	45	537	45	45
83	83	83	83	1,000	83	83
468	468	469	470	5,596	470	471
94	94	94	94	1,120	94	94
356	356	357	357	4,255	357	358
47	47	47	47	560	47	47
56	56	56	56	672	56	57
225	225	225	200	2,665	226	226
-	-	-	-	-	-	-
1,123	1,125	1,126	1,127	13,436	1,129	1,130
100	100	100	100	1,200	100	100
4,436	4,441	4,445	4,424	53,067	4,482	4,487
9,050	9,063	9,075	9,113	108,267	9,072	9,084
2,573	2,576	2,579	2,583	30,779	2,586	2,589

-	-	-	-	-
138	137	136	136	1,678
178	179	179	180	2,112
667	667	667	667	8,000
<u>17,895</u>	<u>17,915</u>	<u>17,935</u>	<u>17,930</u>	<u>214,107</u>
<u>5,495</u>	<u>5,504</u>	<u>5,513</u>	<u>5,548</u>	<u>65,698</u>
406,990	412,485	417,989	423,502	
5,495	5,504	5,513	5,548	
<u>412,485</u>	<u>417,989</u>	<u>423,502</u>	<u>429,049</u>	<u>429,049</u>

-	-
135	134
181	182
667	667
<u>18,003</u>	<u>18,024</u>
<u>5,504</u>	<u>5,513</u>
429,049	434,553
5,504	5,513
<u>434,553</u>	<u>440,066</u>

28%

#REF!

\$ 6,945.15

Year 9							
99	100	101	102	103	104	105	106
Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
95%	95%	95%	95%	95%	95%	95%	95%
23,566	23,595	23,625	23,654	23,684	23,713	23,743	23,773
23,566	23,595	23,625	23,654	23,684	23,713	23,743	23,773
4,718	4,724	4,730	4,736	4,742	4,748	4,754	4,759
259	259	260	260	260	261	261	261
4,977	4,983	4,989	4,996	5,002	5,008	5,014	5,021
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
5,001	5,007	5,013	5,020	5,026	5,032	5,039	5,045
5,001	5,007	5,013	5,020	5,026	5,032	5,039	5,045
170	170	170	170	171	171	171	171
603	604	604	605	606	607	607	608
9	9	9	9	9	9	9	9
67	67	67	67	67	68	68	68
421	422	422	423	423	424	424	425
607	607	607	607	607	607	607	607
45	45	45	45	45	46	46	46
83	83	83	83	83	83	83	83
471	472	472	473	474	474	475	475
94	94	95	95	95	95	95	95
358	359	359	360	360	361	361	362
47	47	47	47	47	47	48	48
57	57	57	57	57	57	57	57
227	227	227	227	228	228	228	229
-	-	-	-	-	-	-	-
1,132	1,133	1,134	1,136	1,137	1,139	1,140	1,142
100	100	100	100	100	100	100	100
4,492	4,496	4,501	4,506	4,510	4,515	4,520	4,525
9,096	9,109	9,121	9,133	9,145	9,158	9,170	9,183
2,592	2,595	2,599	2,602	2,605	2,608	2,612	2,615

-	-	-	-	-	-	-	-
133	132	132	131	130	129	128	128
183	183	184	185	186	187	187	188
667	667	667	667	667	667	667	667
18,044	18,065	18,085	18,106	18,126	18,147	18,167	18,188
5,522	5,531	5,540	5,549	5,558	5,567	5,576	5,585
440,066	445,587	451,118	456,657	462,206	467,764	473,331	478,907
5,522	5,531	5,540	5,549	5,558	5,567	5,576	5,585
445,587	451,118	456,657	462,206	467,764	473,331	478,907	484,492

107	108	Year End
Nov	Dec	
95%	95%	
23,802	23,832	284,031
23,802	23,832	284,031

109	110	111	112
Jan	Feb	Mar	Apr
95%	95%	95%	95%
23,862	23,892	23,922	23,952
23,862	23,892	23,922	23,952

4,765	4,771	56,865
262	262	3,122
5,027	5,033	59,986

4,777	4,783	4,789	4,795
262	263	263	263
5,040	5,046	5,052	5,059

-	-	-
-	-	-
-	-	-
-	-	-
5,051	5,057	55,286
5,051	5,057	60,274

-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
5,064	5,070	5,076	5,083
5,064	5,070	5,076	5,083

171	172	2,046
609	610	7,266
9	9	112
68	68	807
425	426	5,074
607	607	7,289
46	46	546
83	83	1,000
476	477	5,681
95	95	1,137
362	362	4,319
48	48	568
57	57	682
229	200	2,702
-	-	-
1,143	1,144	13,639
100	100	1,200
4,529	4,505	54,068

172	172	172	173
610	611	612	613
9	9	9	9
68	69	69	69
426	427	427	428
607	607	607	607
46	46	46	46
83	83	83	83
477	478	478	479
95	96	96	96
363	363	364	364
48	48	48	48
57	57	57	58
229	230	230	230
-	-	-	-
1,146	1,147	1,149	1,150
100	100	100	100
4,539	4,544	4,548	4,553

9,195      9,236      109,702

9,220      9,232      9,245      9,257

2,618      2,622      31,243

2,625      2,628      2,631      2,635

-	-	-
127	126	1,565
189	190	2,224
667	667	8,000
<u>18,208</u>	<u>18,200</u>	<u>217,362</u>
<u>5,594</u>	<u>5,632</u>	<u>66,669</u>

484,492	490,086	
5,594	5,632	
<u>490,086</u>	<u>495,718</u>	<u>495,718</u>

-	-	-	-
125	124	124	123
191	191	192	193
667	667	667	667
<u>18,250</u>	<u>18,270</u>	<u>18,291</u>	<u>18,312</u>
<u>5,612</u>	<u>5,622</u>	<u>5,631</u>	<u>5,640</u>

495,718	501,331	506,952	512,583
5,612	5,622	5,631	5,640
<u>501,331</u>	<u>506,952</u>	<u>512,583</u>	<u>518,223</u>



