MICHAEL R. BUONAGURO

Barrister and Solicitor

24 HUMBER TRAIL
TORONTO, ONTARIO, M6S 4C1
P: (416) 767-1666
F: (416) 767-1666
EMAIL: mrb@mrb-law.com

November 22, 2023

Ms. Nancy Marconi
Registrar
Ontario Energy Board
P.O. Box 2319
26th Floor
2300 Yonge Street
Toronto, ON
M4P 1E4

DELIVERED BY EMAIL

Dear Ms. Marconi

RE: EB-2022-0157-Leave to Construct Application- Panhandle Regional Expansion Project-Enbridge Gas Inc.

Please find attached the responses of Dr. Robert Petro to the undertakings taken by him at the hearing held on November 15, 2023.

Yours very truly,

Michael R. Buonaguro
Encl.

Ontario Greenhouse Vegetable Growers-Dr. Robert Petro

Undertaking Response to Three Fires Group

OGVG to provide the average amount of product OGVG members' export.

Response:

In 2022, Ontario Produced 530,567 metric tons of greenhouse vegetables[1] of which it exported 382,339 metric tons or around 72%. Ontario's greenhouse vegetable exports represent 88% of Canada's 434,241 metric tons of greenhouse vegetable exports. Canada's greenhouse vegetable imports amount to 157,400 metric tons, or 41% of Ontario's exports and 36% of Canada's exports, respectively.

The ratio of imports and exports has remained relatively constant over the last 5 years even as the trade volume has increased by almost 100,000 metric tonnes. The expansion trade volumes are a direct indicator of how Ontario's greenhouse sector provides food security to Ontario, Canada, and North America. Canada remains a net importer of fruits and vegetables, including from greenhouses, in the winter months when outdoor domestic production is not possible. In return Canadian exports stabilize the North American market.

[1] https://agriculture.canada.ca/sites/default/files/documents/2023-10/greenhouse_veg_mushroom_2022-eng.pdf

Ontario Greenhouse Vegetable Growers-Dr. Robert Petro

Undertaking Response to Ontario Energy Board Staff

OGVG to file its growth study.

Response:

The OGVG's Ontario Growth and Sustainable Prosperity Study[2] and its Executive Summary[3] are attached.

[2] https://2b0cf34b-25d1-489b-91fd-6bfe02d4a274.usrfiles.com/ugd/2b0cf3_073a2fe466d844469d99b41aaffd944a.pdf
[3] https://2b0cf34b-25d1-489b-91fd-6bfe02d4a274.usrfiles.com/ugd/2b0cf3_37e747d17148442899374d901201d4e3.pdf

AIRM

Ontario Growth and Sustainable Prosperity Study 2023

INTRODUCTION

Ontario's greenhouse vegetable sector plays an important role in promoting food security, helping to feed a growing population. The resulting impacts from the COVID-19 pandemic and other international trade disruptions have shown the importance of domestic self-reliance in food production, providing a local source of fresh sustainable food throughout the year. With favourable trends and other positive opportunities, including the adoption of innovative technologies and practices leading to efficiencies and a transition to a lower-carbon economy, the greenhouse sector is well-positioned for growth. However, at the same time there are also key issues to address to help ensure the long-term stability and viability of the sector. Examples include labour shortages, rising input costs, spread of infectious plant pathogens, government regulation leading to new costs and burdensome administration, supply chain disruptions, and inflation impacting demand.

The purpose of this Growth and Sustainable Prosperity study is to undertake a comprehensive analysis and development of a growth strategy for the greenhouse vegetable sector in Ontario. An Enterprise Risk Management (ERM) tool is developed to identify and quantitatively assess core sectoral inhibitors and enablers to create a better understanding of the current state of the greenhouse industry, investigate potential challenges, and highlight opportunities. The main outcome is to establish a common fact-base of key factors and imperatives needed to drive prosperity for the sector.

AIRM

AIRM Consulting Ltd. is an integrated team of scientists and engineers, building transformative solutions to solve some of the most complex challenges. Powered by a design driven innovation process, artificial intelligence (AI) is brought into the heart of day-to-day operations, delivering high-impact statistical insights, predictive models, and end-to-end business solutions. Core to AIRM's business is applying AI for applications in insurance and risk management, including specialization in the world's largest industry - agriculture.

With subject-matter expertise in areas such as actuarial science, insurance and risk management, economics, data science, and engineering, AIRM is dedicated to providing knowledge and expertise and helping clients uncover new capabilities and solutions.

Lead Researchers
Dr. Lysa Porth, MBA, PhD
Shawn Paladeau, ASA
Sheron Quereshi, MActSc, ASA
Jason Jiang, MSc, ASA

contact@airmconsulting.com
www.airmconsulting.com

BIG IMPACT

The Canadian greenhouse vegetable industry is not only a significant contributor to Ontario's economy but also has a significant impact on the Canadian economy as a whole. The industry's farm gate value is $2B, with Ontario contributing $1.3B, and it generates thousands of jobs throughout the entire value chain. Additionally, the industry's commitment to sustainability and innovation positions it as a leader in the global marketplace, contributing to job creation, regional development, and supply chain support nationally. With the growing demand for locally grown, fresh, and sustainable produce, the Canadian greenhouse vegetable industry is well-positioned to meet this demand, further contributing to the sector's economic significance on a national level.

$2.3

BILLION

To Ontario GDP

71%

SHARE

Ontario greenhouse vegetable production in Canada

$1.3

BILLION

To Ontario farm gate value

81.6%

SHARE

Ontario export volume of greenhouse vegetables in Canada

3,800

ACRES

Greenhouse vegetables grown across Canada

32,000+

JOBS

Attributed to the greenhouse vegetable sector in Ontario

9,500

LOW SKILL JOBS

Attributed to the greenhouse vegetable sector in Ontario

22,500

HIGH SKILL JOBS

Attributed to the greenhouse vegetable sector in Ontario

308

EXECUTIVE JOBS

Attributed to the greenhouse vegetable sector in Ontario

CURRENT STATE OF ONTARIO'S VEGETABLE GREENHOUSE INDUSTRY

Canada's greenhouse vegetable industry is known for being technologically advanced and innovative. It has a long history of success in the global marketplace and a reputation for producing high-quality, safe, and sustainable products. This has been achieved through investments in research and development, the adoption of cutting-edge technologies and practices, and the use of efficient and environmentally friendly production methods. The industry's farm gate value is $1.3B, with Ontario contributing $2.3 billion to the provincial GDP.

Ontario, despite accounting for 66% of Canada's greenhouse vegetable value by farmgate, dominates 71% of the harvested acres. The sector generates significant revenue through both local and international markets, with Southern Ontario being a major production hub. In addition, the industry provides over 32,000 jobs for local residents and thousands more throughout the entire value chain. The industry's projected growth rate of 5% annually for the next decade highlights its potential for further job creation and economic contribution. Furthermore, the greenhouse vegetable industry is an environmentally sustainable and efficient method of food production, with an average yield efficiency of 15:1 compared to traditional field farming. This efficiency allows for the production of more food per unit of land and water, promoting food security and sustainable agriculture in Canada. The industry's commitment to sustainability and efficiency makes it a model for environmentally conscious food production practices. Furthermore, with the growing demand for locally grown, fresh, and sustainable produce globally, the Canadian greenhouse vegetable industry is well-positioned to meet this demand, both locally and internationally, further contributing to the sector's economic significance. The industry's dedication to producing high-quality, safe, and sustainable products, coupled with its technological advancements and innovative practices, positions it as a leader in the global marketplace.

Many greenhouse vegetable producers in Ontario sell their products through retail channels to consumers, as well as to the US retail market. The greenhouse vegetable industry in Canada exports a significant portion of its products to the US, with the US accounting for 99% of all Canadian greenhouse vegetable exports. Ontario contributes 86.1% to Canada's greenhouse vegetable exports. The proximity of the Canadian greenhouse vegetable industry to the US border provides several advantages for growers, including access to large consumer markets, well-developed transportation networks, and favourable growing conditions. This allows greenhouse growers to efficiently access markets and transport their products while benefiting from ideal growing conditions that facilitate efficient and productive agriculture operations.

Canada's greenhouse vegetable sector has emerged as a leading producer of greenhouse products in North America, experiencing significant growth and success across the country, especially in Ontario. The sector's success can be attributed to its strong commitment to innovation, sustainability, and quality, resulting in significant capital investments in high-tech greenhouses. These investments have enabled growers to adopt cutting-edge technologies and practices, such as controlled environment agriculture, precision irrigation, and integrated pest management, to increase efficiency, productivity, and competitiveness while producing high-quality, safe, and sustainable products. The increasing consumer demand for locally grown, fresh produce has also contributed to the sector's growth and success. The greenhouse vegetable sector's growth is expected to continue, with an estimated annual growth rate of 5%. Projections for farm gate, export value, and production value are shown in the table below, indicating a positive outlook for the industry's future:

Year	Farmgate	Export Value	Production Value
2022	$1,380,146,250	$1,185,977,100	365,910
2023	$1,449,153,563	$1,245,275,955	384,205
2024	$1,521,611,241	$1,307,539,753	403,416
2025	$1,597,691,803	$1,372,916,740	423,586
2026	$1,677,576,393	$1,441,562,577	444,766
2027	$1,761,455,212	$1,513,640,706	467,004

However, the operating expenses for vegetable greenhouse operators have significantly increased. In 2021, labour costs accounted for 32% of the operating expenses, followed by other operating expenses at 24%, and other crop expenses at 19%. Fuel expenses, plant material purchases for growing, and electricity expenses also contributed to the overall operating costs, with electricity expenses growing by 59% between 2017 to 2021. Additionally, labour costs, other crop expenses, and plant material purchases for growing each increased by 48%, while other operating expenses grew by 23% and fuel expenses grew by 11%.

Both the greenhouse vegetable sector and the automotive industry encounter intense competition, substantial capital investment requirements, and the need to manage operating expenses. The automotive industry focuses on advanced technologies like automation, robotics, and supply chain optimization to enhance efficiency, productivity, and product quality. Similarly, the greenhouse vegetable sector invests in cutting-edge greenhouses, computer-controlled climate systems, hydroponics, and LED lighting to create an optimal environment for plant growth and yield.

Both industries compete fiercely to produce the most efficient, innovative, and high-quality products, whether it be vehicles or fresh, sustainable produce. Managing operating expenses, including labour costs, remains crucial for their success. Despite the challenges, both sectors' dedication to innovation, sustainability, and quality has brought significant economic benefits to Canada.

The greenhouse vegetable sector in Ontario is experiencing remarkable growth, with new facilities being built and upgraded at a rate comparable to constructing an automotive factory every three years. For example, the Stellantis EV Battery plant in Windsor represents a substantial private investment of $5 billion, creating 3,000 jobs. In contrast, the greenhouse vegetable sector has the potential to attract over $6 billion in investments with government assistance, leading to the creation of more than 32,000 jobs within a similar timeframe. Moreover, the greenhouse vegetable sector continuously attracts substantial investments, surpassing the frequency of new automotive plant establishments, where typical investments hover around $500 million. Both industries are significant contributors to Canada's economy. Despite facing challenges, they have demonstrated resilience and dedication in driving economic growth through strategic investments in advanced technologies and sustainable practices.

HIGHLIGHTS

Some of the factors that contribute to this potential include a favourable climate, market demand, technology, growing population, government support, and export potential. Ontario has experienced milder winters and long summers over the years due to changing climates that allow for year-round crop production in greenhouses. There is also a growing demand for locally sourced produce in Ontario, as consumers become increasingly interested in eating fresh, healthy food that is grown close to home. Advances in technology, such as climate control systems, LED lighting, the integration of automation and robotics, renewable energy systems, and the implementation of precision farming techniques have made greenhouse cultivation more efficient and sustainable. As adoption continues to increase, it is expected that further efficiencies will be realized. The increasing adoption of greenhouse vegetable production methods is not only beneficial to the economy but also supports healthy eating habits. As the popularity of greenhouse-grown vegetables continues to increase, it is expected that further efficiencies will be realized, leading to an even greater supply of fresh and healthy produce. Moreover, Ontario's population is projected to continue to grow in the future, which will increase the demand for food, including fresh fruits and vegetables. The greenhouse vegetable industry is well-positioned to meet this demand and support healthy eating habits for Canadians. Ontario's proximity to the US market also provides an opportunity to export fresh produce to the US, which would further increase the greenhouse sector's growth potential. The government of Ontario has been actively supporting the growth of the greenhouse sector, along with other value chain participants through investment in improved infrastructure.

Prosperity

The multiplier effect is a crucial factor in the greenhouse vegetable industry's growth in Ontario, as it generates positive economic activity beyond the industry itself. As the industry expands, it creates demand for related sectors such as logistics and transportation, leading to the creation of new job opportunities. These indirect and induced economic activities and opportunities, in turn, promote economic development, contributing to the overall economic health of the region. The multiplier effect also supports the growth of small and medium-sized businesses in the area. As the greenhouse industry expands, it generates demand for local goods and services, providing opportunities for local businesses to grow and thrive. This fosters a cycle of economic development, with the greenhouse industry contributing to the growth of local businesses, which in turn supports the industry's growth. The multiplier effect is an important aspect of the region's economic vitality, supporting economic growth and job creation. The table below shows that the industry's gross payroll is approximately $1.68 billion, with almost $502 million spent back into the operationally significant regions. The greenhouse industry provides jobs for workers of different skill levels with salaries ranging from $43,827.00 to $500,000.00. The significance of the multiplier effect should be incentive to creating a conducive environment that encourages economic development in the region.

Job Type	Base Salary	Total Payroll	Workers Contribution to Community	Total Community Spend
Low Skill	$43,827	$416.31 M	$13,148	$124.89 M
High Skill	$52,175	$1.174 Bn	$15,652	$356.86 M
Owner	$500,000	$71.50 M	$150,00	$21.45 M
Chief Officer Level	$300,000	$6.00 M	$90,000	$10.80 M
Vice President Level	$400,000	$4.50 M	$120,000	$5.40 M
Total	-	$1.67 Bn	-	$501.74 M

Job Growth

The growth of the greenhouse vegetable industry in Ontario has led to job creation not only within the industry but also in related businesses. This includes skilled labour and management positions as well as jobs in suppliers of seed, fertilizers, equipment, and packaging materials. The expansion of the industry has also led to job growth in transportation and logistics, as well as in retail and food service where the produce is sold. The industry's continued growth and success will create even more job opportunities and contribute to the economic prosperity of the region.

Locally Sourced Food and Export Opportunities

The expansion of greenhouse cultivation in the region has also helped to increase the availability of locally grown produce, which has provided consumers with fresher, healthier options and at the same time has helped to support local farmers. As a significant exporter of fresh produce, particularly to the United States, the greenhouse industry has been an important contributor to the economy of Ontario.

Technology and Research and Development

More recently, the industry has been investing in advanced technologies, which has helped to improve the efficiency and sustainability of the sector. This is contributing to a reduction in the cost of production and an increase in the quantity and quality of produce. The industry's reliance on advanced technologies and sustainable practices also has a positive impact on the local economy. The use of renewable energy, precision farming, and automation not only improves the efficiency and sustainability of the industry but also leads to innovation and new business opportunities. It also attracts research and development activities, thereby boosting innovation and the knowledge-based economy.

Sustainability

The greenhouse industry in Ontario is at the forefront of sustainable agriculture, actively working towards reducing its carbon footprint and adopting sustainable practices. Many greenhouse operators are utilizing renewable energy sources like solar panels and geothermal systems to power their operations, promoting the development of renewable energy in the region. The industry is also adopting precision farming techniques and automated systems that control lighting, temperature, and humidity to optimize crop growth and conserve energy. This technology-driven approach is particularly relevant to greenhouse vegetable production, where precision farming helps to optimize resource use and reduce waste. Recycling systems like rainwater harvesting, greywater recycling, and composting are being implemented to minimize waste and reduce water consumption.

Moreover, many greenhouse operators are exploring carbon offset programs and markets to sell carbon credits and offset their emissions. This generates additional income for the industry while supporting the development of sustainable energy and low-carbon projects. The OGVG Hydrogen Integrated Greenhouse Studies is a prime example of the industry's innovative approach to sustainable agriculture. By identifying optimal CO2 levels and modeling blended fuel ratios, growers can ensure crops receive the optimal dose of CO2 while not producing any further CO2 beyond the net-zero threshold.

The greenhouse industry's commitment to sustainability and innovation is evident through its adoption of sustainable practices and exploration of new technologies. By reducing its environmental impact and promoting sustainable agriculture, the industry is contributing to the overall health and wellbeing of the region.

Infrastructure and Utilities

The greenhouse vegetable industry in Ontario faces a significant obstacle due to the lack of modern infrastructure and utilities, including transportation, communication networks, water supply, and waste management systems. The absence of these essential resources makes it challenging for growers to access them and transport products to the market, leading to reduced competitiveness and profitability. To facilitate the growth of the greenhouse sector and other agriculture businesses, the government must prioritize investment in infrastructure, especially in rural areas. The private sector and the government are collaborating on infrastructure initiatives aimed at improving access and supporting the industry's growth. The industry requires a reliable and clean water supply for crop growth, and the proper disposal of waste materials is essential to minimize environmental impact. Therefore, reliable and efficient infrastructure is crucial to support the greenhouse vegetable industry's continued growth and success in Canada.