Year 10						
113	114	115	116	117	118	119
May	Jun	Jul	Aug	Sep	Oct	Nov
95%	95%	95%	95%	95%	95%	95%
23,982	24,012	24,042	24,072	24,102	24,132	24,162
23,982	24,012	24,042	24,072	24,102	24,132	24,162
4,801	4,807	4,813	4,819	4,825	4,831	4,837
264	264	264	265	265	265	266
5,065	5,071	5,077	5,084	5,090	5,097	5,103
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
5,089	5,096	5,102	5,108	5,115	5,121	5,127
5,089	5,096	5,102	5,108	5,115	5,121	5,127
173	173	173	173	174	174	174
614	614	615	616	617	617	618
9	9	9	9	9	10	10
69	69	69	70	70	70	70
428	429	429	430	431	431	432
607	607	607	607	607	607	607
46	46	46	46	46	46	46
83	83	83	83	83	83	83
480	480	481	481	482	483	483
96	96	96	96	96	97	97
365	365	366	366	367	367	367
48	48	48	48	48	48	48
58	58	58	58	58	58	58
231	231	231	231	232	232	232
-	-	-	-	-	-	-
1,152	1,153	1,154	1,156	1,157	1,159	1,160
100	100	100	100	100	100	100
4,558	4,563	4,568	4,572	4,577	4,582	4,587
9,270	9,282	9,295	9,307	9,320	9,332	9,345
2,638	2,641	2,645	2,648	2,651	2,654	2,658

-	-	-	-	-	-	-
122	121	120	119	119	118	117
194	195	196	196	197	198	199
667	667	667	667	667	667	667
18,332	18,353	18,374	18,395	18,416	18,437	18,458
5,649	5,658	5,667	5,677	5,686	5,695	5,704
518,223	523,872	529,530	535,198	540,875	546,560	552,256
5,649	5,658	5,667	5,677	5,686	5,695	5,704
523,872	529,530	535,198	540,875	546,560	552,256	557,960

120

**Dec**            **Year End**

95%

24,192            288,321

24,192            288,321

4,843            57,724

266              3,169

5,109            60,892

-                  -

-                  -

-                  -

-                  -

5,134            56,121

5,134            61,185

174              2,077

619              7,376

10               114

70               832

432              5,151

607              7,289

46               554

83               1,000

484              5,766

97               1,154

368              4,384

48               577

58               692

200              2,740

-                  -

1,162            13,845

100              1,200

4,559            54,751

9,390            111,493

2,661            31,715

-	-
116	1,447
200	2,342
667	8,000
<u>18,446</u>	<u>220,333</u>
<u>5,746</u>	<u>67,988</u>
<hr/>	
557,960	
5,746	
<u>563,706</u>	<u>563,706</u>

RETAIL PRICES			
Varieties	Capacity Used	Annual Production	30
Basil	40%	2,832	50%
Lettuce	50%	4,375	0%
Microgreens	10%	895	80%
Totals	100%	8,102	

WHOLESALE PRICES			
Varieties	Capacity Used	Annual Production	\$/kg
Basil	40%	2,832	15.00
Lettuce	50%	4,375	14.00
Microgreens	10%	895	20.00
Totals	100%	8,102	

RETAIL PRICES		% of total Sales	
Daily annualized volume (above)	22	93	
Avg price / kg	\$ 44		
Annual Sales	\$ 357,321	60%	
Monthly Sales	\$ 29,777	<b>\$ 17,866</b>	

WHOLESALE PRICES		% of total Sales	
Daily annualized volume (above)	22	62	
Avg price / kg	\$ 15		
Annual Sales	\$ 121,630	40%	
Monthly Sales	\$ 10,136	<b>\$ 4,054</b>	

Large-Scale: Industrial Warehouse	Small Scale: Red Shipping Container (Racks)	Small Scale: Blue Shipping Container (Racks)
---	---	--

Crop Variety:	Large-Scale: Industrial Warehouse	Small Scale: Red Shipping Container (Racks)	Small Scale: Blue Shipping Container (Racks)
Basil	450,000	7,080	5,320
Butterhead Lettuce	450,000	8,750	10,640
Microgreens	450,000	8,950	10,640

Sales by Size (Grams)				Current Pricing/Package (C		
142	300	200	Total Sales	30	142	300
50%	0%	0%	100%	\$ 2.50	\$ 4.00	\$ 4.50
30%	70%	0%	100%	\$ 2.00	\$ 3.00	\$ 4.20
20%	0%	0%	100%	\$ 4.50	\$ 17.00	

Total Sales by Variety	% of Total Sales \$	\$/kg	Total Packaging Cost
\$ 42,480	35%	\$ 0.44	\$ 1,246
\$ 61,250	50%	\$ 0.22	\$ 963
\$ 17,900	15%	\$ 0.44	\$ 394
<b>\$ 121,630.00</b>			<b>\$ 2,602</b>

Small Scale: Green Shipping Container (Hanging Panels)	Large-Scale: Containerized (Rotating)
8,130	128,420
6,000	78,390
8,300	22,830

---

0.001							
Grams)	Price (per Kilogram) for each Package Size					Total Sale	
200	30	142	300	200	30	142	
\$ 12.96	\$ 83	\$ 28	\$ 15	\$ -	\$ 118,000	\$ 39,887	
\$ 10.00	\$ 67	\$ 21	\$ 14	\$ -	\$ -	\$ 27,729	
	\$ 150	\$ 120	\$ -	\$ -	\$ 107,400	\$ 21,430	

---

s by Size					Packaging		
					0.44	0.44	0.22
300	200	Total Sales by Variety	% of Total Sales \$	Average Price / Kg	30	142	300
\$ -	\$ -	\$ 157,887	44%	\$ 56	\$ 623	\$ 623	\$ -
\$ 42,875	\$ -	\$ 70,604	20%	\$ 16	\$ -	\$ 578	\$ 674
\$ -	\$ -	\$ 128,830	\$ 0	\$ 144	\$ 315	\$ 79	\$ -
	-	<b>\$ 357,320.77</b>					



0.22	
200	Package Cost
\$ -	\$ 1,246
\$ -	\$ 1,251
\$ -	\$ 394
	<b>\$ 2,891</b>

**Small Scale: Red Shipping Container (Racks)**

Verticle Farming Type:

2

Annual Productive Capacity: 8,102

Installed Cost of entire facility	157,000
Percent Equity	70%
Percent Debt (Conventional Loans)	30%