Greenhouses require significant energy for heating, lighting, and equipment used in the production process. As the Canadian greenhouse vegetable industry moves towards lit production, the energy demand is increasing. Access to reliable electricity is essential for the industry's efficient operation. Although many greenhouse operations in Ontario use natural gas to heat their facilities, the government is pushing for a transition towards electric heating. However, feasibility remains a challenge due to factors such as lack of electricity, insufficient infrastructure, and high electricity costs. These issues must be addressed to successfully transition the industry to sustainable energy sources. Infrastructure and utilities such as transportation, energy, water, and natural gas pipelines are critical for the growth of the greenhouse industry in Ontario, ensuring efficient and sustainable operations.

Rising energy costs in the Ontario greenhouse sector have been a significant challenge for many growers. The increasing prices of electricity and natural gas, the primary sources of energy for greenhouses, have resulted in higher operating costs and decreased profitability. While the Ontario government has implemented programs to help the greenhouse sector reduce energy costs and improve efficiency, many growers are still struggling to keep pace with the rising costs. Some stakeholders criticize the program's accessibility, with restrictive eligibility requirements that limit the number of growers who can benefit from it. Additionally, there have been concerns about the program's transparency regarding the application process and decision-making criteria, which are perceived to be complicated and vague. The government could consider reforming the low-cost agriculture energy rate class to make it more accessible to all growers in the Ontario greenhouse sector. Furthermore, the industry must continue exploring new technologies and practices to lower energy costs and improve competitiveness.

PROJECT OBJECTIVES

In this study, an Enterprise Risk Management (ERM) framework is developed to comprehensively examine the interplay of the dynamic risks and opportunities facing the greenhouse vegetable sector in Ontario, to construct a holistic set of recommendations to help drive growth and prosperity. The research and analysis undertaken in this project has demonstrated the potential for high growth across the Ontario greenhouse vegetable sector, as measured by:

- ERM-driven present value cash flow analysis over a 5-year period for various greenhouses operating in the province. This is based on identifying, assessing, and prioritizing potential risks to the sector's capital and earnings, and the potential impact of various risks on the sector's ability to generate positive cash flow.

- Increases in output, as measured by total 5-year change in revenue, and profit, per acre, calculated as an average across various vegetable greenhouses in the province.

These metrics have been calculated and compared across various plausible scenarios, which may arise and be influenced by the actions or inactions of relevant stakeholders, that could impact the Ontario greenhouse vegetable sector. The values have been derived from the actual experience of vegetable greenhouses operating across Ontario, of various sizes and crop portfolios.

KEY FINDINGS

For each greenhouse analyzed on an individual level, the projected increases in the present value of profit, averaged over each modeled optimistic scenario, ranged from 17% to 128%. The variability in results is due to differences in various operating features, such as expense structure and crop diversification.

When assessing the production output of all greenhouses considered, the analysis was conducted at an aggregate level, with both optimistic and adverse scenarios identified as having the most significant potential impact on growth and decline. These scenarios were found to affect multiple factors, with gains or losses quantified as a percentage. The results are relevant to the entire sector, and the modeled optimistic scenarios project an increase in revenue-per-acre and profit-per-acre ranging from 4% to 13% and 2% to 62%, respectively, as shown in the tables below. It's important to note that even seemingly small gains in revenue and profit can have a substantial effect when applied to a larger scale, given the size and importance of the greenhouse vegetable sector. However, the lack of modern infrastructure remains a significant obstacle to the sector's expansion, emphasizing the need for infrastructure improvement to enable significant returns on sectoral growth. These gains are expected to have a ripple effect on local, regional, and national economies through job creation, community spending, regional development, and support of related industries in the sector's supply chain.

Overall, the findings indicate a potential for growth and prosperity in the Ontario greenhouse vegetable sector, underlining the importance of implementing risk management strategies to support this growth. The development of such strategies should consider infrastructure improvement and other enablers that generate growth opportunities.

Optimistic Enablers Generating Growth Opportunities

Scenario	Description	Impacted Variables	5 Year Gain
1	Optimizing growing variables	Yield, pricing, input costs	62%
2	Trade harmonization and demand	Pricing, trade & market access	58%
3	Innovative technology implementation	Input costs/savings, yield	39%
4	Reduced regulatory burden	Labour costs, yield	48%
5	Climatic impacts on outdoor agriculture	Yield, pricing, input costs	49%
6	Access to and optimizing infrastructure	Input costs	2%
7	Increased automation to reduce challenges	Labour costs, yield	46%

Adverse Impacts Inhibiting Enablers

Scenario	Description	Impacted Variables	5 Year Gain
1	Lack of labour supply	Labour costs	(27%)
2	Increasing regulations (Housing, workers)	Labour costs, other costs	(37%)
3	Lack of trade harmonization	Selling price	(50%)
4	Oversupply due to trade, regulation, disease	Selling price	(89%)
5	Inflationary and input cost pressures	Production & labour costs, selling price	(51%)
6	High workforce turnover (less skilled workforce)	Yield, quality, operating costs	(59%)
7	Decreasing demand for vegetables	Selling price	(107%)
8	Greater crop threats (pests and disease)	Yield, labour & input costs	(40%)
9	More frequent severe weather events	Production, operating costs	(53%)

The analysis conducted in this study demonstrates that the greenhouse vegetable sector in Ontario is well positioned for both public and private investment opportunities. The benefits that are expected to arise from the growth of the sector are significant, as discussed above, and include increases in national GDP, enhanced food security, and a strengthened position for Canada in the international agricultural market. Further benefits, which extend to all stakeholders across the province, include expansion of job opportunities across the labour pool, growth of various industries, and benefits to consumers in surrounding communities and across the province.

As with any investment, fostering the growth of the sector through government support and private investment involves risks and challenges. Some primary risks and challenges highlighted from an in-depth analysis of the current state of the sector, along with forecasts of likely developments pertinent to the viability of the sector, include:

Market risk, such as the selling price driven demand is not adversely impacted by competing sectors; input costs do not rapidly increase unexpectedly.

Operational risk, such as ensuring there is sufficient infrastructure to support the sector; ability to adapt to changes in climate and environment, such as increases of harmful pathogens in surrounding environments.

Strategic risk, such as diversification in terms of growing the crop portfolio; overall changes in consumer trends for greenhouse products is maintained and continues to grow; the ability to exploit current technological innovations to attain a competitive edge internationally; disruptions to supply changes, as seen during COVID19.

Additional modelling to support the quantitative analysis included scenario modelling concerning downside risk, which finds the potential decrease in the present value of profit, as an average for each identified downside risk, ranges from -23% to -178% for each modelled vegetable greenhouse. When considering changes to production outputs, changes ranged from -6% to -23%, and -27% to -107%, for revenue per acre, and profit-per-acre, respectively.

To realize the potential growth of the Ontario greenhouse vegetable sector and its subsequent benefits for all stakeholders, industry leaders must adopt a comprehensive and robust prosperity strategy. This should include a primary focus on mitigating the most likely risk events that may have the greatest impact on prosperity. Moreover, for each corresponding mitigation strategy, the growth strategy should consider the potential to exploit each risk event as an opportunity to enhance growth.

Key components that should be considered in the growth and prosperity strategy include:

- Harmonizing trade and regulations with the United States, including updating a North American Perimeter Approach.
- Reducing regulatory burdens and collaborating with the government.
- Improving risk management and insurance programs tailored to the unique needs of the greenhouse sector.
- Investing in provincial infrastructure expansion, such as water, sanitary sewer, electrical, and roads.
- Enhancing utility usage with available government support and incentives.
- Adopting a strategy to optimize utility usage with available government support and incentives to support implementation.
- Considering greenhouse labour needs within temporary foreign worker programs and immigration approval processes.
- Need for investment in training and education programs to ensure a skilled workforce capable of meeting the demands of the greenhouse vegetable sector.
- Aging workforce from source countries and reliance on current countries may lead to risks as the Temporary Foreign Worker (TFW) programs have fewer younger workers enlisting
- Prioritizing the acquisition and implementation of newly developed technology for greenhouse production.
- Establishing government financial support and incentives to support individual greenhouses in adopting strategies into long-term business planning.
- Establishing incentives to lower the cost of capital for new market entrants and smaller-sized operations within the greenhouse sector.
- Establishing partnerships between universities and greenhouses to facilitate new research and development, including opportunities for student co-op work and research.
- Increasing crop portfolio diversity within individual greenhouses can help to manage risks and create new opportunities for growth. Additionally, adding new crops to the portfolio in the future can further diversify the sector and enhance its resilience.
- Creating or expanding programs that provide grants or financial incentives to companies and start-ups that specialize in technology applicable within the greenhouse sector.
- Establishing a framework for a carbon-offsetting program.
- Increase trade access by pursuing trade agreements and reducing trade barriers.
- Prioritize pest risk mitigation by implementing integrated pest management and developing contingency plans.
- Develop a competitive advantage by differentiating Ontario greenhouse vegetables from products of other countries and exploring new marketing channels.
- Monitor and address trade actions that may affect export and diversify export markets.

Enterprise Risk Management Framework

Enterprise risk management (ERM) is a holistic approach used to identify, measure, and respond to key risks that could impact the stability, profitability and future growth of an industry or organization. The primary purpose is to facilitate all relevant stakeholder objectives, through assisting any decision-making process by considering the tradeoffs between risk and reward; with an emphasis on value-creation and the optimal allocation of resources. In the context of this project, the industry of focus is the Ontario greenhouse vegetable sector, whose stakeholders include greenhouse owners/employees, government agencies, agricultural market buyers/sellers and the many communities across the province where greenhouses reside.

Greenhouse agriculture represents a significant portion of the industry in several municipalities across the province, contributing to the provincial GDP and export values. With over 3,800 acres of greenhouse vegetable production, the sector produces consistent year-round yields of tomatoes, cucumbers, and peppers, and is diversifying into other crops such as berries, lettuces, and melons. The provincial allocation of greenhouse agriculture in 2022 is led by Leamington with 1,968 acres, followed by Kingsville, Chatham-Kent, Niagara, Hamilton, and other regions. The greenhouse vegetable sector is a significant economic powerhouse, contributing over $2.3 billion to the provincial GDP and having a total farmgate value of $1.3 billion. Table 1 provides an overview of how each region in the province contributes to economic activity at the provincial and national levels. By adopting an ERM approach, industry leaders can identify and mitigate risks while also exploiting opportunities for growth, leading to a prosperous and sustainable future for the greenhouse vegetable sector in Ontario.

Table 1: 2022 Regional Impacts of greenhouse vegetable agriculture in Ontario

Region	Acreage	GDP $	Farmgate Value	Export		Production	Jobs	
				Volume (Tn)	Value (CAD)	Volume (Tn)	Labour	Value Chain
Kingsville	947	$573,296,491	$327,632,713	91,233	$281,538,927	127,888	2,368	5,683
Leamington	1,968	$1,191,255,919	$680,789,809	189,574	$585,011,279	26,5740	4,920	11,809
Chatham-Kent	446	$269,876,202	$154,231,316	42,948	$32,532,918	60,203	1,115	2,675
Hamilton	60	$36,330,010	$20,762,206	5,781	$17,841,226	8,104	150	360
Niagara	107	$64,978,568	$37,134,545	10,341	$31,910,183	14,495	268	644
Other	271	$164,262,811	$93,874,411	26,140	$80,667,467	3,6643	678	1,628
Total	3,800	$2,300,000,000	$1,314,425,000	366,017	$1,129,502,000	513,074	32,300	

The outcome of this ERM analysis is to provide a set of recommendations for industry players to facilitate the growth of the Ontario greenhouse vegetable sector. These recommendations will be informed by a comprehensive analysis of the total risk exposure across the sector. The ERM framework defines risk as any uncertainty or deviation from best-estimate forecasts that follows from any decision-making process. The analysis categorizes risk into two types:

Downside risk, which adversely impacts profit and drives the creation of mitigation strategies to prevent any impediment to profit and future growth.

Upside risk, which favourably impacts profit and provides value-creation opportunities. Upside risk should be included in any ERM business strategies to exploit profit and future growth.
The steps in the undertaken ERM process, which make up the individual sections of this report

include:

1. Risk Inventory, which correspond to the Risk Assessment and Identification component of the ERM process.

2. Scenario Modelling and Sensitivity Analysis, which correspond to the Risk Analysis and Modelling component of the ERM process.

3. Conclusion and Recommendation, which correspond to the Risk Evaluation and Response component of the ERM process.

4. An additional section is included on Community Benefits resulting from local greenhouse operations, which were identified from the undertaken analysis.

The primary **objectives and needs** of identified stakeholders concerning the growth and prosperity of the greenhouse sector across Ontario is presented in the table below.

<u>GREENHOUSE OWNERS/OPERATORS</u>

- Effective mitigation techniques/strategies that can be implemented to offset risk events that adversely impact operation/profit when they arise, which considers all risk-types:

  Operational Risk, for example: damage to greenhouse infrastructure (i.e extreme weather events or accidental fire), deterioration or break-down of key equipment, failed human processes such as failure to respond to sub-optimal internal environmental conditions, failure to identify or respond to harmful pathogen.

  Strategic Risk, for example: changes to foreign workers program, higher employee turnover rate, changes to regulations pertaining to agricultural trade, loss of key supplier for farming inputs, failure to keep up with latest technological developments within the sector.

  Market Risk, for example: unfavourable changes to farming input costs, including costs for utilities, increases to minimum wages, higher than expected interest rates expenses when acquiring loans.

- Stable, or favourable changes, in the demand and selling price of Canadian greenhouse vegetable products, both domestically and internationally

- Stable, or favourable changes, to input costs, such as utility expenses (energy pricing)
- Accessible labour pool with job candidates willing to work at reasonable wages.

- Minimal government red-tape, or regulatory oversight, while undertaking an expansion of current greenhouse operations (or in general, less oversight and gatekeepers)

- Establishment of insurance, or, similar government support program, that can be used to mitigate risk while undertaking an expansion of current greenhouse operation.

- Coordination across the sector to ensure diversification of products produced (crop type, acres planted)

- Establish good relations with community, such that any undertaken expansion is welcomed (improve permitting experience).

- Maintain positive image in the community as an industry that provides necessary services that is environmentally friendly and contributes to the community.

- Government initiatives facilitating the growth of the sector, such as introducing programs which expedite processes related to new entrants in the greenhouse sector, policies that reduce barriers to hiring foreign workers, regulations that help give greenhouse products a competitive edge in foreign markets, or financial incentive programs (research, energy efficiency retrofits).

- Government programs providing capital investment, or interest free loans, for individual greenhouses undertaking operational expansion or upgrade/adopting facilitates with latest technological developments within the sector.

- Implementation of effective marketing strategy that considers various communication channels reaching all segments of the population.

- Maintain favourable outlook regarding private investment in the sector, with a particular focus on new entrants within the sector and optimizing processes for current entrants.

- Current legislation, and any newly introduced regulations, are fair, reasonable, and easily adaptable by the greenhouse sector. Current regulation that is unnecessarily burdensome (i.e. extensive record keeping) is improved and/or overturned.

- Create opportunities to benefit from being a carbon-deficient industry.

- Continual improvement to greenhouse infrastructure that lowers inputs costs and/or improve efficiency (i.e. improvement in lightening system).

<u>TECHNOLOGY COMPANIES</u>

- Attain opportunities to expand products into new markets and industries.

- Seek opportunities for new technological innovation from addressing industry specific barriers to growth (i.e. automation to address labour shortages, technological solutions to light abatement).

- Increase value of industry by playing a role in food production and domestic food security.

- Attain opportunities for government funding, or research institution partnership, through facilitating the development of technology to support the growth of the sector.

- Provide commercial and scaling opportunities in collaboration with the greenhouse vegetable sector.

UTILITY COMPANIES (ENERGY AND WATER)

- Government support for establishing infrastructure necessary for providing utility services to greenhouse operations.
- Consideration of geographic spread when permitting new entrants into the greenhouse sector, to prevent strain on individual energy (gas, electricity) or water/wastewater provider.
- Ensure accessible education is available to energy-intensive industries concerning the minimization of utility use (i.e. installation of LED lights, light load during peak hours).
- Government support for implementing alternative energy production to lessen load on local utility providers.
- Establish and maintain cooperation between utility companies and industry regarding the scheduling of activities involving heavy usage of energy/water consumption, such that accessing utility services are not burdensome.
- Implementation of programs, policies, or regulations that compel industries to increase efficient use of energy and water.
- Implemented strategy from both private sector and government to support the adoption of cogeneration projects for sectors heavily reliant on utilities services, such as the greenhouse sector.

COMMUNITY

- Minimize the impact of industry operations for residents; whose primary concerns regarding the greenhouse sector include:
  - light abatement
  - traffic volume for shipping
  - pollution and destruction of natural habitat
  - disruption of utility services
  - housing supply and off-farm housing solutions for the offshore workforce

- Foster the expansion of industry/businesses that will contribute to the local economy, either through taxation, spending locally, attracting new commerce to the area and increase tourism.

- Foster the expansion of industry/businesses that will provide employment opportunities for community residents of various ages and levels of education.

- Improve community image through supporting environmentally sustainable industries.

GOVERNMENT

- Growth of the greenhouse sector favourably impacts Canadian GDP, drives job creation, and increases agricultural export.

- Provides less carbon intensive alternative to traditional agriculture, which in turn allows increases to domestic food production while not significantly adding to the national carbon output.

- The growth of the greenhouse sector decreases risk pertaining to food shortages, as it results in more domestic food production that is:
  - Immune from foreign exchange risk
  - More resilient to adverse climate seasons

- Adds competitive landscape to Canadian agriculture sector, both domestically and internationally.

- Provides the opportunity for establishing a carbon-offsetting program (i.e. greenhouse sector is a carbon-deficient industry); helping Canada achieve future greenhouse reduction targets.

- Sector becomes a leader for moving industry towards increasing efficiency of energy consumption and environmentally sustainable production. For example, the adoption of LED lights across the sector.

- Growth of the sector provides job opportunities, contributing to a lowering of the unemployment rate.

- Ensure greenhouse operations adhere to regulatory measures, relevant law, or any governing legislation. For example, minimum wage laws are enforced, taxation rules are followed.

- Provides data/information on voluntary surveys assessing the status and viability of the sector. Establishes communication channels with relevant government agencies.

<u>EMPLOYEES</u>

- Competitive wages that respond to changes in cost-of-living expenses. In addition, the availability insurance benefits.

- Safe work environment with adequate training program for new staff on safety regulations and equipment use. Work environment is not hazardous to health, including air quality circulation, and no exposure to toxic chemicals. Overall safe work environment, with periodic machinery maintenance.

- For foreign, or out of town, workforce, food and rooming accommodation are of high standard.

- Job application process is streamlined and hiring decisions made in a timely manner.

- Provided with education opportunities that increase skill/talent which will improve skill set for future employment.

- Flexibility of work schedule. Accommodation for leave, return to home-country, in the event of emergency.

- Equal and fair treatment of work environment that is free of discrimination regardless of gender, ethnicity, and country of origin.

Risk Inventory

The first step undertaken in the ERM process is the creation of a risk inventory. In the context of the greenhouse growth and prosperity study, risk is defined as any development or event, either internal or external to the operation of a greenhouse, which impacts the future profitability or growth of the sector across Ontario, either favourable or adversely. Consistent with an ERM framework, risks are categorized and identified in the broadest sense. Identifying risks as general as possible helps with consistency for ranking their impact and overall importance for deciding which risks to mitigate, transfer or retain.

In addition to reviewing relevant literature on the status of the sector in Ontario, the creation of the Risk Inventory was largely informed from interviews conducted with different stakeholders, which included greenhouse owners/management, energy providers and NGOs that work within the sector, and government.

The construction of the risk inventory followed the Casualty Actuary Society (CAS) risk categories developed by the Enterprise Risk Management Committee. This includes Hazard, Financial, Operational, and Strategic risk categories. Each is briefly summarized next.

- Hazard Risk. This includes risks arising from liability torts, property damage, natural catastrophe, etc.
- Financial Risk. This combines investment risks and risks that interact between assets and liabilities.
- Operational Risk. This segments risk caused by internal (operational) and external (environmental) causes.
- Strategic Risks This is focused on business competition and trends and includes reputational risk as well.

For each defined risk, realistic scenarios that would likely drive the risk event are provided in Appendix A. The scenarios provide valuable qualitative analytical insight that will form the basis of the following section, Risk Modelling.

The risk inventory is summarized as a heat map. A heat map categorizes each risk by their frequency and severity. For many of the defined risks, there is insufficient data for quantifying their probability of occurrence. Thus, the heat map relies on qualitative information attained from stakeholder interviews, as well as expert judgment acquired from prior ERM studies in other industries with relevant risks analogous to the risk exposure across the Ontario greenhouse vegetable sector. The cells in the map are color coded, with those risks colored in red indicating higher importance.

Table 2: Risk Inventory Heat Map

	Low Frequency	Medium Frequency	High Frequency
High Severity	Failure to adequately fulfill tasks related to health management of greenhouse vegetables/ floriculture Unexpected changes in the accessibility of water Larger than expected pest population in greenhouse Default in payments owed for delivered goods Unexpected changes in foreign exchange rates	Future market demand for greenhouse products is less than expected Unexpected changes in perception regarding greenhouse operation Failure to maintain staffing requirements.	Optimal staffing levels
Medium Severity	Higher than expected amount of food spoilage Actual expenses exceed budgeted expenses in long-term business strategy Unexpected changes in greenhouse farming regulation Failure to exploit technological innovation Failure in transportation logistics Failure to retain/gain new wholesale contracts	Failure to maintain internal greenhouse conditions for optimal growth Unanticipated changes to farming inputs Greater water requirements than expected The frequency of human error involving tasks related to harvest is larger than expected Unexpected changes to trade regulations Unfavourable external Weather Conditions Selling price of products are lower than expected	
Low Severity	Larger than expected pest population in greenhouse Unexpected changes to applicable taxation laws Failure to obtain additional land for expansion Failure to attain an effective marketing strategy	Higher than expected costs of capital.	

Risk Modelling – Scenario Modelling

Scenario modelling is an essential tool used in the ERM process to assess the impact of various risk events on the profitability and production output of greenhouse vegetable operations. By considering the interplay between risks and their specific effects on different components of the sector, scenario modelling enables the creation of a financial model projecting cashflows over a 5-year period for greenhouse operations of different sizes and crop portfolios. An additional model aggregates the outputs of individual greenhouse models, enabling sector-wide analysis of production output.

The key purpose of scenario modelling is to compare and rank various scenarios based on the model output. This information is crucial in developing a growth and prosperity strategy, as it provides valuable quantitative information for decision-making.

DATA AND BASELINE FORECAST

After engaging in discussions with industry experts and analyzing financial and operational data received from four representative Ontario greenhouse vegetable producers, baseline forecasts were developed. These case studies were selected to represent various crop types, mixes, acres, practices, and structures, such as total planted area, plants-per-area, selling price-per-fruit/vegetable, labour and operational expenses, and number of fruit/vegetables sold. Table 3 below provides a summary of the crop types and operational sizes of the participating greenhouse operations.

Table 3: Summary Characteristics by Case Study

	Greenhouse #1 Less than 15 Acres, 1 Crop	**Greenhouse #2** 15 - 40 Acres, 1 Crop	**Greenhouse #3** Less than 15 Acres, Multi-Crop	**Greenhouse #4** >40 acres, Multi-Crop
Crop(s) Grown	1 Crop	1 Crop	Multi-Crop	Multi-Crop
Total Planted Area (square metres)	Less than 15 Acres	15-40 Acres	Less than 15 Acres	15-40 Acres

To create a baseline scenario, or best-estimate financial forecast based on the provided datasets, four assumption sets were derived. The modelling consisted of the following main steps:

- Estimation of the current annual net income for each individual greenhouse. Published data on vegetable greenhouse operations was referenced for modelling assumptions not available from the study's participants. The key variables considered are shown in Appendix A.
- Projection of future annual cash flows. This involved forecasting year-to-year changes in market variables that may impact the vegetable greenhouse sector, such as inflation on inputs, changes in supply and demand for products and changes in size of, and regulation pertaining to, the labour pool, as examples. The baseline projected cash flows assume no expansion or growth strategy is undertaken from stakeholders within the industry.
- Calculation of the Present Value of projected cashflows over a 5-year period, where the net income for each future year is discounted to the current period (using Bank of Canada Bond-Yields). This value is used to quantify and compare the impact of each modelled scenario, by quantifying the percent change to the present value of projected cashflows for each scenario, relative to the baseline projection.

- Quantify the change in production output for the sector, as measured by revenue-per-acre and profit-per-acre, over the 5-year projection period. These values are calculated as a weighted average of the production outputs for each of the individually modelled greenhouses, where weights are assigned based on the estimated proportion each individual greenhouse's crop portfolio comprise of the total production volume of vegetables grown in the Ontario greenhouses sector.

Table 4 provides an overview of the modelled baseline scenario for each greenhouse in the case study.

Table 4: Summary Characteristics by Case Study

	Greenhouse #1	Greenhouse #2	Greenhouse #3	Greenhouse #4
	1 Crop	1 Crop	Multi-Crop	Multi-Crop
	< 15 Acres	15-40 Acres	< 15 Acres	15-40 Acres
Total Income (initial year)	$6,201,270	$10,291,016	$2,920,170	$44,242,206
Total Expenses (initial year)	$4,292,521	$10,168,755	$2,367,486	$38,315,506
Net Cash Flows (initial year)	$1,908,749	$122,261	$552,684	$5,926,700
Time-0 Discounted Cashflows (over 5-year projection)	$10,819,198	$2,468,549	$3,309,202	$35,338,238

SCENARIO MODELLING

The most plausible developments that may impact the future profitability of the vegetable greenhouse sector in Ontario are identified, which are key considerations for developing a growth and prosperity strategy. The considered developments are built into several possible example scenarios for illustration purposes and reflect insights derived from interviews with various stakeholders across the industry and independent research. The scenarios consider developments that are both internal and external to operations within a vegetable greenhouse. Scenarios are modelled by specifying annual changes in relevant model assumptions over a forward-looking 5-year period (2022-2026). The following two tables, Table 5 and Table 5, illustrate each development with relevant model assumptions, which are categorized as either optimistic or adverse future scenarios, respectively.

Table 5: Optimistic Scenarios

Scenario	Scenario Description	Impacted Assumptions
	Optimistic	
1	Optimization of environmental control variables leading to improved crop yield/quality, increased selling price, reduced water costs, and reduced electricity costs. Examples: • Predictive analytics that provide real-time insights to inform optimized environmental conditions (i.e. light, temperature, humidity, CO2, etc. relative to yield and quality)	Fruit/Vegetable crop output per square metre Selling Price per fruit/vegetable Water costs Electricity costs
2	Higher than expected increase in market demand of vegetable greenhouse products, which follows from emerging demographic trends, such as: • Increase value in foods produced locally • Diets that prioritize fresh and healthy fruits/vegetables • Increase value in foods produced with sustainable practices • Crop diversification into crops that are more valuable	Selling Price per fruit/vegetable
3	Successful implementation of technology that includes optimization of environmental control variables and energy usage. This includes reduced input costs associated with optimizing fertilizer and chemicals, water, natural gas, and CoGen savings, in addition to realizing improved crop yield/quality. Examples: • Advanced software and systems control the volume, timing and duration of CO2 released into the greenhouse, considering other variables, such as temperature, humidity, and light. • Several benefits related to increased growth rates and biomass production, reduction in time to plant maturity, and reduction in heat (pending on method can provide heat), fertilization and water costs (reduces transpiration)	Fertilizer and Chemical Costs Natural Gas Costs CoGen Savings Fruit/Vegetable crop output per square metre Water costs
4	Favourable changes to government regulation pertaining to foreign labour, in addition to realizing improved crop yield/quality. Examples: • Improvements in regulation regarding foreign labour reduces administrative burden and costs • Increased availability of foreign labour improves the labour pool resulting in more skilled employees • Crop quality and yield are improved due to a variety of factors related to labour	Labour Costs Fruit/Vegetable crop output per square metre
5	Long-term changes in climate adversely impact outdoor agriculture, resulting in the food industry becoming more dependent on the greenhouse sector, which in turn favourably impacts sales volume and price. the government will introduce more better benefits to carbon-capturing industries to respond to climate change (more incentives for no-carbon agricultural) and investment into renewable energies and sustainable technologies ready for adoption	Fruit/Vegetable crop output per square metre Selling Price per fruit/vegetable CoGen Savings
6	Successful implementation of technology to decrease input (ie. water) usage and costs.	Water costs
7	Adoption of emerging technology to improve greenhouse automation, leading to reduced labour costs, in addition to realizing improved crop yield/quality. Examples include: • Reduction in staffing requirements due to automation of some functions - Reduction in the impact to production related to labour needs • Greater employment appeal for younger portion of labour market, who are more inclined to engage in jobs that involve computers and emerging technology applications • Automation leading to early detection of diseases, resulting in improved crop yield and quality • Automation leading to optimization of crop yield and quality	Labour Costs Fruit/Vegetable crop output per square metre

Table 6: Adverse Scenarios

Adverse		
Scenario	**Scenario Description**	**Impacted Assumptions**
1	Unfavourable changes to temporary foreign workers program, which in turn, adversely impacts foreign labour supply, resulting in a need to increase wages to attract domestic workers	Labour Costs
2	Legislated changes to required housing standards for temporary foreign workers or increased regulation in labour, farm operations, etc.	Labour Costs Other Costs
3	International competitors achieve superior economies of scale and implement emerging technology unavailable in Canada, resulting in lower prices.	Selling Price per fruit/vegetable
4	Factors impacting oversupply of certain fruits/vegetables in the sector, resulting in lower fruit/vegetable prices. Example: • Disease pertaining to certain crop causes a grower to shift to another crop, increasing supply of that crop and lowering prices	Selling Price per fruit/vegetable
5	Inflation impacting input costs for the greenhouse vegetable sector are greater than the extent to which products prices can be increased, in addition to potential decreased demand for fresh fruits/vegetables due to increasing prices.	Production Costs Labour Costs Selling Price per fruit/vegetable
6	Higher than expected employee turnover rate: • Additional expenses for hiring and training • Temporary slowdown in production • Higher proportion of workforce with less experience/skills	Fruit/Vegetable crop output per square metre Other Expenses per square metre
7	Less than expected long-term demand for vegetable greenhouse products (i.e. introduction of crops, alternatives, not commonly produced in greenhouse, which increase in popularity)	Selling Price per fruit/vegetable
8	Greater than expected frequency, and severity, of viruses emerging in vegetable greenhouses across Ontario	Fruit/Vegetable crop output per square metre Total Labour Cost
9	Increase in frequency of severe weather events, resulting in larger than expected repair and routine maintenance costs	Production Costs

To assess and compare the impact of each scenario, the percentage change in the present value of projected cashflows, relative to the baseline scenario, was calculated. To identify similarities and differences in the impact of each scenario, a ranking system was used. It is worth noting that despite variations among the four greenhouse operations in terms of crop types, sizes, structures, etc., there is considerable consistency in the ranking of scenarios. Table 7 and Table 8 below present the ranking results for the optimistic and adverse future scenarios, respectively.

Table 7: Optimistic Impact Rankings by Farm Size

Optimistic Scenario	Greenhouse #1 Less than 15 Acres, 1 Crop	Greenhouse #2 15 – 40 Acres, 1 Crop	Greenhouse #3 Less than 15 Acres, Multi-Crop	Greenhouse #4 >40 acres, Multi-Crop
1	2	1	2	3
2	1	2	1	2
3	6	4	6	6
4	4	6	4	1
5	5	3	5	5
6	7	7	7	7
7	3	5	3	4

Table 8: Ranking of Adverse Scenarios

Adverse Scenario	Greenhouse #1 L Less than 15 Acres, 1 Crop	Greenhouse #2 15 – 40 Acres, 1 Crop	Greenhouse #3 Less than 15 Acres, Multi-Crop	Greenhouse #4 >40 acres, Multi-Crop
1	9	9	9	9
2	8	7	8	4
3	5	6	7	8
4	2	2	2	2
5	7	5	6	7
6	3	4	3	3
7	1	1	1	1
8	4	8	5	6
9	6	3	4	5

To further assess the potential impact of each scenario on the future prosperity of the sector, the change in production output, as measured by revenue-per-acre, and profit-per-acre, were calculated over the 5-year projection period for each scenario. These values are calculated individually for each modelled greenhouse and then combined to provide an average value for the sector. The weights used in the average calculation are equal to the proportion each individual greenhouse's crop portfolio comprise of the total production volume of vegetables grown in the

Ontario greenhouses sector.