**Equity**

Capital Expenditure	109,900
---------------------	---------

**Debt**

Capital Expenditure	47,100
---------------------	--------

**Loan Amortization Schedule (Commercial Loan)**

Annual Interest Rate:	5.19%
Years:	20
Payments per period:	12
Amount:	47,100

Monthly Payments	Payment	Principal	Interest	Balance
1	(316)	(112)	(204)	46,988
2	(316)	(113)	(203)	46,875
3	(316)	(113)	(203)	46,762
4	(316)	(114)	(202)	46,648
5	(316)	(114)	(202)	46,534
6	(316)	(115)	(201)	46,420
7	(316)	(115)	(201)	46,305
8	(316)	(116)	(200)	46,189
9	(316)	(116)	(200)	46,073
10	(316)	(117)	(199)	45,957
11	(316)	(117)	(199)	45,840
12	(316)	(118)	(198)	45,722
13	(316)	(118)	(198)	45,604
14	(316)	(118)	(197)	45,408
15	(316)	(119)	(197)	45,289
16	(316)	(120)	(196)	45,169
17	(316)	(120)	(196)	45,049
18	(316)	(121)	(195)	44,928
19	(316)	(121)	(195)	44,807
20	(316)	(122)	(194)	44,686

Monthly Payments	Payment	Principal	Interest	Balance
21	(316)	(122)	(194)	44,563
22	(316)	(123)	(193)	44,441
23	(316)	(123)	(193)	44,317
24	(316)	(124)	(192)	44,194
25	(316)	(124)	(191)	44,069
26	(316)	(125)	(191)	43,944
27	(316)	(125)	(190)	43,819
28	(316)	(126)	(190)	43,693
29	(316)	(126)	(189)	43,566
30	(316)	(127)	(189)	43,439
31	(316)	(128)	(188)	43,312
32	(316)	(128)	(188)	43,184
33	(316)	(129)	(187)	43,055
34	(316)	(129)	(187)	42,926
35	(316)	(130)	(186)	42,796
36	(316)	(130)	(185)	42,666
37	(316)	(131)	(185)	42,535
38	(316)	(132)	(184)	42,403
39	(316)	(132)	(184)	42,271
40	(316)	(133)	(183)	42,138
41	(316)	(133)	(183)	42,005
42	(316)	(134)	(182)	41,871
43	(316)	(134)	(181)	41,737
44	(316)	(135)	(181)	41,602
45	(316)	(136)	(180)	41,467
46	(316)	(136)	(180)	41,330
47	(316)	(137)	(179)	41,194
48	(316)	(137)	(179)	41,056
49	(316)	(138)	(178)	40,918
50	(316)	(138)	(177)	40,780
51	(316)	(139)	(177)	40,641
52	(316)	(140)	(176)	40,501
53	(316)	(140)	(176)	40,361
54	(316)	(141)	(175)	40,220
55	(316)	(142)	(174)	40,078
56	(316)	(142)	(174)	39,936
57	(316)	(143)	(173)	39,794
58	(316)	(143)	(172)	39,650
59	(316)	(144)	(172)	39,506
60	(316)	(145)	(171)	39,362
61	(316)	(145)	(171)	39,216
62	(316)	(146)	(170)	39,071
63	(316)	(146)	(169)	38,924
64	(316)	(147)	(169)	38,777
65	(316)	(148)	(168)	38,629
66	(316)	(148)	(167)	38,481

Monthly Payments	Payment	Principal	Interest	Balance
67	(316)	(149)	(167)	38,332
68	(316)	(150)	(166)	38,182
69	(316)	(150)	(165)	38,032
70	(316)	(151)	(165)	37,881
71	(316)	(152)	(164)	37,729
72	(316)	(152)	(164)	37,577
73	(316)	(153)	(163)	37,424
74	(316)	(154)	(162)	37,270
75	(316)	(154)	(162)	37,116
76	(316)	(155)	(161)	36,961
77	(316)	(156)	(160)	36,806
78	(316)	(156)	(160)	36,649
79	(316)	(157)	(159)	36,492
80	(316)	(158)	(158)	36,335
81	(316)	(158)	(157)	36,176
82	(316)	(159)	(157)	36,017
83	(316)	(160)	(156)	35,858
84	(316)	(160)	(155)	35,697
85	(316)	(161)	(155)	35,536
86	(316)	(162)	(154)	35,374
87	(316)	(162)	(153)	35,212
88	(316)	(163)	(153)	35,049
89	(316)	(164)	(152)	34,885
90	(316)	(165)	(151)	34,720
91	(316)	(165)	(151)	34,555
92	(316)	(166)	(150)	34,389
93	(316)	(167)	(149)	34,222
94	(316)	(167)	(148)	34,055
95	(316)	(168)	(148)	33,887
96	(316)	(169)	(147)	33,718
97	(316)	(170)	(146)	33,548
98	(316)	(170)	(145)	33,378
99	(316)	(171)	(145)	33,207
100	(316)	(172)	(144)	33,035
101	(316)	(173)	(143)	32,862
102	(316)	(173)	(142)	32,689
103	(316)	(174)	(142)	32,515
104	(316)	(175)	(141)	32,340
105	(316)	(176)	(140)	32,164
106	(316)	(176)	(139)	31,988
107	(316)	(177)	(139)	31,811
108	(316)	(178)	(138)	31,633
109	(316)	(179)	(137)	31,454
110	(316)	(179)	(136)	31,275
111	(316)	(180)	(136)	31,095
112	(316)	(181)	(135)	30,914