The following tables illustrate the change in production output under each scenario, and its value relative to the change under the baseline scenario:

Table 9: **Optimistic Enablers Generating Growth Opportunities**

Optimistic Scenario	Revenue/sq.m (Year 1)	Revenue/sq.m (Year 5)	Gain in Year 5 (relative to Base)	Profit/sq.m (Year 1)	Profit/sq.m (Year 5)	Gain in Year 5 (relative to Base)
Base	$98.21	$138.29	N/A	$16.21	$29.59	N/A
1	$98.21	$155.73	13%	$16.21	$48.05	62%
2	$98.21	$155.58	13%	$16.21	$46.88	58%
3	$98.21	$146.90	6%	$16.21	$41.00	39%
4	$98.21	$143.90	4%	$16.21	$43.70	48%
5	$98.21	$152.75	10%	$16.21	$44.04	49%
6	$98.21	$138.29	0%	$16.21	$30.15	2%
7	$98.21	$146.72	6%	$16.21	$43.06	46%

Table 10: **Adverse Impacts Inhibiting Growth Opportunities**

Adverse Scenario	Revenue/sq.m (Year 1)	Revenue/sq.m (Year 5)	Decline in Year 5 (relative to Base)	Profit/sq.m (Year 1)	Profit/sq.m (Year 5)	Decline in Year 5 (relative to Base)
Base	$98.21	$138.29	N/A	$16.21	$29.59	N/A
1	$98.21	$138.29	0%	$16.21	$21.50	-27%
2	$98.21	$138.29	0%	$16.21	$18.50	-37%
3	$98.21	$123.46	-11%	$16.21	$14.76	-50%
4	$98.21	$112.08	-19%	$16.21	$3.37	-89%
5	$98.21	$138.29	0%	$16.21	$14.45	-51%
6	$98.21	$122.35	-12%	$16.21	$12.11	-59%
7	$98.21	$106.74	-23%	$16.21	-$1.97	-107%
8	$98.21	$130.13	-6%	$16.21	$17.90	-40%
9	$98.21	$138.29	0%	$16.21	$13.87	-53%

SENSITIVITY ANALYSIS

Sensitivity analysis was conducted to pinpoint the areas of production that are particularly crucial for profitability. This information can then be used to refine and strengthen growth strategies for the sector. Sensitivity analysis is a method of quantifying the impact on revenue and/or expenses resulting from a change in a single model variable. This differs from the scenario analysis discussed in the previous section, which examined model variables in aggregate.

During the sensitivity analysis, each model variable was modified by a factor in the initial year of projection only, and the resulting percentage change in the present value of projected cash flows was calculated. The range of considered factors was -5% to 5%, with adjustments made in 1% increments. The adjustments were made to both increase and decrease the model variables, taking into account both upside and downside risk. It is important to note that depending on the specific variable being considered, a decrease or increase in the variable may correspond to a decrease or increase in profit.

Sensitivity analysis was completed individually on each of the four modelled greenhouses. An additional model was created which aggregates the cashflows for all individual greenhouses to calculate a combined average for the sensitivity analysis. For the initial sensitivity run, total production and operational expenses were combined into one variable. The results of the sensitivity analysis at a 5% shock level, where variables were changed in a way that had a positive impact on profit, are presented in the following chart. It is important to note that the percent change in present value would have the same magnitude, but in the opposite direction, if the variables were changed in the opposite direction. The results at all shock levels are provided in the report's appendix.

Table 11: **Sensitivity Analysis**

	Greenhouse #1 Less than 15 Acres, 1 Crop	Greenhouse #2 15 – 40 Acres, 1 Crop	Greenhouse #3 Less than 15 Acres, Multi-Crop	Greenhouse #4 >40 acres, Multi-Crop	Combined Average
Successful Fruits/ Vegetables per square metre	13%	92%	20%	28%	27%
Selling price per fruit/vegetable	13%	92%	20%	28%	27%
Total production operational costs	6%	69%	11%	15%	15%
Total labour costs	3%	20%	5%	9%	8%

The sensitivity analysis revealed that for each greenhouse, revenue-related variables had the greatest impact on profit. However, labour and other production expenses were also identified as important areas with the potential to drive growth and increase profit. As a result, all aspects of greenhouse operations will be taken into consideration in the final recommendations for the development of a growth and prosperity strategy for the sector.

To further demonstrate the potential of each area of production in promoting growth (upside risk) or hindering profit (downside risk), the projected cash flows for Greenhouse #2 are shown in the graphs below. These graphs illustrate the impact of a 5% shock on both favourable and unfavourable changes, relative to the greenhouse's baseline projections:

Figure 1: Impact on Yearly Cashflows at 5% Positive Shock

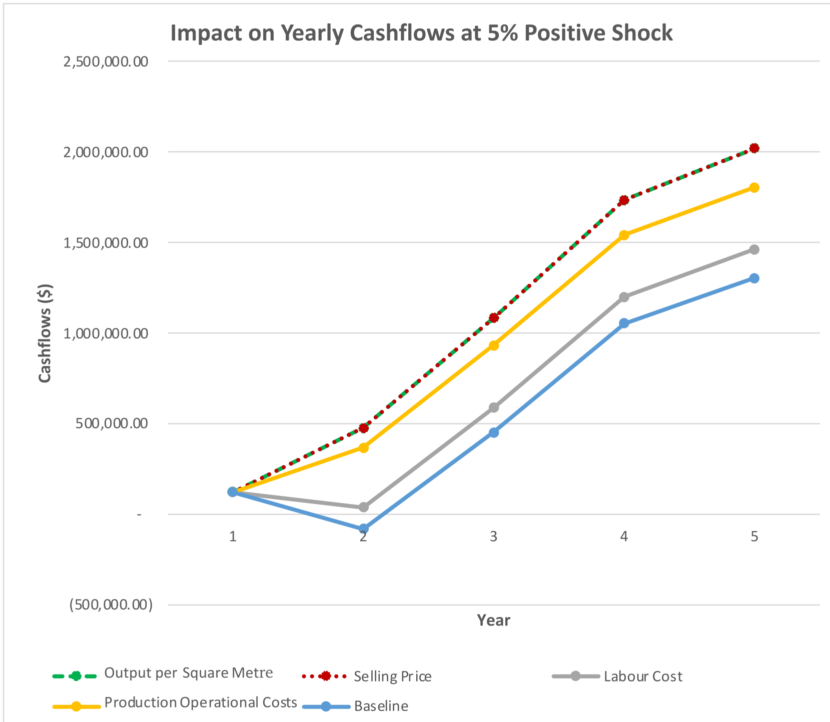
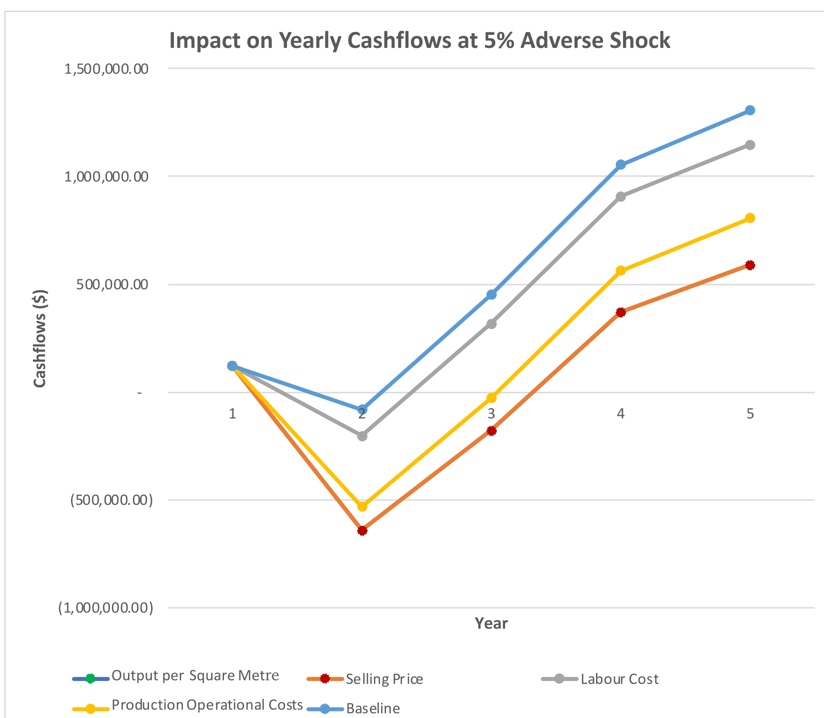


Figure 2: Impact on Yearly Cashflows at 5% Adverse Shock



Further sensitivity analysis was completed on a more granular level, considering each individual variable comprising of the total production/operational expenses. There existed a general trend between which areas were most/least crucial to profit; however, the precise rank for each variable differed between farms. The following chart illustrates the impact to profit when applying a 5% decrease (note, the same shock in the opposite direction would have an identical impact in the opposite direction if the variables increased by 5%):

Table 12: **Sensitivity Analysis on Individual Variables**

Rank	Greenhouse #1 Less than 15 Acres	Greenhouse #2 15 – 40 Acres, 1 Crop	Greenhouse #3 15 – 40 Acres, Multi-Crop	Greenhouse #4 >40 acres, Multi-Crop
1	Trays, Boxes, and Other Packing/sq.m (1.38%)	Natural Gas/sq.m (12.17%)	Trays, Boxes, and Other Packing/sq.m (2.8%)	Other Expenses/sq.m (4.2%)
2	Natural Gas/sq.m (0.99%)	Soil Costs/sq.m (11.82%)	Fertilizer and Chemical Costs (1.58%)	Total Electricity costs (2.43%)
3	Soil Costs/sq.m (0.83%)	Marketing costs/sq.m (11.64%)	Other Expenses/sq.m (1.47%)	Trays, Boxes, and Other Packing/sq.m (2.08%)
4	Fertilizer and Chemical Costs (0.59%)	water/sq.m (8.39%)	Natural Gas/sq.m (1.21%)	Natural Gas/sq.m (1.55%)
5	Other Expenses/sq.m (0.27%)	Fertilizer and Chemical Costs (5.83%)	Soil Costs/sq.m (1.12%)	Soil Costs/sq.m (1.27%)

Expense items in the accounting data provided by the study participants which had a lesser impact on profit when shocked included Solar Costs, Labour Insurance, Property Taxes, Repairs/Maintenance for small tools, Professional dues and fees, Marketing costs, Automobile expenses and Freight/Trucking expenses. The minimal impact follows from the total incurred costs for these items relative to the total annual expenses incurred for the greenhouse.

One further area of inquiry pertaining to the results of the sensitivity modelling involved quantifying the benefits from crop diversification. The impact following an adverse scenario may be limited to a subset of crop-types from the total crop portfolio. Examples of plausible scenarios with this feature that may arise include:

- Introduction of crop-specific virus, where the impact to the model variable 'Successful Fruits/Vegetables' would be limited to one crop.
- Larger than expected volume of crops brought to market, where the impact to the model variable 'Selling price per fruit/vegetable' would be limited to one crop.

Thus, quantifying the benefits that follow from crop diversification will focus on these two key model variables 'Successful Fruits/Vegetables per square metre and 'Selling price per fruit/vegetable'. In contrast, it is unlikely that future scenarios will arise in which their impact on other model variables, such as labour and utilities, are dependent on the number of crop-types grown.

Of the four greenhouses in the case studies, two had a crop portfolio consisting of more than one crop-type (Greenhouse #3, 2 crop types; Greenhouse #4, 3 crop types). Considering only these two greenhouses, the sensitivity modelling was re-run and modified such that the shock to an assumption would only impact the projections for 1 crop for Greenhouse #3, and 1 and 2 crops for Greenhouse #4. The results from these new projections were compared to the results in the initial sensitivity analysis, where every crop was uniformly impacted by a shocked variable, which are shown in the table below.

Greenhouse #3

Variable/Change	Successful Fruits/Vegetables per square metre	
	2 Crop	1 Crop
-5%	-19.8%	-9.9%
-4%	-15.9%	-7.9%
-3%	-11.9%	-5.9%
-2%	-7.9%	-4.0%
-1%	-4.0%	-2.0%
0%	0.0%	0.0%
1%	4.0%	2.0%
2%	7.9%	4.0%
3%	11.9%	5.9%
4%	15.9%	7.9%
5%	19.8%	9.9%

Variable/Change	Selling price per fruit/vegetable	
	2 Crop	1 Crop
-5%	-19.8%	-9.9%
-4%	-15.9%	-7.9%
-3%	-11.9%	-5.9%
-2%	-7.9%	-4.0%
-1%	-4.0%	-2.0%
0%	0.0%	0.0%
1%	4.0%	2.0%
2%	7.9%	4.0%
3%	11.9%	5.9%
4%	15.9%	7.9%
5%	19.8%	9.9%

Greenhouse #4

Variable/ Change	Successful Fruits/Vegetables per square metre		
	3 Crop	2 Crop	1 Crop
-5%	-28.1%	-18.8%	-9.4%
-4%	-22.5%	-15.0%	-7.5%
-3%	-16.9%	-11.3%	-5.6%
-2%	-11.3%	-7.5%	-3.8%
-1%	-5.6%	-3.8%	-1.9%
0%	0.0%	0.0%	0.0%
1%	5.6%	3.8%	1.9%
2%	11.3%	7.5%	3.8%
3%	16.9%	11.3%	5.6%
4%	22.5%	15.0%	7.5%
5%	28.1%	18.8%	9.4%

Variable/ Change	Selling price per fruit/vegetable		
	3 Crop	2 Crop	1 Crop
-5%	-28.1%	-18.8%	-9.4%
-4%	-22.5%	-15.0%	-7.5%
-3%	-16.9%	-11.3%	-5.6%
-2%	-11.3%	-7.5%	-3.8%
-1%	-5.6%	-3.8%	-1.9%
0%	0.0%	0.0%	0.0%
1%	5.6%	3.8%	1.9%
2%	11.3%	7.5%	3.8%
3%	16.9%	11.3%	5.6%
4%	22.5%	15.0%	7.5%
5%	28.1%	18.8%	9.4%

The difference between the results for each greenhouse highlights the potential benefits of crop diversification in mitigating risk. For instance, if Greenhouse #4 only cultivated a single crop type and a virus emerged that decreased annual yield by 5% over the projection period, the present value of profit would be significantly impacted by 28.1%, as shown in the above chart. However, in real-world scenarios, a pathogen may only impact one crop type within a greenhouse. In such a case, for Greenhouse #4, a 5% reduction in annual yield for just one crop type would result in a 9.4% decrease in the present value of profit. This is a much smaller decrease in magnitude compared to the 28.1% decrease that would occur if the virus affected all three crop types equally.

COMMUNITY BENEFITS

Several community benefits are expected to follow the development, or expansion, of existing vegetable greenhouse operations. Some of the key benefits are highlighted below.

- Carbon-offsetting opportunities for existing industries, providing environmental and economic benefits, and boosting efforts to contribute to a net-zero economy.
- Attraction of upstream and downstream businesses that align with the greenhouse vegetable sector. This includes suppliers of inputs and organizations further down the value chain, such as marketing, transportation, and warehousing.
- Creation of a hub for technology-focused companies focused on emerging technologies, such as AI, data science and robotics with the aim to improve efficiency within the greenhouse vegetable sector.
- Attraction of investment for important infrastructure expansion, which provides direct benefits to supporting surrounding sectors.
- Attraction of research-focused organizations, attracting public and private investment with potential for international scalability.
- Demand for talent and high-quality professionals, with greenhouses providing relevant and exciting work opportunities that incorporate the use of new cutting-edge technologies that span robotics and AI.
- Creation of additional employment opportunities that support the growth of indirect industries.
- Focus area for research institutions and alignment with new areas of training and education with a focus on Science, Technology, Engineering and Math (STEM) and agri-business.
- Growth of indirect sectors, such as housing, restaurants, and tourism, boosting local commerce.
- Increased demand on the financial sector, including Accounting and Banking services, and development of business risk management programs tailored to the greenhouse vegetable sector.
- Meet changing consumer tastes and expectations towards locally grown, healthy and fresh food, while contributing to improved food security.

Conclusion and Recommendations

The application of the ERM framework in this study has provided important insights into the role of Ontario's greenhouse vegetable sector in promoting food security and meeting the needs of a growing population. Despite challenges posed by the COVID-19 pandemic and international trade disruptions, the sector's emphasis on local, fresh, and sustainable food production has gained renewed importance. The adoption of innovative technologies and practices has positioned the greenhouse vegetable sector for growth, but long-term sustainability depends on managing risks related to labour, input costs, disease, regulation, supply chains, and inflation. This study has identified and quantitatively assessed potential challenges and opportunities, providing a fact-based foundation for driving prosperity in the sector.

The results of the quantitative assessment highlight the significant impact of fruit/vegetable selling price per unit, production levels per square metre, total production operational costs, and total labour costs on greenhouse profitability. Key stakeholders in the greenhouse vegetable sector should incorporate these risks into their strategies and decision-making processes. It is crucial to adopt policies and practices that mitigate the adverse effects of these risks on profitability (downside risk). Additionally, stakeholders should explore actions that exploit these risks to increase profitability (upside risk). To realize the potential growth of the Ontario greenhouse vegetable sector and benefit all stakeholders, industry leaders must embrace a comprehensive prosperity strategy. This strategy should prioritize mitigating the most probable risk events that have the greatest impact on prosperity. Furthermore, the growth strategy should consider how each mitigation strategy can be leveraged as an opportunity to enhance growth.

Diversification of crop portfolio included in long-term business plan. On-farm business decisions to diversify crops can provide several benefits, including reducing the frequency and severity of harmful pathogens impacting all planted acreage and hedging against market risks. Diversification of the crop portfolio should be included in the long-term business plan. Additionally, this strategy can benefit local communities by increasing the proportion of food purchased locally. To support this objective, government programs could provide tax incentives to existing greenhouses that introduce new crops into their existing portfolio. Other risk management and insurance incentives that recognize the benefits of diversification may also be helpful. Therefore, both on-farm business decisions and government policy development can play a role in promoting crop diversification in the greenhouse vegetable sector.