Monthly Payments	Payment	Principal	Interest	Balance
113	(316)	(182)	(134)	30,732
114	(316)	(183)	(133)	30,549
115	(316)	(183)	(132)	30,366
116	(316)	(184)	(132)	30,182
117	(316)	(185)	(131)	29,997
118	(316)	(186)	(130)	29,811
119	(316)	(187)	(129)	29,625
120	(316)	(187)	(128)	29,437
121	(316)	(188)	(128)	29,249
122	(316)	(189)	(127)	29,060
123	(316)	(190)	(126)	28,870
124	(316)	(191)	(125)	28,680
125	(316)	(191)	(124)	28,488
126	(316)	(192)	(124)	28,296
127	(316)	(193)	(123)	28,103
128	(316)	(194)	(122)	27,909
129	(316)	(195)	(121)	27,714
130	(316)	(196)	(120)	27,519
131	(316)	(196)	(119)	27,322
132	(316)	(197)	(119)	27,125
133	(316)	(198)	(118)	26,927
134	(316)	(199)	(117)	26,728
135	(316)	(200)	(116)	26,528
136	(316)	(201)	(115)	26,327
137	(316)	(202)	(114)	26,126
138	(316)	(202)	(113)	25,923
139	(316)	(203)	(112)	25,720
140	(316)	(204)	(112)	25,516
141	(316)	(205)	(111)	25,310
142	(316)	(206)	(110)	25,104
143	(316)	(207)	(109)	24,898
144	(316)	(208)	(108)	24,690
145	(316)	(209)	(107)	24,481
146	(316)	(210)	(106)	24,272
147	(316)	(210)	(105)	24,061
148	(316)	(211)	(104)	23,850
149	(316)	(212)	(103)	23,637
150	(316)	(213)	(103)	23,424
151	(316)	(214)	(102)	23,210
152	(316)	(215)	(101)	22,995
153	(316)	(216)	(100)	22,779
154	(316)	(217)	(99)	22,562
155	(316)	(218)	(98)	22,344
156	(316)	(219)	(97)	22,125
157	(316)	(220)	(96)	21,905
158	(316)	(221)	(95)	21,685

Monthly Payments	Payment	Principal	Interest	Balance
159	(316)	(222)	(94)	21,463
160	(316)	(223)	(93)	21,240
161	(316)	(224)	(92)	21,017
162	(316)	(225)	(91)	20,792
163	(316)	(226)	(90)	20,567
164	(316)	(227)	(89)	20,340
165	(316)	(227)	(88)	20,113
166	(316)	(228)	(87)	19,884
167	(316)	(229)	(86)	19,655
168	(316)	(230)	(85)	19,424
169	(316)	(231)	(84)	19,193
170	(316)	(232)	(83)	18,960
171	(316)	(233)	(82)	18,727
172	(316)	(234)	(81)	18,492
173	(316)	(235)	(80)	18,257
174	(316)	(237)	(79)	18,020
175	(316)	(238)	(78)	17,783
176	(316)	(239)	(77)	17,544
177	(316)	(240)	(76)	17,305
178	(316)	(241)	(75)	17,064
179	(316)	(242)	(74)	16,822
180	(316)	(243)	(73)	16,580
181	(316)	(244)	(72)	16,336
182	(316)	(245)	(71)	16,091
183	(316)	(246)	(70)	15,845
184	(316)	(247)	(69)	15,598
185	(316)	(248)	(68)	15,350
186	(316)	(249)	(67)	15,101
187	(316)	(250)	(66)	14,851
188	(316)	(251)	(65)	14,600
189	(316)	(252)	(63)	14,348
190	(316)	(253)	(62)	14,094
191	(316)	(255)	(61)	13,840
192	(316)	(256)	(60)	13,584
193	(316)	(257)	(59)	13,327
194	(316)	(258)	(58)	13,069
195	(316)	(259)	(57)	12,811
196	(316)	(260)	(56)	12,550
197	(316)	(261)	(55)	12,289
198	(316)	(262)	(53)	12,027
199	(316)	(263)	(52)	11,764
200	(316)	(265)	(51)	11,499
201	(316)	(266)	(50)	11,233
202	(316)	(267)	(49)	10,966
203	(316)	(268)	(48)	10,698
204	(316)	(269)	(47)	10,429

Monthly Payments	Payment	Principal	Interest	Balance
205	(316)	(270)	(45)	10,159
206	(316)	(272)	(44)	9,887
207	(316)	(273)	(43)	9,614
208	(316)	(274)	(42)	9,341
209	(316)	(275)	(41)	9,066
210	(316)	(276)	(40)	8,789
211	(316)	(277)	(38)	8,512
212	(316)	(279)	(37)	8,233
213	(316)	(280)	(36)	7,953
214	(316)	(281)	(35)	7,672
215	(316)	(282)	(34)	7,390
216	(316)	(284)	(32)	7,106
217	(316)	(285)	(31)	6,822
218	(316)	(286)	(30)	6,536
219	(316)	(287)	(29)	6,249
220	(316)	(288)	(27)	5,960
221	(316)	(290)	(26)	5,670
222	(316)	(291)	(25)	5,379
223	(316)	(292)	(24)	5,087
224	(316)	(293)	(22)	4,794
225	(316)	(295)	(21)	4,499
226	(316)	(296)	(20)	4,203
227	(316)	(297)	(19)	3,906
228	(316)	(299)	(17)	3,607
229	(316)	(300)	(16)	3,307
230	(316)	(301)	(15)	3,006
231	(316)	(302)	(13)	2,704
232	(316)	(304)	(12)	2,400
233	(316)	(305)	(11)	2,095
234	(316)	(306)	(9)	1,788
235	(316)	(308)	(8)	1,481
236	(316)	(309)	(7)	1,172
237	(316)	(310)	(5)	861
238	(316)	(312)	(4)	550
239	(316)	(313)	(3)	236
240	(316)	(314)	(1)	-

<b>Small Scale: Red Shipping Container (Racks)</b>			Vertical Farming Type:		
		Mthly. Dep.			
<b>Equipment</b>	120,000	667			
<b>Buildings</b>	-	-			
<b>Equipment Depreciation</b>					
Monthly Payments	Equipment Start of Month	Equipment	-	1	2
<b>End of Month</b>			- 120,000	120,000	119,333
				119,333	118,667
<b>Building Depreciation</b>					
Monthly Payments	Building Start of Month	Building End of Month	-	1	2
<b>Month</b>			-	-	-
			-	-	-
<b>Land Appreciation</b>					
	Month		-	1	2
	<b>Land Value</b>		- 700,000		701,751

0.1250%

2 Annual Productive Capacity: 8,102

Salvage Rate Salvage Value Useful Life (15 years or 180 mths)

0%	-	180					
0%	-	180					
	3	4	5	6	7	8	9
118,667	118,000	117,333	116,667	116,000	115,333	114,667	
118,000	117,333	116,667	116,000	115,333	114,667	114,000	
	3	4	5	6	7	8	9
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
	3	4	5	6	7	8	9
702,628	703,507	704,386	705,266	706,148	707,031	707,914	
	10	11	12	13	14	15	16
114,000	113,333	112,667	112,000	111,333	110,667	110,000	
113,333	112,667	112,000	111,333	110,667	110,000	109,333	
	10	11	12	13	14	15	16
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
	10	11	12	13	14	15	16