Diversification of crops grown between farms
To manage market risk, it is beneficial for farms to coordinate the crops they grow to reduce the total production volume of a single crop-type in the market at any given time. This strategy can help increase sales by avoiding situations where a particular crop type dominates the market, leading to oversupply and reduced prices. Diversification of the crop portfolio for individual growers can also help to mitigate disease and market risks. For greenhouses with a rotating crop schedule, it may be possible to consider rotation schedules to better manage supply. Coordination between growers and the establishment of a framework by government or industry advisory boards can improve communication and help establish more strategic crop allocation targets. This approach allows individual greenhouses to plan and coordinate accordingly, contributing to more efficient use of resources and reducing market risks.

Improved risk management and insurance programs tailored to the unique needs of the greenhouse sector. Managing risk is crucial for producers to navigate the variability in their cash flows. Adequate risk management and insurance programs can help mitigate key risk factors related to crop price and yield, input costs, disease risk, and more. Research indicates that the adoption of best practices and technology is more likely when robust insurance and risk management approaches are in place. These approaches may also encourage more investment and expansion in the sector, leading to greater profitability and favourable impacts on GDP. This, in turn, enhances the competitiveness of the Canadian greenhouse sector.

Prioritize the acquisition and implementation of newly developed technology for greenhouse production. Establish government financial support/incentives to support individual greenhouses adopt strategy into long-term business planning. Prioritizing technology in automation and risk management can result in substantial benefits such as improved yield outcomes, quality, and operating costs. Automation of key tasks can reduce labour costs, and the integration of new sensors and AI applications can help maximize crop health and productivity through optimal environmental controls. These technologies help reduce the variability of key risks and, in some cases, may facilitate new insurance solutions. Achieving this objective requires not only investment in necessary technology but also costs associated with installing the technology, training management and staff, and other related expenses. Prioritizing technology in automation and risk management can ultimately improve the competitiveness and profitability of the greenhouse sector while also addressing key risks and challenges.

Create/expand programs that provide grants, or financial incentives, to companies and start-ups that specialize in technology applicable within the greenhouse sector.
By prioritizing technology in automation and risk management, there is an expected benefit of reducing the risks and costs associated with acquiring and implementing the technology. This includes opportunities to work with local growers to prototype, refine, and scale the technology. Furthermore, prioritizing key technologies can positively contribute to addressing challenges related to food production sustainability and the resiliency of the sector. The benefits of implementing such technology extend beyond cost savings and risk reduction. Prioritizing technology in automation and risk management can ultimately improve the competitiveness and sustainability of the greenhouse sector by enabling more efficient use of resources, reducing waste, and enhancing crop yields. This, in turn, can have a positive impact on the environment, the economy, and the overall well-being of the community.

Establish partnership between educational and research institutions and individual greenhouses to facilitate the creation of research opportunities and student co-op projects within the sector.
Prioritizing research funding and collaboration initiatives is essential in developing new solutions for the greenhouse sector and encouraging a multi-disciplinary approach to solving complex challenges. This approach will help improve food security in Canada while also exposing younger generations to job prospects within the sector. Investing in research and development is critical for the greenhouse sector to remain competitive and adapt to changing market conditions and consumer preferences. Collaboration between industry, academia, and government can help to identify research gaps and areas of focus, facilitating the development of innovative solutions to address key challenges. Moreover, this approach can create new opportunities for young professionals and encourage them to pursue careers in the greenhouse sector, contributing to the growth and sustainability of the industry in the long run. By prioritizing research funding and collaboration initiatives, the greenhouse sector can continue to innovate and thrive while addressing critical food security challenges.

Establishment of incentives to lower the cost of capital for new market entrants and smaller-sized operations within the greenhouse sector. To continue attracting new entrants and growth of the sector, various programs and incentives should be established. This will help to foster competitiveness within the market and meet increased needs regarding fruit and vegetable production as a health and fresh source of food. Access to capital is also expected to contribute to the adoption of technology and improve efficiencies of scale, also providing benefits from a risk management perspective.

Establish framework for carbon-offsetting program. There are carbon-offsetting opportunities between the greenhouse sector and various existing industries within Ontario. To establish a framework where the potential benefits could be realized would require government involvement. The benefits, which extend to many stakeholders, may include a reduction in emissions, as well as economic/financial benefits related to carbon credits.

Adoption of a strategy to optimize utility usage with available government support/incentives to support implementation. There are various approaches that can minimize utility usage. Examples include adoption of technologies that help monitor and attain optimal internal climate control (heating, light, etc.), reduced water usage for irrigation, routine maintenance and repair of greenhouse infrastructure, etc. These benefits extend beyond lowering operational costs for greenhouses, providing more resources to meet demand and service local communities.

Consideration of greenhouse labour needs within temporary foreign worker programs and/or immigration approval processes. Government supported programs, and processes are critical for ensuring access to sufficient labour resources. This may include quotas for the selection of immigration applications with a working history in the agricultural industry or a demonstrated willingness to work in the greenhouse sector. Government may also facilitate processes to establish training and job placement programs within the greenhouse sector for newly landed residents. Temporary Foreign Worker programs may also be expanded and improved to lessen the burden, and this could extend to consideration regarding worker accommodations.

Adoption of optimal farm size range to maximizes productivity and profitability in the sector. Farm size can play an important role in achieving the full prosperity potential of the fruit and vegetable production sector. Farms that are too small may lack economies of scale, making it difficult to compete and generate sufficient profits. On the other hand, farms that are too large may become too complex to manage effectively, leading to inefficiencies and reduced profitability. Therefore, to achieve the full prosperity potential in the fruit and vegetable production sector, it is essential to find the optimal farm size range that balances economies of scale and effective management. This may involve implementing policies and incentives that encourage farm consolidation or division, depending on the prevailing conditions in the local market. For example, in areas where land is fragmented and farms are small, policies that incentivize farm consolidation and the creation of larger farming units may be appropriate. This can help to achieve economies of scale and improve profitability by reducing input costs and improving the efficiency of farm operations. In contrast, in areas where large farms dominate the market, policies that incentivize farm division and the creation of smaller farming units may be appropriate. This can help to reduce the complexity of farm management and improve the ability of smaller farmers to compete effectively.

Appendix A

For each defined risk, realistic scenarios that would likely drive the risk event are provided in Appendix A. The scenarios provide valuable qualitative analytical insight that will form the basis of following section, risk modelling.

Risk Category	Risk	Definition	Common Scenarios that drive risk event
Operational	Higher than expected amount of product spoilage	The volume of products lost due to spoilage (i.e. rotten before being brought to market) is greater than what is expected in the long-term business plan, adversely impacting profitability.	• Crop spoilage resulting from contaminated fertilizer or water. • Failure to adequately follow required precautions for transportation, which results in product spoilage prior to reaching destination. • Failure to ensure internal greenhouse conditions are optimal for greenhouse farms: temperature, humidity, air quality. • Improper storage of harvested crops prior to shipment or sale. • The wholesaler contractor fails to proceed with the contract, unable to find replacement before products rots. • Logistical errors with transportation services, products are not brought to their destination in required time.

Risk Category	Risk	Definition	Common Scenarios that drive risk event

Operational	Larger than expected pest population in greenhouse	Larger than anticipated pest population, and/or frequency of outbreaks, within the greenhouse, which results in higher incurred costs related to pest control or increased levels of product spoilage.	• Introduction of harmful disease/pathogens into greenhouse vegetation, which is the result of
			  ○ human-to-crop contact
			  ○ vector-borne disease introduced from mosquitoes, ticks, or other parasite/insects that have entered the greenhouse.
			• Failure to identify and fixing damaged infrastructure, which in turn increases the frequency of pests entering the greenhouse.
			• Lack of staff expertise for identifying, and properly responding to, a pest outbreak
			• Failure to apply pesticides when required to do so.
			• Human error when applying pesticides; for example, using the incorrect type of pesticide or not applying adequate amounts.

Operational	Failure to maintain internal greenhouse conditions optimal for growth.	The internal greenhouse conditions (such as temperature or humidity) are less than optimal, which result in a lower-than-expected yield of vegetables or floriculture than had been expected for the season.	• Failure of staff to identify when the internal environment of the greenhouse deviates from optimal growing conditions. • Failure of staff to take appropriate actions when the internal environment of the greenhouse deviates from optimal growing conditions. • Damage to greenhouse infrastructure, such as the ventilation system, which in turn impacts the ability to maintain optimal growing conditions. • Incorrect measure of variables related to internal greenhouse conditions because of faulty instruments used for reading variables such as temperature, humidity, air quality, etc.
Strategic	Unanticipated changes to farming inputs	This risk relates to the quality of the final product being less than expected as a result of unanticipated changes to the farming inputs used in production.	• Main supplier for key inputs, such as seeds or fertilizer, ceases operation; requiring the use of an alternative supplier whose products result in a decrease in the quality of greenhouse products. • New regulation bans the use of pesticides currently employed in the greenhouse sector. Replacement products are not as effective or have undesirable effects on plant quality. • Unexpected change in prices for key inputs, such as seeds or fertilizer, that require the use of alternative products that are not as effective or have undesirable effects on plant quality. • Human error related to artificial selection (inadequate expertise or human error when interfering with selection of crop variety) • Unexpected genetic drift in plant population, resulting in a lower-than-expected yield or quality of final products.

Risk Category	Risk	Definition	Common Scenarios that drive risk event
Operational	Failure to adequately fulfill tasks related to health management of greenhouse vegetables/floriculture	This risk relates to the failure to adequately fulfill tasks/responsibilities required to maintain the long-term health and viability of the products grown in the greenhouse, which in turn results in - Decreased quality of final product - Increased spoilage.	• Human error in management of records related to routine farm check-ups. • Changes in the availability of specialized farm services used to assist with routine health management of greenhouse crop production. • Failed human processes for identifying and responding to: - nutritional deficiencies in soil - contamination of water supply - emergence of virus variants, or new diseases, not addressed through current risk mitigation practices • Following the unexpected departure of experienced staff members, there is a period with inadequate expertise within greenhouse staff to fulfill required tasks related to health management of the greenhouse crops.
Strategic	Unexpected changes in the accessibility of water	Constant access to large quantities of water is fundamental to greenhouse operations. This risk relates to any unexpected development impacting the accessibility of water.	• Abnormal weather patterns (droughts, higher than usual temperature) results in a disruption of water services. • New environmental regulation, such as: - Limiting the volume of water individual businesses can use during a specified timeframe - Introduction of higher rates aiming to deter excessive water use, which in turn creates issues with affordability • New housing, or commercial development, in surrounding area that increases competitive landscape regarding access to water. • Unexpected event results in a temporary disruption that lasts long enough to impact production, such as failed processes at utility company to prevent contamination from agricultural run-off
Strategic	Greater water requirements than expected	There is uncertainty in water requirements for greenhouse operations. This risk relates to any development that results in greater water requirements than initially budgeted, which can result in: - Higher incurred expenses than initially budgeted - Decrease in crop quality - Increase in spoilage	• Higher than normal external temperature, or daily sunlight radiation impacting dryness of soil, which in turn increases water requirements for soil. • Inability to detect and/or fix damaged infrastructure that is a source of water wastage. • Greater than expected water requirements for new vegetables/floriculture crops introduced into the greenhouse. • Less than expected benefits from implemented technology that is used to reduce/recycle water.

Risk Category	Risk	Definition	Common Scenarios that drive risk event
Operational	The frequency of human error involving tasks related to harvest is larger than expected	This risk relates to any unintentional deviation from established guidelines and/or procedures related to the cultivation and harvesting of crops, which in turn adversely impacts the quality/quantity of final greenhouse products.	• Higher than expected rate of staff turn-over, increasing proportion of employees with little-to-no experience, which contributes to larger than expected wastage. • Following the operational expansion of the greenhouse, there is an inability to hire staff with necessary expertise to optimally perform procedures at harvest. • Less than optimal methods employed in age identification of vegetables and floriculture, which results in crops being harvested outside the optimal range for product quality, which in turn impacts volume or sales price of product.
Financial	Future market demand for greenhouse products are less than expected	The profitability and potential for growth of the greenhouse sector is dependent on future market demand. This risk relates to any development that results in less than expected market demand for greenhouse products	• Event involving contamination of greenhouse products that results in human illness, which adversely impacts customer perception concerning the safety of greenhouse products. • Misinformation is spread by competitors concerning the safety and/or healthiness of products grown in greenhouses. • The introduction, or increase use of, Genetically Modified Crops in the Greenhouse sector, adversely impacts market demand, which is a result from incorrect conception regarding the safety of GMO crops. • Unexpected changes in population diet trends. For Example: - New fad diets that have a lower reliance on vegetables, such as the paleo diet, gains popularity amongst larger segments of the population - Higher than expected reliance on fast-food, or meal options that are processed, due to convenience. • Product characteristics selected for branding are not as effective as expected for increasing consumer population. For example, overestimation of population concerns with ideas of ‘grown in Canada’, or ‘sustainability/environmentally friendly’.
Strategic	Unexpected changes in perception regarding greenhouse operation	The ability to establish a new greenhouse, or expand an existing operation, is dependent on public perception. This risk relates to any development that adversely impacts the public's perception of greenhouse operations.	• Misconception among public concerning relationship between greenhouses and cannabis production, compounded by misinformation regarding cannabis production which results in unanticipated hostility of greenhouse operation in surrounding community. • Inability to appease concerns of surrounding residents concerning: - light abatement - noise - increased traffic surrounding greenhouse. • Misinformation regarding the impact of greenhouse expansion and carbon inefficiency

Risk Category	Risk	Definition	Common Scenarios that drive risk event
Financial	Actual expenses exceed budgeted expenses in long-term business strategy	The profitability and long-term viability of the sector is dependent on ensuring actual incurred expenses remain manageable. This risk relates to any development which results in an unanticipated increase in actual incurred expenses; including both internal (i.e. labour) and external (goods/services provided from a 3rd party) expenses.	• Regulatory changes pertaining to the greenhouse sector results in an increase in operational expenses (for example, increase in number of inspections or banning of certain fertilizers/pesticides requiring the purchase of more costly alternatives) • Changes to labour laws result in required increase to wages/benefits paid to staff. • Higher than expected inflation: costs of farming inputs rise rapidly without warning (i.e. seedling, fuel, utilities etc.) • Higher than expected number of costly repairs on greenhouse, which can result from: - Extreme weather causing property damage. - Vandalism - Improper use of equipment causing damage • Higher than expected number of employees required to run a greenhouse. • Higher than expected administration work involving the hiring of foreign workers. • Higher than expected incurred costs regarding the implementation, and maintenance, of new technology. • Poor technique from inexperienced employees results in a larger amount of wastage of inputs, such as seeds or soil, than normally expected, requiring the purchase of additional inputs. • Closure of key supplier for farming inputs, resulting in the need to use a more costly alternative. • Relocation of key suppliers, which results in an increase in associated transportation costs.
Financial	Selling price of products are lower than expected	The profitability and long-term sustainability of the greenhouse sector is dependent on the sales price of products brought to market. This risk relates to a difference in the actual selling price of products from the price forecasted in business planning.	• Higher than expected new entrants into the greenhouse sector, which results in supply exceeding customer demand, consequently requiring a lowering of sales price. • Unexpected competition from new entrants into the traditional farming industry that offer lower prices for similar products produced within the greenhouse sector. • Overly optimistic outlook of market growth, which results in supply exceeding customer demand, consequently requiring a lowering of sales price to minimize wastage. • Economic-wide recession/depression, which results in the inability of the customer base to afford products, who then seek cheaper alternatives.

Risk Category	Risk	Definition	Common Scenarios that drive risk event
Financial	Higher than expected costs of capital	Greenhouses have a long production cycle which can involve high capital requirements. This risk relates to any development that impacts the costs, or access, to capital.	• Debt acquisition from recent business expansion, or repairs, precedes unexpected adverse changes in the market which results in higher than usual interest rate expenses. • Unexpected need for cash/capital occurs in a usually high interest rate environment. • Larger than expected capital requirements for expansion, upgrades, or repairs, which results in higher-than-expected interest rate expenses. • Less than favourable outcome when using capital investments to support future operational needs. For example, - the timing investments are brought to market impact their total cash value, such as converting stocks/equity to cash during a market recession (commonly referred to as liquidity risk). - fixed income securities can depreciate when brought to market before maturity.
Operational	Default in payments owed for delivered goods	This risk relates to any event where retailers/distributors/partners/customers fail to fulfill payment obligations. This risk includes delays in payments, as there are costs related to receiving late payments (especially if expected cash flows are used to finance debt or to fund further business expansion)	• Economic recession results in a higher than usual rate of default, or delay in payments, from key customers. • Change in ownership, or management board, of key clientele, which results in poor company performance; impacting their ability to fulfil contract payments on time.
Strategic	Unexpected changes in greenhouse farming regulation	The greenhouse industry is subject to various government regulations. This risk relates to any unexpected introduction, or change to current, regulation that impacts greenhouse operations.	• Restrictions, or all out ban, regarding the use of certain products used in farming (fertilizers, pesticides, supplements), results in the need to seek more costly, or less effective, alternatives. • Legislation introducing new training requirements for staff is costly. • Introduction of restrictions on individual greenhouse consumption of energy adversely impacts output. • Increase in the number of on-site inspections by relevant governing bodies, which results in more required upgrades to infrastructure which are costly. • Introduction of new regulation in the greenhouse sector that require the use of more costly changes to inputs in place (i.e. ban on certain chemicals/pesticide or requirements on lightbulbs that minimize the impact of light abatement) • Introduction of new zoning regulations prohibit greenhouse development on land intended to be purchased for expansion. • Restrictions on certain genetically modified crops used in greenhouse production. • Introduction of new regulation restricting the proportion of total workforce that are foreign.