708,799	709,685	710,572	711,461	712,350	713,240	714,132	
17	18	19	20	21	22	23	
109,333	108,667	108,000	107,333	106,667	106,000	105,333	
108,667	108,000	107,333	106,667	106,000	105,333	104,667	
17	18	19	20	21	22	23	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
17	18	19	20	21	22	23	
715,025	715,918	716,813	717,709	718,607	719,505	720,404	
24	25	26	27	28	29	30	
104,667	104,000	103,333	102,667	102,000	101,333	100,667	
104,000	103,333	102,667	102,000	101,333	100,667	100,000	
24	25	26	27	28	29	30	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
24	25	26	27	28	29	30	
721,305	722,206	723,109	724,013	724,918	725,824	726,731	
31	32	33	34	35	36	37	
100,000	99,333	98,667	98,000	97,333	96,667	96,000	
99,333	98,667	98,000	97,333	96,667	96,000	95,333	
31	32	33	34	35	36	37	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
31	32	33	34	35	36	37	
727,640	728,549	729,460	730,372	731,285	732,199	733,114	
38	39	40	41	42	43	44	
95,333	94,667	94,000	93,333	92,667	92,000	91,333	
94,667	94,000	93,333	92,667	92,000	91,333	90,667	
38	39	40	41	42	43	44	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
38	39	40	41	42	43	44	
734,031	734,948	735,867	736,787	737,708	738,630	739,553	
45	46	47	48	49	50	51	

90,667	90,000	89,333	88,667	88,000	87,333	86,667
90,000	89,333	88,667	88,000	87,333	86,667	86,000
45	46	47	48	49	50	51
-	-	-	-	-	-	-
-	-	-	-	-	-	-
45	46	47	48	49	50	51
740,477	741,403	742,330	743,258	744,187	745,117	746,048
52	53	54	55	56	57	58
86,000	85,333	84,667	84,000	83,333	82,667	82,000
85,333	84,667	84,000	83,333	82,667	82,000	81,333
52	53	54	55	56	57	58
-	-	-	-	-	-	-
-	-	-	-	-	-	-
52	53	54	55	56	57	58
746,981	747,915	748,850	749,786	750,723	751,661	752,601
59	60	61	62	63	64	65
81,333	80,667	80,000	79,333	78,667	78,000	77,333
80,667	80,000	79,333	78,667	78,000	77,333	76,667
59	60	61	62	63	64	65
-	-	-	-	-	-	-
-	-	-	-	-	-	-
59	60	61	62	63	64	65
753,542	754,484	755,427	756,371	757,316	758,263	759,211
66	67	68	69	70	71	72
76,667	76,000	75,333	74,667	74,000	73,333	72,667
76,000	75,333	74,667	74,000	73,333	72,667	72,000
66	67	68	69	70	71	72
-	-	-	-	-	-	-
-	-	-	-	-	-	-
66	67	68	69	70	71	72
760,160	761,110	762,061	763,014	763,968	764,923	765,879
73	74	75	76	77	78	79
72,000	71,333	70,667	70,000	69,333	68,667	68,000
71,333	70,667	70,000	69,333	68,667	68,000	67,333

73	74	75	76	77	78	79
-	-	-	-	-	-	-
-	-	-	-	-	-	-
73	74	75	76	77	78	79
766,836	767,795	768,755	769,716	770,678	771,641	772,606
80	81	82	83	84	85	86
67,333	66,667	66,000	65,333	64,667	64,000	63,333
66,667	66,000	65,333	64,667	64,000	63,333	62,667
80	81	82	83	84	85	86
-	-	-	-	-	-	-
-	-	-	-	-	-	-
80	81	82	83	84	85	86
773,571	774,538	775,506	776,476	777,446	778,418	779,391
87	88	89	90	91	92	93
62,667	62,000	61,333	60,667	60,000	59,333	58,667
62,000	61,333	60,667	60,000	59,333	58,667	58,000
87	88	89	90	91	92	93
-	-	-	-	-	-	-
-	-	-	-	-	-	-
87	88	89	90	91	92	93
780,366	781,341	782,318	783,296	784,275	785,255	786,237
94	95	96	97	98	99	100
58,000	57,333	56,667	56,000	55,333	54,667	54,000
57,333	56,667	56,000	55,333	54,667	54,000	53,333
94	95	96	97	98	99	100
-	-	-	-	-	-	-
-	-	-	-	-	-	-
94	95	96	97	98	99	100
787,219	788,203	789,189	790,175	791,163	792,152	793,142
101	102	103	104	105	106	107
53,333	52,667	52,000	51,333	50,667	50,000	49,333
52,667	52,000	51,333	50,667	50,000	49,333	48,667
101	102	103	104	105	106	107
-	-	-	-	-	-	-

-	-	-	-	-	-	-	-
101	102	103	104	105	106	107	
794,133	795,126	796,120	797,115	798,112	799,109	800,108	
108	109	110	111	112	113	114	
48,667	48,000	47,333	46,667	46,000	45,333	44,667	
48,000	47,333	46,667	46,000	45,333	44,667	44,000	
108	109	110	111	112	113	114	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
108	109	110	111	112	113	114	
801,108	802,110	803,112	804,116	805,121	806,128	807,135	
115	116	117	118	119	120	121	
44,000	43,333	42,667	42,000	41,333	40,667	40,000	
43,333	42,667	42,000	41,333	40,667	40,000	39,333	
115	116	117	118	119	120	121	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
115	116	117	118	119	120	121	
808,144	809,154	810,166	811,179	812,193	813,208	814,224	
122	123	124	125	126	127	128	
39,333	38,667	38,000	37,333	36,667	36,000	35,333	
38,667	38,000	37,333	36,667	36,000	35,333	34,667	
122	123	124	125	126	127	128	
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	
122	123	124	125	126	127	128	
815,242	816,261	817,281	818,303	819,326	820,350	821,376	
129	130	131	132	133	134	135	136
34,667	34,000	33,333	32,667	32,000	31,333	30,667	30,000
34,000	33,333	32,667	32,000	31,333	30,667	30,000	29,333
129	130	131	132	133	134	135	136
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
129	130	131	132	133	134	135	136

822,402	823,430	824,460	825,490	826,522	827,555	828,590	829,625
137	138	139	140	141	142	143	144
29,333	28,667	28,000	27,333	26,667	26,000	25,333	24,667
28,667	28,000	27,333	26,667	26,000	25,333	24,667	24,000
137	138	139	140	141	142	143	144
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
137	138	139	140	141	142	143	144
830,662	831,701	832,740	833,781	834,823	835,867	836,912	837,958
145	146	147	148	149	150	151	152
24,000	23,333	22,667	22,000	21,333	20,667	20,000	19,333
23,333	22,667	22,000	21,333	20,667	20,000	19,333	18,667
145	146	147	148	149	150	151	152
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
145	146	147	148	149	150	151	152
839,005	840,054	841,104	842,156	843,208	844,262	845,318	846,374
153	154	155	156	157	158	159	160
18,667	18,000	17,333	16,667	16,000	15,333	14,667	14,000
18,000	17,333	16,667	16,000	15,333	14,667	14,000	13,333
153	154	155	156	157	158	159	160
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
153	154	155	156	157	158	159	160
847,432	848,492	849,552	850,614	851,677	852,742	853,808	854,875
161	162	163	164	165	166	167	168
13,333	12,667	12,000	11,333	10,667	10,000	9,333	8,667
12,667	12,000	11,333	10,667	10,000	9,333	8,667	8,000
161	162	163	164	165	166	167	168
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
161	162	163	164	165	166	167	168
855,944	857,014	858,085	859,158	860,231	861,307	862,383	863,461
169	170	171	172	173	174	175	176

8,000	7,333	6,667	6,000	5,333	4,667	4,000	3,333
7,333	6,667	6,000	5,333	4,667	4,000	3,333	2,667
169	170	171	172	173	174	175	176
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
169	170	171	172	173	174	175	176
864,541	865,621	866,703	867,787	868,872	869,958	871,045	872,134
177	178	179	180	181	182	183	184
2,667	2,000	1,333	667				
2,000	1,333	667	0				
177	178	179	180	181	182	183	184
-	-	-	-				
-	-	-	-				
177	178	179	180	181	182	183	184
873,224	874,316	875,408	876,503	877,598	878,695	879,794	880,893
185	186	187	188	189	190	191	192
185	186	187	188	189	190	191	192
185	186	187	188	189	190	191	192
881,995	883,097	884,201	885,306	886,413	887,521	888,630	889,741
193	194	195	196	197	198	199	200
193	194	195	196	197	198	199	200
193	194	195	196	197	198	199	200
890,853	891,967	893,082	894,198	895,316	896,435	897,556	898,677
201	202	203	204	205	206	207	208
201	202	203	204	205	206	207	208
201	202	203	204	205	206	207	208
899,801	900,926	902,052	903,179	904,308	905,439	906,570	907,704
209	210	211	212	213	214	215	216
209	210	211	212	213	214	215	216
209	210	211	212	213	214	215	216
908,838	909,974	911,112	912,251	913,391	914,533	915,676	916,821
217	218	219	220	221	222	223	224
217	218	219	220	221	222	223	224
217	218	219	220	221	222	223	224
917,967	919,114	920,263	921,413	922,565	923,718	924,873	926,029

225	226	227	228	229	230	231	232
225	226	227	228	229	230	231	232
225	226	227	228	229	230	231	232
927,186	928,345	929,506	930,668	931,831	932,996	934,162	935,330
233	234	235	236	237	238	239	240
233	234	235	236	237	238	239	240
233	234	235	236	237	238	239	240
936,499	937,670	938,842	940,015	941,190	942,367	943,545	944,724

Representative Model:	Index Value	Index
Large-Scale: Industrial Warehouse (Racks)	2	Small Scale: Red Shipping Conta
Small Scale: Red Shipping Container (Racks)		
Small Scale: Blue Shipping Container (Racks)		
Small Scale: Green Shipping Container (Hanging Panels)		
Large-Scale: Containerized (Rotating Platforms)		

Benefits	
WCB	3.5%
EI 1.4% x 1.88	2.6%
CPP	5.0%
HP	4.0%
<b>Total</b>	<b>15.1%</b>

Number of Employees	Index		
		Manager	Mktg assistant
Large-Scale: Industrial Warehouse (Racks)	1	1	1
Small Scale: Red Shipping Container (Racks)	2	0	0
Small Scale: Blue Shipping Container (Racks)	3	0	0
Small Scale: Green Shipping Container (Hanging P	4	0	0
Large-Scale: Containerized (Rotating Platforms)	5	1	0
	\$/hr	\$ 80.0	\$ 28.0
	Benefits	15.1%	15.1%

Weeks per year	48		
Employee hours per week	Index	CEO	Mktg assistant
Large-Scale: Industrial Warehouse (Racks)	1	40	40
Small Scale: Red Shipping Container (Racks)	2	0	0
Small Scale: Blue Shipping Container (Racks)	3	0	0
Small Scale: Green Shipping Container (Hanging P	4	0	0
Large-Scale: Containerized (Rotating Platforms)	5	40	

Cost with Dashboard Input

Variable Production Costs	\$/kg	0%
Lettuce	\$ 6.50	6.50
Basil	\$ 6.50	6.50
Microgreens	\$ 6.50	6.50



<b>Lease</b>	<i>Warehouse Lease Rate = \$7.00/sg ft. Land Lease Rate = \$2,000 per month</i>		Building size sq. m.
Large-Scale: Industrial Warehouse (Racks)	\$ 560,000	Rent (warehouse)	41,250
Small Scale: Red Shipping Container (Racks)	\$ 12,000	Rent (Industrial Yard)	30
Small Scale: Blue Shipping Container (Racks)	\$ 12,000	Rent (Industrial Yard)	30
Small Scale: Green Shipping Container (Hanging P	\$ 12,000	Rent (Industrial Yard)	30
Large-Scale: Containerized (Rotating Platforms)	\$ -	No Rent (Purchased)	1400
<b>Municipal Tax</b>			0.022
Large-Scale: Industrial Warehouse (Racks)	1	\$ -	
Small Scale: Red Shipping Container (Racks)	2	\$ -	
Small Scale: Blue Shipping Container (Racks)	3	\$ -	
Small Scale: Green Shipping Container (Hanging P	4	\$ -	
Large-Scale: Containerized (Rotating Platforms)	5	\$ 22,022	