Risk Category	Risk	Definition	Common Scenarios that drive risk event
Financial	Unexpected changes to applicable taxation laws	Total greenhouse profit is dependent on relevant taxation laws. This risk relates to any unanticipated change to governing legislation that alters taxation laws applicable to the greenhouse sector.	• Unexpected increase in taxation rates applicable to the greenhouse sector (such as business income tax • or property tax) • Introduction of consumption tax applicable to certain greenhouse products that were not previously taxed (i.e. vegetable products), which in turn adversely impact sales • Increase to current consumption tax rates currently applicable to certain greenhouse products (i.e. floriculture products), which in turn adversely impact sales. • Changes to rules and regulations regarding business expense deduction that adversely impacts total annual taxation. • Failure of government proposed taxation benefit, whose implementation was included in long-term business strategy (for example, proposed tax benefits for carbon-neutral businesses, proposed tax-incentives for domestic agricultural expansion) • Introduction of environmental legislation that creates special taxes specific to utility companies to deter excessive consumption
Strategic	Unexpected changes to trade regulations	This risk relates to unexpected changes to the governing rules and regulations pertaining to foreign trade, which impact the profitability of the greenhouse sector. This risk relates to legislative changes introduced by both domestic and foreign governments.	• Introduction, or increase to, existing tariffs by foreign governments in key export markets, which adversely impacts the profits of exported products. • Removal of tariffs from domestic governments, which in turn results in an increase in the volume of imported products in the domestic market • Introduction of new regulation by foreign governments, which prohibit the import of certain greenhouse products (i.e. banning products grown with the use of certain pesticides or products with traces of certain GMOs) • Introduction of new regulation by foreign governments, which result in exported products being placed at a competitive disadvantage (i.e. subsidies or preferential tax treatment towards domestically produced products, implementation of Country-of-Origin labelling legislation which adversely impact target consumer population) • Introduction of new trade regulation, which increase the costs for the shipment of goods across international borders (introduction of required residual testing prior to export, new labelling/packaging requirements)
Financial	Unexpected changes in foreign exchange rates	This risk relates to any unexpected changes in foreign exchange rates that impact the profitability of the greenhouse sector.	• An unexpected increase in the value of the Canadian dollar results in a decrease in the demand for greenhouse products in key foreign markets. • An unexpected decrease in the value of the Canadian dollar results in a decrease in the selling price of foreign imports; adversely impacting domestic sales. • Unexpected changes in foreign rates adversely impact the cost of greenhouse inputs that are imported. • Unexpected changes in foreign rates adversely impact capital investment which were intended to fund future greenhouse expansion.

Risk Category	Risk	Definition	Common Scenarios that drive risk event
Strategic	Unfavourable external weather conditions	This risk relates to unfavourable weather patterns that impact the productivity and profitability of greenhouse operations.	• Less than expected amount of seasonal sunlight radiation which requires an increase in the use of artificial lighting, which in turn results in higher utility costs and/or input costs (such as frequency of lightbulb replacement) • Unusual extreme average seasonal temperature resulting in higher-than-expected incurred costs related to maintaining optimal growing temperatures in greenhouse (i.e. utility costs for heating or cooling) • Extreme weather events result in external damage to greenhouse infrastructure, resulting in unanticipated repairs that are costly.
Strategic	Failure to maintain staffing requirements.	Attaining optimal performance and output of a greenhouse operation is largely dependent on maintaining and fulfilling staffing requirements. This risk relates to any failure in maintaining these staffing requirements, which includes both unexpectedly high turnover rates and the failure to hire new employees during a staffing shortage.	• Increase in wages in competing sectors, such as traditional farming, which increase the employee turnover rate in the greenhouse sector. • Changes in laws pertaining to the hiring of foreign workers that create obstacles for fulfilling staffing shortages with temporary foreign workers. For example, - Introduction of new administration requirements, such as additional background checks, which increase the costs and length of time required to hire foreign workers. - New requirements for providing benefits/insurance for foreign workers that make hiring unaffordable. - Laws requiring the hiring of Canadian citizens to take precedence over foreign workers. • Unexpected staff dissatisfaction with job (length of work hours, working conditions, lack of benefits/vacation), which results in higher-than-expected employee turnover rates. • Higher than expected maintenance requirements on housing for foreign workers that become unmanageable, which in turn lead to higher-than-expected departure of foreign workers.
Strategic	Failure to exploit technological innovation	The Greenhouse sector is always evolving. This risk involves the failure of businesses within the greenhouse sector to utilize new technological innovation available to greenhouse operations, which in turn leaves them at a disadvantage relative to their competitors.	• Inability to obtain capital requirements, such as loans, to purchase latest technological developments within the greenhouse sector. • Unwillingness of governments to subsidize greenhouse infrastructure required for the industry to adopt recent technological practices. • Inadequate expertise within Greenhouse staff required to implement and operate latest technological developments. • Inability to develop new technologies that can capture CO_2 emissions from machinery. • Inability to effectively implement new technologies that can harness solar energy.

Risk Category	Risk	Definition	Common Scenarios that drive risk event
Strategic	Failure to obtain additional land for expansion	Greenhouse operations require large landmass to operate. This risk relates to an inability to expand operations as a result from failing to obtain additional land.	• Higher than expected costs associated with extending hydro-lines/gas-lines to property intended for greenhouse development. • Failure to receive required permit/approval for greenhouse development on nearby available land. • Failure to secure loan required to purchase additional land. • Unexpected increase in property value makes purchase of additional land unaffordable.
Strategic	Failure in transportation logistics	Maximizing sales usually require the shipment of products across various destinations. This risk relates to a failure in transportation logistics which prevent, or increase the costs, of transporting products.	• Increase in incidences related to theft, damage, or contamination of goods during transportation, requiring the purchase of additional insurance, creating affordability issues with transporting products long-distance. • Failure of internal transportation services (equipment breakdown, loss of staff personnel that possess necessary skills) which results in the requirement of 3rd party transportation services not included in budget. • Closure, or relocation, of a key transportation provider, followed by a failure to find replacement in a reasonable timeframe. • Changes in schedule of 3rd party transportation providers (i.e. decrease in frequency of trips), which increases the duration products are in transit, limiting the volume of products that can be shipped without impacting product quality • Introduction of new regulations (i.e. inspections, limits on rail speed) impact the duration of travel time which creates issues related to product quality upon delivery • Introduction of new regulations pertaining to the transportation of food, such as additional requirements for packaging and inspection, which increase the costs of long-distance sales.
Strategic	Failure to retain/gain new wholesale contracts	Wholesale contracts provide a high degree of certainty that a fixed volume of products will be purchased at a predetermined price, a common practice employed in the greenhouse sector. This risk involves any scenario which impacts a greenhouse ability to renew or establish selling contracts with wholesale purchasers.	• The unreasonably low purchasing price offered in new/renewed contract makes transaction unprofitable. • Key wholesalers fail to fulfill contracts due to bankruptcy or other financial issues. • Key wholesaler relocates, creating logistical issues to continue or renew contracts. • Wholesalers unexpectedly decline to offer renewal of contract because they are provided with more favourable alternatives, such as better purchasing prices from importers. • Breakdown in relationship with key wholesaler due to disagreements regarding fulfillment of obligations (i.e. disagreement over agreed quality of product or disagreement regarding timeliness of payments/delivery of goods), resulting in either disruption of business with wholesalers or an unexpected failure to renew contract.

Risk Category	Risk	Definition	Common Scenarios that drive risk event
Strategic	Failure to attain an effective marketing strategy	Successful marketing is a key element to retaining and expanding the consumer population. This risk relates to any failure in attaining the desired goals from any marketing strategy undertaken by the greenhouse sector.	• Chosen marketing strategy fails to adequately differentiate product from other products. • Incorrect marketing channel chosen for reaching target population (i.e. selecting internet vs television as the method for maximizing exposure to population with the most potential to purchase greenhouse products) • Chosen area of focus for branding fails to resonate with potential customer base (i.e. selecting 'locally produced' vs. 'environmentally sustainable products' vs. 'healthy consumption' as the primary focus of branding).
Strategic	Failure to benefit from carbon sequestration activity	Many greenhouse operations utilize carbon as a necessary input, which qualifies their operation as a carbon sink. This risk relates to any failure in attempting to exploit and benefit from carbon sequestration practices.	• Failure of the government to proceed with tax legislation that awards carbon credits to carbon neutral industries. • Failure to attain technology that captures and transfers carbon from carbon intensive industries. (either being too costly, failure to get public support or being unavailable in operating jurisdiction). • Inability to coordinate with carbon-producing industries to establish methods for coordinating carbon capture.

Appendix B

Detailed results of Scenario Analysis

The following table illustrates the impacted assumptions for each individual scenario and the magnitude which their values change from the baseline projection. The shocks are modelled as annual changes in assumptions from the preceding year and are cumulative. For example, if "Successful Fruits/Vegetables" has a shock value of 2% in year 2, and 3% shock value in year 3, the difference from the value used in the baseline scenario will be 2% year 2 and 5.06% in year 3 (1.02 * 1.03) -1 = 5.06%.

Optimistic Scenarios					
Scenario	**Impacted Assumptions**	**Change from prior year**			
		2	3	4	5
1	Successful Fruits/Vegetables	2%	2%	2%	2%
	Selling Price per fruit/vegetable	1%	1%	1%	1%
	Water costs	-10%	-8%	-1%	0%
	Electricity/ Natural Gas Costs	-3%	-2%	-1%	0%
2	Selling Price per fruit/vegetable	4%	4%	2%	2%
3	Fertilizer and Chemical Costs	-5%	-4%	-3%	-2%
	Natural Gas Costs	-7%	-5%	-3%	-2%
	CoGen Savings	10%	10%	10%	10%
	Successful Fruits/Vegetables	2%	2%	1%	1%
	Water costs	-2%	-2%	-2%	-2%
4	Labour Costs	-15%	-5%	-2%	-2%
	Successful Fruits/Vegetables	1%	1%	1%	1%
5	Successful Fruits/Vegetables	2%	1%	1%	1%
	Selling Price per fruit/vegetable	2%	1%	1%	1%
	CoGen Savings	5%	5%	3%	2%
6	Water costs	-10%	-5%	0%	0%
7	Labour Costs	-5%	-4%	-3%	-2%
	Successful Fruits/Vegetables	3%	2%	1%	0%

Adverse Scenarios					
Scenario	**Impacted Assumptions**	**Change from prior year**			
		2	3	4	5
1	Labour Costs	10%	5%	3%	2%
2	Labour Costs	10%	10%	0%	0%
	Other Costs	15%	15%	0%	0%
3	Selling Price per fruit/vegetable	-5%	-15%	0%	0%
4	Selling Price per fruit/vegetable	-10%	0%	-10%	0%
5	Production Operational Costs	4%	5%	4%	3%
	Labour Costs	2%	2%	2%	2%
6	Successful Fruits/Vegetables	-5%	-5%	-2%	0%
	Other Expenses/sq.m	5%	5%	3%	2%
7	Selling Price per fruit/vegetable	-10%	-7%	-5%	-3%
8	Successful Fruits/Vegetables	-4%	-2%	0%	0%
	Total Labour Cost	4%	2%	2%	1%
9	Production Operational Costs	10%	1%	10%	0%

The following table illustrates the change in the Present Values of projected cashflows for each individual farm and modelled scenario, along with percent change from the value calculated in the baseline scenario.

	Greenhouse #1		Greenhouse #2	
Scenario	**PV**	**% Change**	**PV**	**% Change**
Baseline	$10,819,198	N/A	$2,468,549	N/A
Optimistic #1	$13,123,659	21%	$6,811,913	176%
Optimistic #2	$13,310,547	23%	$6,546,878	165%
Optimistic #3	$12,449,767	15%	$5,829,981	136%
Optimistic #4	$12,887,491	19%	$5,586,132	126%
Optimistic #5	$12,869,416	19%	$5,879,193	138%
Optimistic #6	$10,863,144	0%	$3,023,464	22%
Optimistic #7	$12,931,383	20%	$5,791,022	135%
Adverse #1	$9,668,453	-11%	$814,040	-67%
Adverse #2	$9,385,242	-13%	$169,402	-93%
Adverse #3	$8,820,090	-18%	-$803,983	-133%
Adverse #4	$6,714,442	-38%	-$4,250,922	-272%
Adverse #5	$9,141,444	-16%	-$1,764,327	-171%
Adverse #6	$8,073,898	-25%	-$2,107,502	-185%
Adverse #7	$5,885,271	-46%	-$5,608,271	-327%
Adverse #8	$8,807,652	-19%	-$728,108	-129%
Adverse #9	$8,850,412	-18%	-$3,084,827	-225%

	Greenhouse #3		Greenhouse #4	
Scenario	**PV**	**% Change**	**PV**	**% Change**
Baseline	$3,309,202	N/A	$35,338,238	N/A
Optimistic #1	$4,389,351	33%	$52,333,407	48%
Optimistic #2	$4,482,375	35%	$53,112,466	50%
Optimistic #3	$4,096,213	24%	$46,146,650	31%
Optimistic #4	$4,300,979	30%	$53,272,067	51%
Optimistic #5	$4,274,647	29%	$49,965,270	41%
Optimistic #6	$3,336,164	1%	$35,562,835	1%
Optimistic #7	$4,312,808	30%	$52,008,902	47%
Adverse #1	$2,752,085	-17%	$24,412,030	-31%
Adverse #2	$2,420,192	-27%	$14,931,207	-58%
Adverse #3	$2,367,825	-28%	$21,075,845	-40%
Adverse #4	$1,376,278	-58%	$6,053,353	-83%
Adverse #5	$2,365,156	-29%	$20,520,243	-42%
Adverse #6	$1,937,825	-41%	$12,888,902	-64%
Adverse #7	$985,822	-70%	$137,736	-100%
Adverse #8	$2,355,574	-29%	$19,846,846	-44%
Adverse #9	$2,158,963	-35%	$18,307,939	-48%

Detailed results of Sensitivity Analysis

The following table illustrates the change in the Present Values of projected cashflows for each individual farm at each shock level performed in the sensitivity analysis.

Farm #1

Variable/ Change	Successful Fruits/Vegetables per square metre	Selling price per fruit/vegetable	Total labour costs	Total production operational costs
-5%	-12.88%	-12.88%	3.18%	5.55%
-4%	-10.30%	-10.30%	2.54%	4.44%
-3%	-7.73%	-7.73%	1.91%	3.33%
-2%	-5.15%	-5.15%	1.27%	2.22%
-1%	-2.58%	-2.58%	0.64%	1.11%
0%	0.00%	0.00%	0.00%	0.00%
1%	2.58%	2.58%	-0.64%	-1.11%
2%	5.15%	5.15%	-1.27%	-2.22%
3%	7.73%	7.73%	-1.91%	-2.22%
4%	10.30%	10.30%	-2.54%	-4.44%
5%	12.88%	12.88%	-3.18%	-5.55%

Farm #2

Variable/ Change	Successful Fruits/Vegetables per square metre	Selling price per fruit/vegetable	Total labour costs	Total production operational costs
-5%	-92.42%	-92.42%	20.04%	68.62%
-4%	-73.93%	-73.93%	16.03%	54.90%
-3%	-55.45%	-55.45%	12.02%	41.17%
-2%	-36.97%	-36.97%	8.01%	27.45%
-1%	-18.48%	-18.48%	4.01%	13.72%
0%	0.00%	0.00%	0.00%	0.00%
1%	18.48%	18.48%	-4.01%	-13.72%
2%	36.97%	36.97%	-8.01%	-27.45%
3%	55.45%	55.45%	-12.02%	-41.17%
4%	73.93%	73.93%	-16.03%	-54.90%
5%	92.42%	92.42%	-20.04%	-68.62%

Farm #3

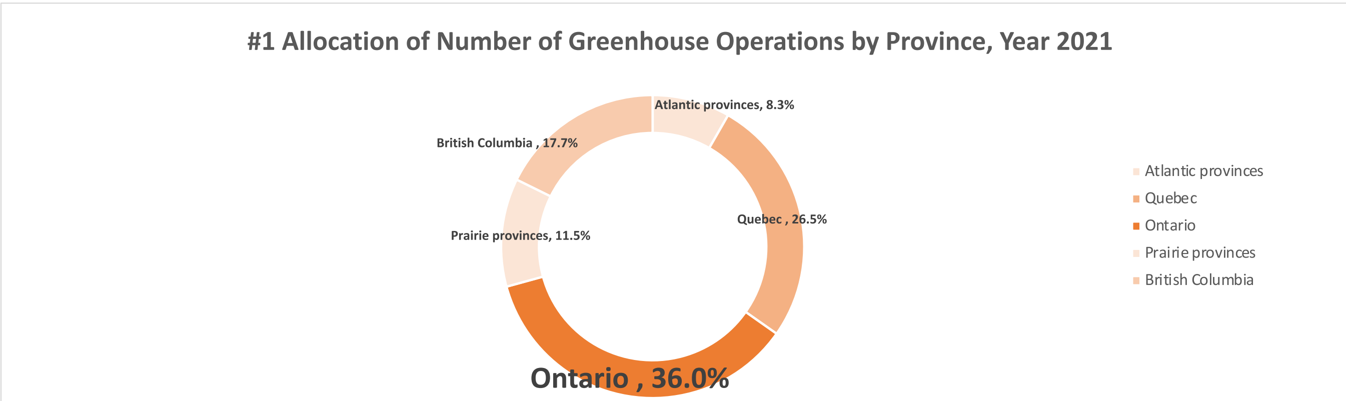
Variable/ Change	Successful Fruits/Vegetables per square metre	Selling price per fruit/vegetable	Total labour costs	Total production operational costs
-5%	-19.83%	-19.83%	5.03%	10.60%
-4%	-15.86%	-15.86%	4.03%	8.48%
-3%	-11.90%	-11.90%	3.02%	6.36%
-2%	-7.93%	-7.93%	2.01%	4.24%
-1%	-3.97%	-3.97%	1.01%	2.12%
0%	0.00%	0.00%	0.00%	0.00%
1%	3.97%	3.97%	-1.01%	-2.12%
2%	7.93%	7.93%	-2.01%	-4.24%
3%	11.90%	11.90%	-3.02%	-6.36%
4%	15.86%	15.86%	-4.03%	-8.48%
5%	19.83%	19.83%	-5.03%	-10.60%

Farm #4

Variable/ Change	Successful Fruits/Vegetables per square metre	Selling price per fruit/vegetable	Total labour costs	Total production operational costs
-5%	-28.14%	-28.14%	9.24%	14.70%
-4%	-22.51%	-22.51%	7.39%	11.76%
-3%	-16.88%	-16.88%	5.55%	8.82%
-2%	-11.25%	-11.25%	3.70%	5.88%
-1%	-5.63%	-5.63%	1.85%	2.94%
0%	0.00%	0.00%	0.00%	0.00%
1%	5.63%	5.63%	-1.85%	-2.94%
2%	11.25%	11.25%	-3.70%	-5.88%
3%	16.88%	16.88%	-5.55%	-8.82%
4%	22.51%	22.51%	-7.39%	-11.76%
5%	28.14%	28.14%	-9.24%	-14.70%

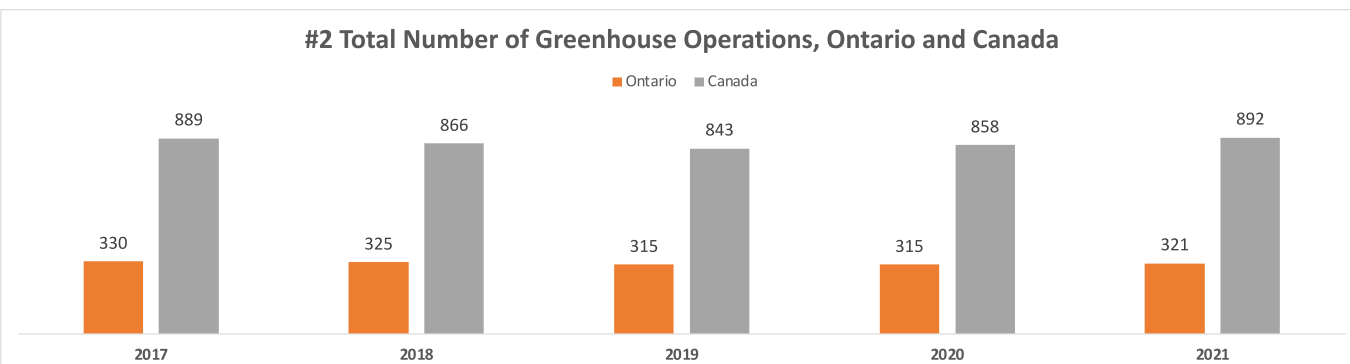
Appendix C

Industry Statistics



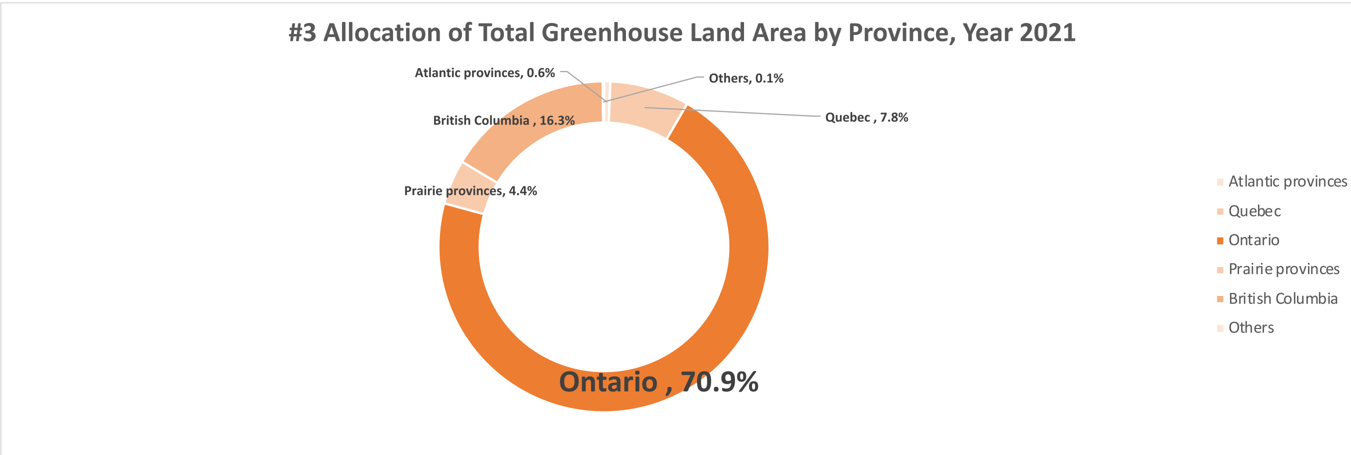
Allocation of Number of Greenhouse Operations by Province, Year 2021

Statistics Canada. Table 32-10-0019-01 Estimates of specialized greenhouse operations, greenhouse area, and months of operation (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210001901)



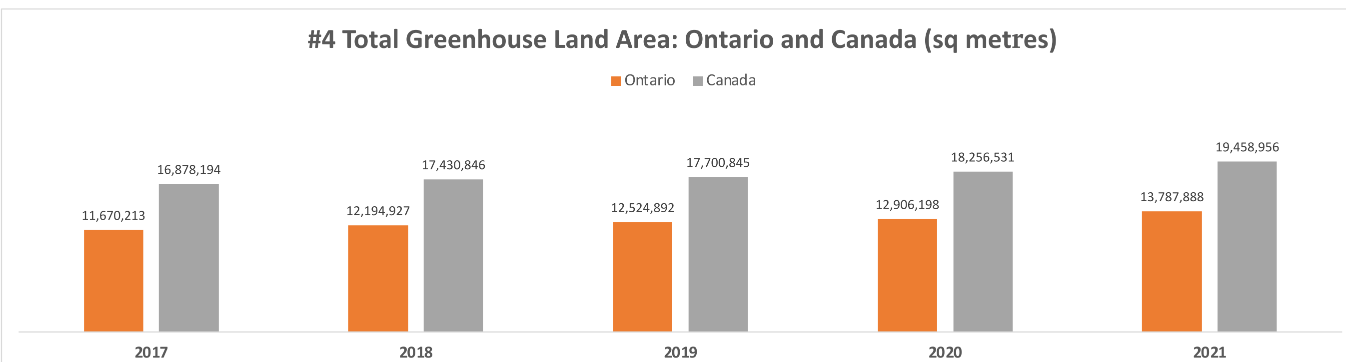
Total Number of Greenhouse Operations, Ontario and Canada

Statistics Canada. Table 32-10-0019-01 Estimates of specialized greenhouse operations, greenhouse area, and months of operation (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210001901)



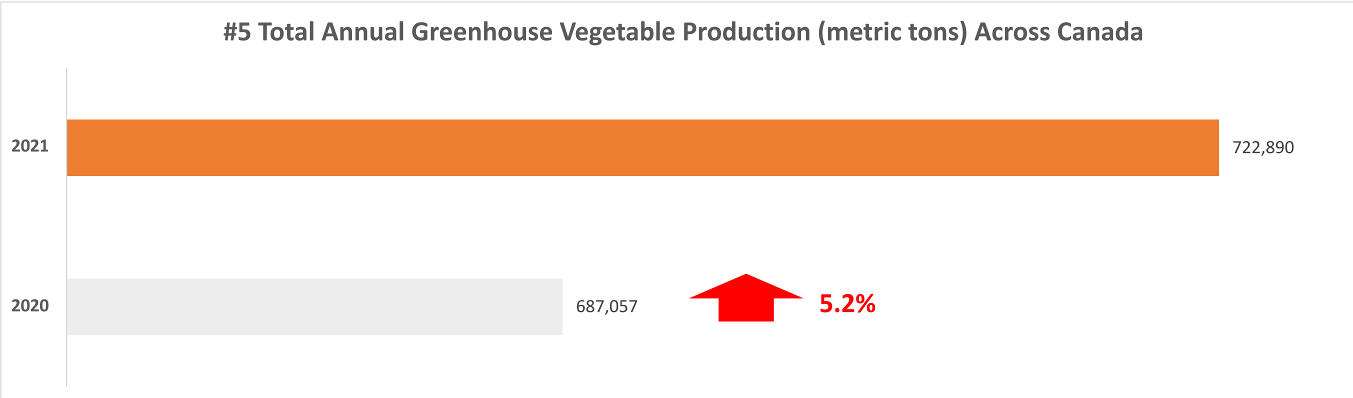
Allocation of Total Greenhouse Vegetable Production by Province, Year 2021

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



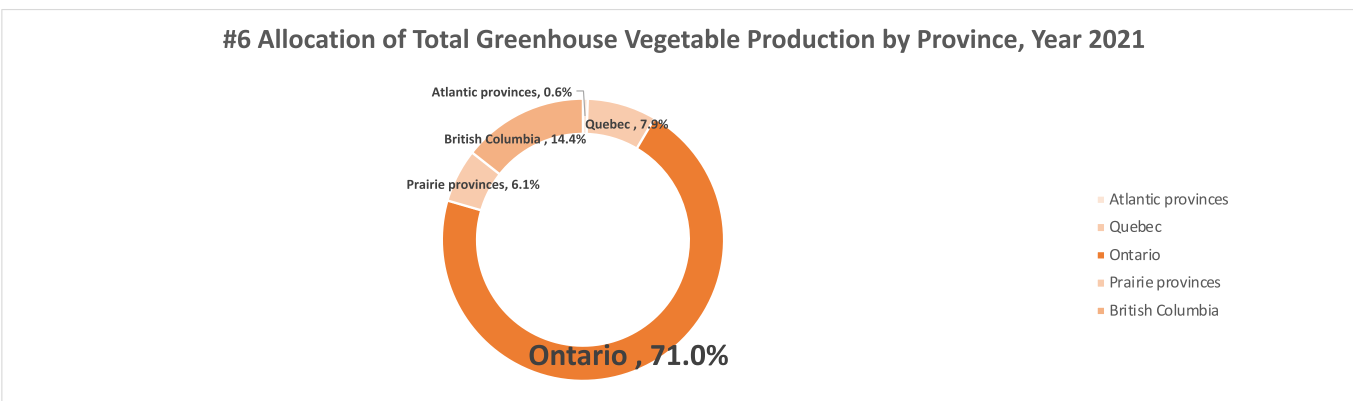
Total Greenhouse Land Area: Ontario and Canada (*sq metres*)

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



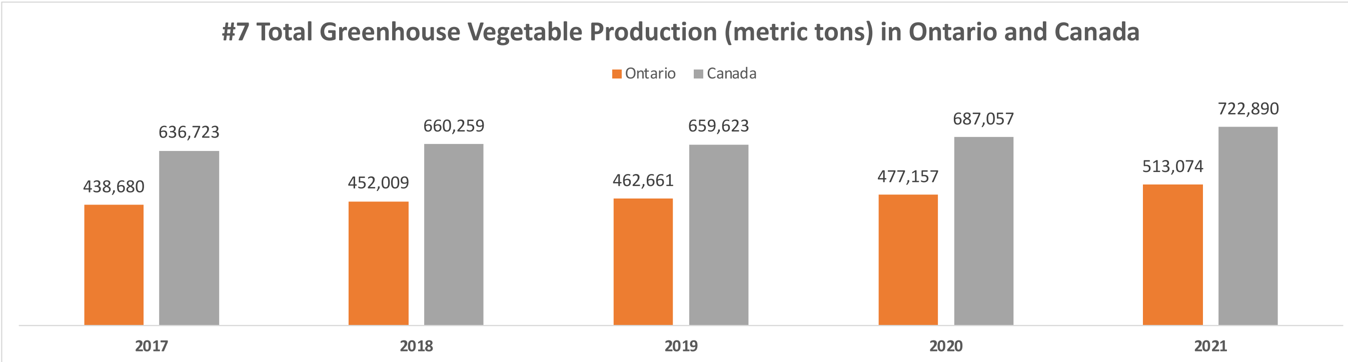
Total Annual Greenhouse Vegetable Production (Metric Tons) Across Canada

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



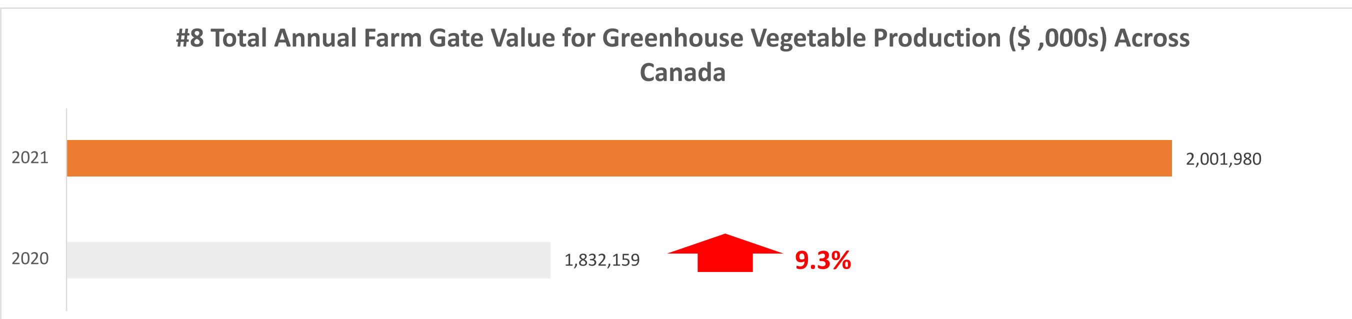
Allocation of Total Greenhouse Vegetable Production by Province, Year 2021

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



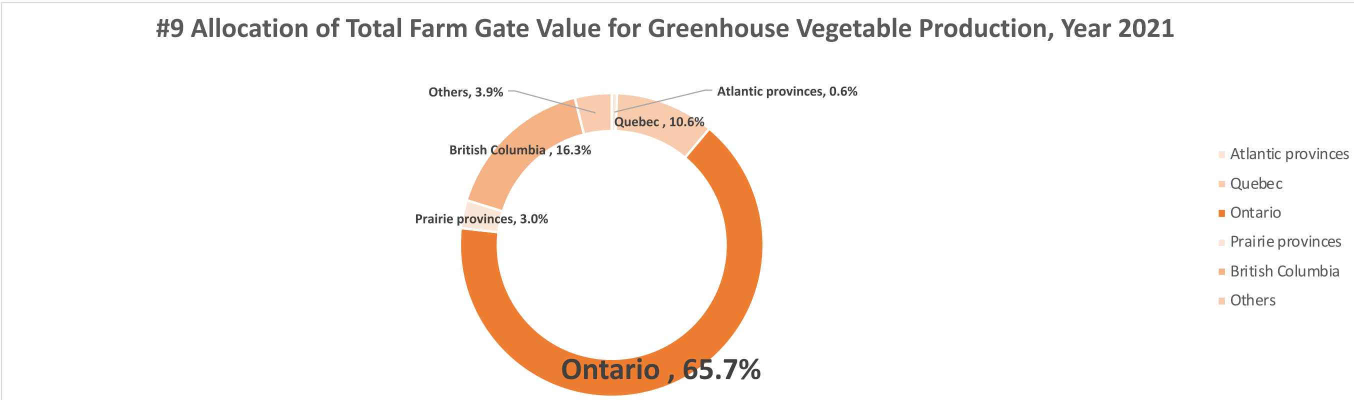
Total Greenhouse Vegetable Production (Metric Tons) in Ontario and Canada