<b>Utilities Cost</b>		LED per unit	Units
Large-Scale: Industrial Warehouse (Racks)	1	0.5	3000
Small Scale: Red Shipping Container (Racks)	2		
Small Scale: Blue Shipping Container (Racks)	3	0.7	6
Small Scale: Green Shipping Container (Hanging P	4		180
Large-Scale: Containerized (Rotating Platforms)	5		72800

<b>Operating Overheads</b>		Office	Upfront Office C
Large-Scale: Industrial Warehouse (Racks)	1	3000	20000
Small Scale: Red Shipping Container (Racks)	2	500	2000
Small Scale: Blue Shipping Container (Racks)	3	500	2000
Small Scale: Green Shipping Container (Hanging P	4	500	2000
Large-Scale: Containerized (Rotating Platforms)	5	1000	5000

<b>CapEx</b>		Equipment	Installation
Large-Scale: Industrial Warehouse (Racks)	1	\$ 17,000,000	\$ 1,650,000
Small Scale: Red Shipping Container (Racks)	2	\$ 120,000	\$ 10,000
Small Scale: Blue Shipping Container (Racks)	3	\$ 211,500	\$ 10,000
Small Scale: Green Shipping Container (Hanging P	4	\$ 145,000	\$ 10,000
Large-Scale: Containerized (Rotating Platforms)	5	\$ 1,750,000	\$ 50,000

<b>Capital Sourcing</b>	
Equity	70%
Commercial Bank Loans	30%
Line of Credit	0

Electricity Cost
kwh

<b>Other Costs</b>	
Electricity	0.10
Vehicle Operations	1000
Insurance (0.4% of Capital Expenditure)	0.4%
Business License (monthly)	\$ 83
Photocopier lease	\$ 400

<b>Equipment Costs</b>	
Large-Scale: Industrial Warehouse (Racks)	\$ 17,000,000
Small Scale: Red Shipping Container (Racks)	\$ 120,000
Small Scale: Blue Shipping Container (Racks)	\$ 211,500
Small Scale: Green Shipping Container (Hanging P	\$ 145,000
Large-Scale: Containerized (Rotating Platforms)	\$ 1,750,000

<b>Opening Balance</b>		10%
Large-Scale: Industrial Warehouse (Racks)	\$ 1,700,000	
Small Scale: Red Shipping Container (Racks)	\$ 12,000	
Small Scale: Blue Shipping Container (Racks)	\$ 21,150	
Small Scale: Green Shipping Container (Hanging P	\$ 14,500	
Large-Scale: Containerized (Rotating Platforms)	\$ 175,000	

<b>Professional fees (Accounting and Legal)</b>	
Large-Scale: Industrial Warehouse (Racks)	15000
Small Scale: Red Shipping Container (Racks)	1000
Small Scale: Blue Shipping Container (Racks)	1000
Small Scale: Green Shipping Container (Hanging P	1000
Large-Scale: Containerized (Rotating Platforms)	10000

Large-Scale: Industrial Warehouse (Racks)	The Large-Scale Industrial Warehouse (Rack
Small Scale: Red Shipping Container (Racks)	The Small Scale: Red Shipping Container is o
Small Scale: Blue Shipping Container (Racks)	The Small Scale: Blue Shipping Container (Ra
Small Scale: Green Shipping Container (Hanging Panels)	The Small Scale: Green Shipping Container (l
Large-Scale: Containerized (Rotating Platforms)	The Large-Scale Containerized (Rotating Plat

<b>Taxes</b>	
Federal: Net Tax Rate	15%
Alberta Corporate	8%
Federal: Net Tax Rate (Small Business)	9%
Alberta: Small Business	2%
Capital Gains (Combined top marginal rate AB and Fed)	24%

Percent of Direct Sales (Retail)	Index Value	Index
0%	61	60%

1%  
2%  
3%  
4%  
5%  
6%  
7%  
8%  
9%  
10%  
11%  
12%  
13%  
14%  
15%  
16%  
17%  
18%  
19%  
20%  
21%  
22%  
23%  
24%  
25%  
26%  
27%  
28%  
29%  
30%  
31%  
32%  
33%  
34%  
35%  
36%  
37%  
38%  
39%  
40%  
41%  
42%  
43%  
44%  
45%  
46%  
47%

48%  
49%  
50%  
51%  
52%  
53%  
54%  
55%  
56%  
57%  
58%  
59%  
60%  
61%  
62%  
63%  
64%  
65%  
66%  
67%  
68%  
69%  
70%  
71%  
72%  
73%  
74%  
75%  
76%  
77%  
78%  
79%  
80%  
81%  
82%  
83%  
84%  
85%  
86%  
87%  
88%  
89%  
90%  
91%  
92%  
93%  
94%

95%  
96%  
97%  
98%  
99%  
100%

|

ainer (Racks)

Management					
VP Finance	VP Logistics	Horticulturalists	Administrative	Customer service	
1	1	4	1	1	
0	0	0	0	0	
0	0	0	0	0	
0	0	0	0	0	
0	0	2	0	0	
\$ 48.0	\$ 48.0	\$ 48.0	\$ 23.0	\$ 20.0	
15.1%	15.1%	15.1%	15.1%	15.1%	

Management					
VP Finance	VP Logistics	Horticulturalists	Administrative	Customer service	
40	40	40	40	40	
0	0	0	0	0	
0	0	0	0	0	
0	0	0	0	0	
		40			

Input Cost Index		
-20%	3	0%
-10%		
0%		
10%		
20%		

3.28
dollars per sq. m fixed utilities
135,300
98
98
98
4592

LED Costs			H	
\$/kWh	Operating hours	Total LED	HVAC per unit	Units
0.1	4928	\$ 739,200	0.011	3000
0.1	5840	\$ 2,551	0.349	6
0.1	365	\$ 6,570		
0.1	12	\$ 87,360		

Software	Vehicle Lease	Website	Meals and Travel
100	1500	20000	50000
100	580	2000	4000
100	580	2000	4000
100	580	2000	4000
100	850	20000	15000

Land Price (AB)	Land Prep Costs	Structure	Delivery	Other
0	\$ -	\$ -		600000
0	\$ 10,000	\$ -	5000	
0	\$ 10,000	\$ -	5000	
0	\$ 10,000	\$ -	5000	
\$ 700,000	\$ 150,000	\$ 300,000	\$ 50,000	

0.10
------



s) style vertical farming operating is characterised by being housed in a large closed environment in one of three small-scale shipping container options highlighted for this work. This model is based off (stacks) is one of three small-scale shipping container options highlighted for this work. This model is based on Hanging Panels) is one of three small-scale shipping container options highlighted for this work. This model (forms) is also large scale in the sense that the shipping containers come in sets of 14 units, requiring

Greenhouse Staff			Greenhouse Payroll			
Level 1 - Growers	level 2 - Growers	Level 3- Growers	Maintenance	Drivers	Packaging	
40	12	4	1	4		4
0	0	0	0	0		0
0	0	0	0	0		0
0	0	0	0	0		0
0	0	2	0	2		0
\$ 15.0	\$ 17.5	\$ 22.5	\$ 25.0	\$ 30.0		\$ 15.0
15.1%	15.1%	15.1%	15.1%	15.1%		15.1%

Greenhouse Staff			Greenhouse Payroll			
Level 1 - Growers	level 2 - Growers	Level 3- Growers	Maintenance	Drivers	Packaging	
40	40	40	40	40		40
0	0	0	0	0		0
0	0	0	0	0		0
0	0	0	0	0		0
40				40		

HVAC Costs			Total		CO2 Costs	Heating and Cooling
\$/kWh	Operating hours	Total HVAC				
0.1	4928	\$ 16,262	\$ 755,462			
			\$ 6,620	\$ 110		
0.1	6020	\$ 1,259	\$ 3,810	\$ 375	\$	3,425
0.1			\$ 6,570	\$ 375		
0.1			\$ 87,360			
			\$	7,235		

Opening Balanc	Total
\$ 1,700,000	20,950,000
\$ 12,000	157,000
\$ 21,150	257,650
\$ 14,500	184,500
\$ 175,000	3,175,000

ustrial warehouse. The grow beds are static (i.e. do not rotate or move), and they are stacked on large s  
a U.S. companies technology and data, with at least one example in Alberta. It has static grow beds stack  
ased off a technology currently being supplied by a Canadian company. It incorporates static PVC piping :  
; model incorporates the most technology of the three small-scale options. It differs from the other two s  
g considerable capital expenditure upfront. It differs from the other large-scale option because it comes |

Training	Warehouse / Shipping	Operator
1	4	0
0	0	1
0	0	1
0	0	1
0	0	0
\$ 25.0	\$ 17.5	\$ 48.0
15.1%	15.1%	15.1%

Training	Warehouse / Shipping	Owner Operator
40	40	0
0	0	20
0	0	20
0	0	20
		0

steel industrial shelving. Each grow bed has a row of LED lights suspended above and the nutrients are cycled through the plants. The system is built on PVC shelving and uses fluorescent lights rather than LED lights (which cuts costs upfront). This technology is also capable of being placed in very cold northern climates. There are examples of small-scale options in the way it organizes the space within the shipping container. It hangs vertical growing columns and is pre-built and simply needs to be set up in place at the location. The technology incorporates innovative rotation

through the system with pumps. This vertical farming model requires considerable energy comes prebuilt and is the most affordable option of the three small scale varieties this technology being used at this time in the arctic. This option is more expensive channels from the ceiling of the container, allowing them to fit more growing area providing grow platforms inside the shipping containers which cuts down on labour and t

capital investment upfront. There are already 2-3 examples of this style of vertical farm in Alberta. Data for this is less than the other two small-scale containerized operations highlighted in this work. The LED lighting is per square foot. The hanging channels are pushed from side-to-side as the user tends to the crops. The LED lighting reduces the number of LED lights required. The technology is supplied by a Canadian company and there are already t



This model comes from a Canadian (Alberta) supplier that provides vertical farming equipment to industri

lights are set into hanging "boards" or "panels" that hang between the plants. This technology is currently  
two examples of this technology in Alberta at this time.

ial vertical farming operations.

owned by a U.S. company.

**Small Scale: Red Shipping Container (Racks)**

Vertical Farming Type:

Labour	# of People	Wage Rate(\$/hr)
Manager	0	\$ 80
Marketing assistant	0	\$ 28
VP Finance	0	\$ 48
VP Logistics	0	\$ 48
Administrative	0	\$ 23
Horticulturalists	0	\$ 48
Customer service	0	\$ 20
Level 1 - Growers	0	\$ 15
level 2 - Growers	0	\$ 18
Level 3- Growers	0	\$ 23
Maintenance	0	\$ 25
Drivers	0	\$ 30
Packaging	0	\$ 15
Training	0	\$ 25
Warehouse / Shipping	0	\$ 18
Owner Operator	1	\$ 48

Variables:		
Monthly Revenue	21920	
Monthly Municipal Tax	-	
Monthly Lease	1,000	
Monthly Electricity (LED &	552	
Monthly Fixed Utilities Cost	8	
Monthly Heating and Cooling:	-	
Monthly CO2:	9	
Monthly Office Costs:	42	
Upfront Office Costs	2,000	
Monthly Freight Costs	392	0.58
Monthly Vehicle Lease	580	
Monthly Insurance	40.00	
Opening Balance	12,000	
Monthly Website Maintenance	50	
Upfront Website Cost	2,000	
Software Subscription	100	
Professional Fees	1,000	
Meals and Travel	333	
Photocopier Lease	-	

	Monthly repair costs
Large-Scale: Industrial Warehouse (Racks)	21,250
Shipping Container (Racks - Florescent Lights)	150
Shipping Container (Racks - LED Lights)	264
Shipping Container (Hanging Grow Panels)	181
Large-Scale: Containerized (Rotating Platforms)	2,188

Overtime Wage Rate (\$/hr)	EI, CPP, Benefits (%)	Hours per week	Weeks per year
\$ 120	15.1%	-	48
\$ 42	15.1%	-	48
\$ 72	15.1%	-	48
\$ 72	15.1%	-	48
\$ 35	15.1%	-	48
\$ 72	15.1%	-	48
\$ 30	15.1%	-	48
\$ 23	15.1%	-	48
\$ 26	15.1%	-	48
\$ 34	15.1%	-	48
\$ 38	15.1%	-	48
\$ 45	15.1%	-	48
\$ 23	15.1%	-	48
\$ 38	15.1%	-	48
\$ 26	15.1%	-	48
\$ 72	15.1%	20	48

Sum:

\$/kg

at 1.5% (annual) of equipment

Annual Cost	Monthly Cost
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
53,030	4,419
-	-