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



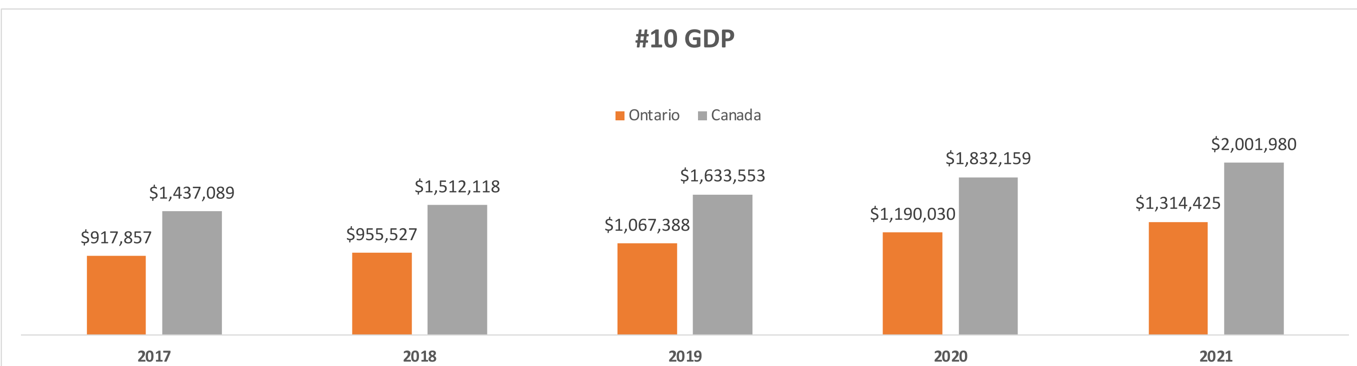
Total Annual Farm Gate Value for Greenhouse Vegetable Production (thousands of Canadian $) Across Canada

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



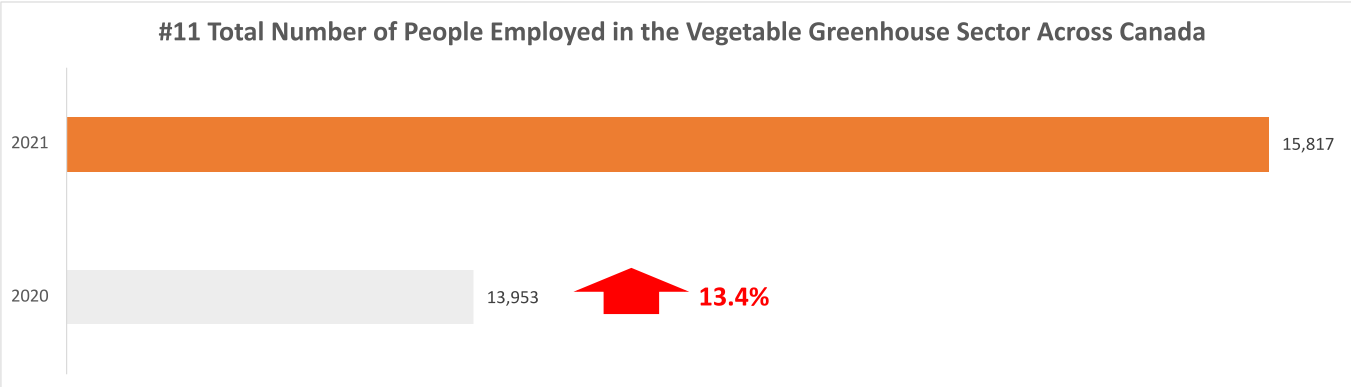
Allocation of Total Farm Gate Value for Greenhouse Vegetable Production, Year 2021

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



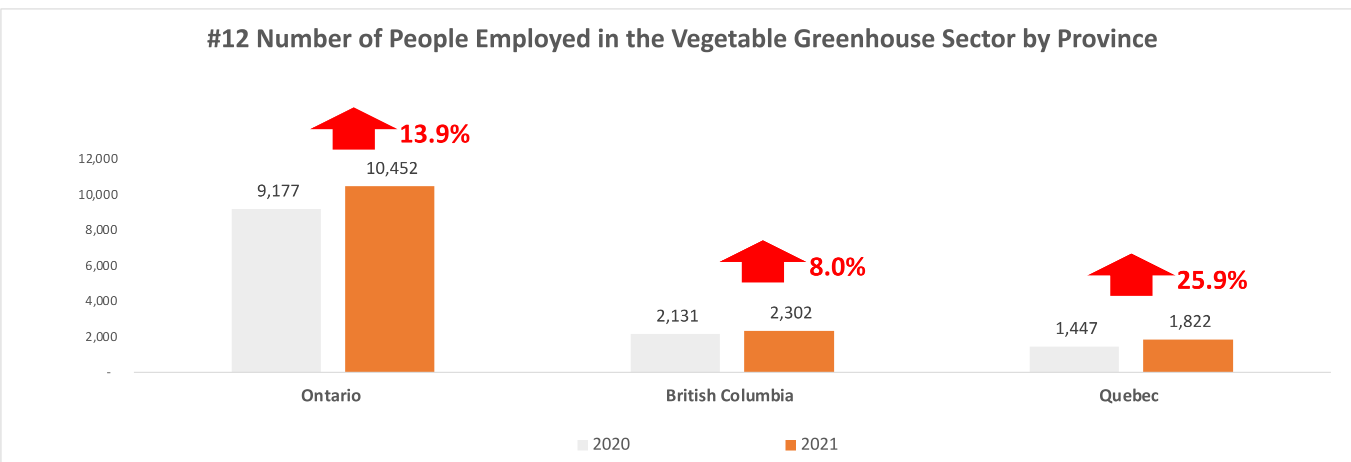
Total Farm Gate Value for Greenhouse Vegetable Production ($000's) in Ontario and Canada

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



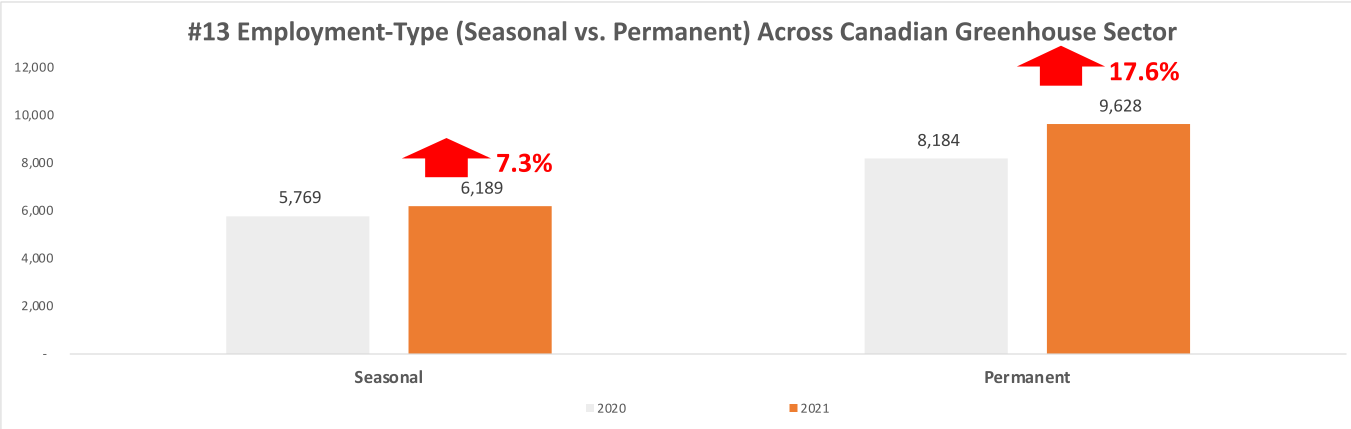
Total Number of People Employed in the Vegetable Greenhouse Sector Across Canada

Statistics Canada. Table 32-10-0028-01 Total number of employees of specialized greenhouse operations (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210002801)



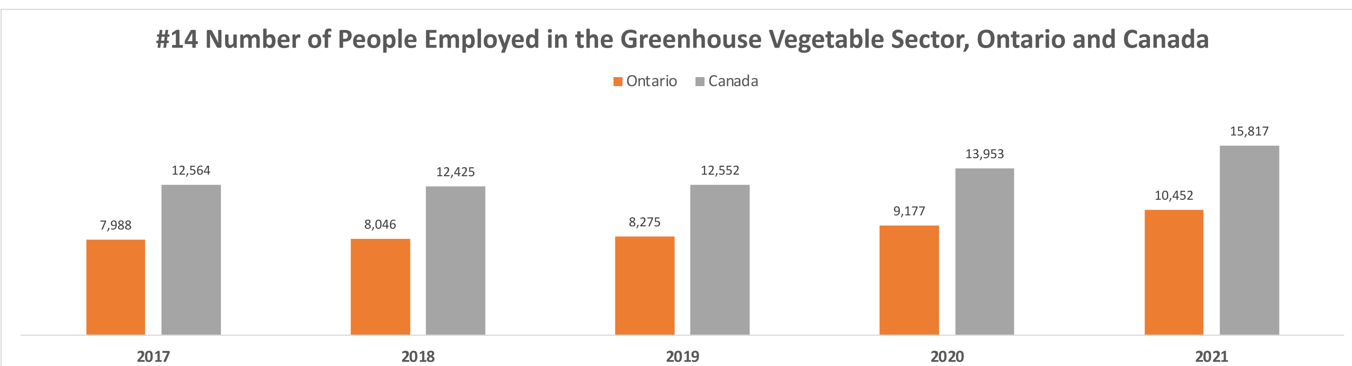
Number of People Employed in Vegetable Greenhouse Operation by Province

Statistics Canada. Table 32-10-0028-01 Total number of employees of specialized greenhouse operations (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210002801)



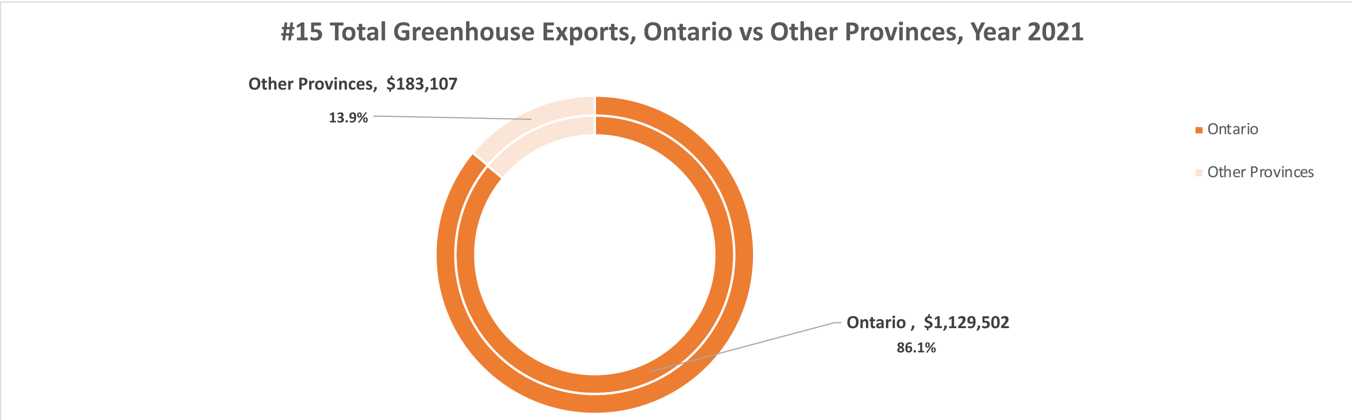
Employment-Type (Seasonal vs. Permanent) Across Canadian Greenhouse Sector

Statistics Canada. Table 32-10-0028-01 Total number of employees of specialized greenhouse operations (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210002801)



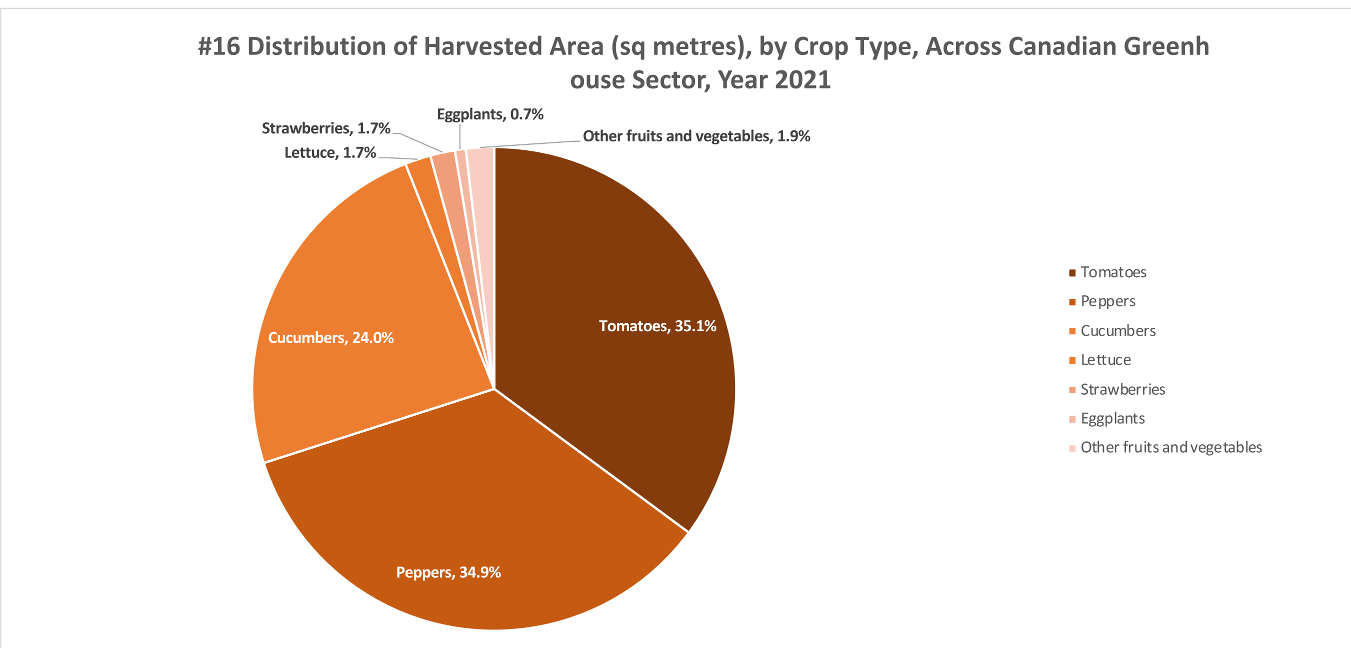
Number of People Employed in the Greenhouse Vegetable Sector, Ontario and Canada

Statistics Canada. Table 32-10-0028-01 Total number of employees of specialized greenhouse operations (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210002801)



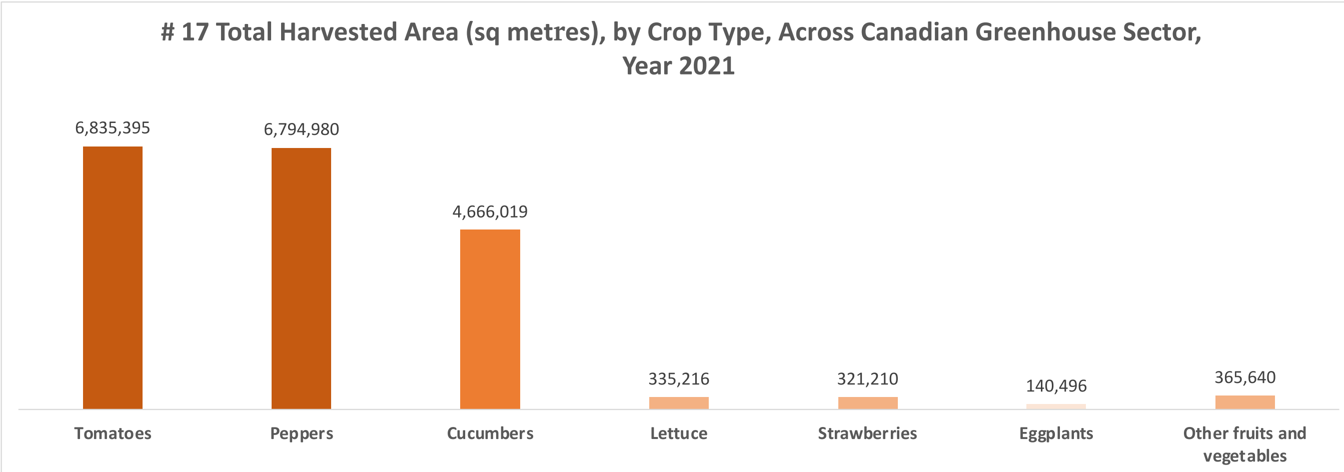
Total Greenhouse Exports, Ontario vs Other Provinces, Year 2021

Statistics Canada (CATSNET, June 2022) (https://agriculture.canada.ca/en/sector/horticulture/reports/statistical-overview-canadian-greenhouse-vegetable-mushroom-industry-2021)



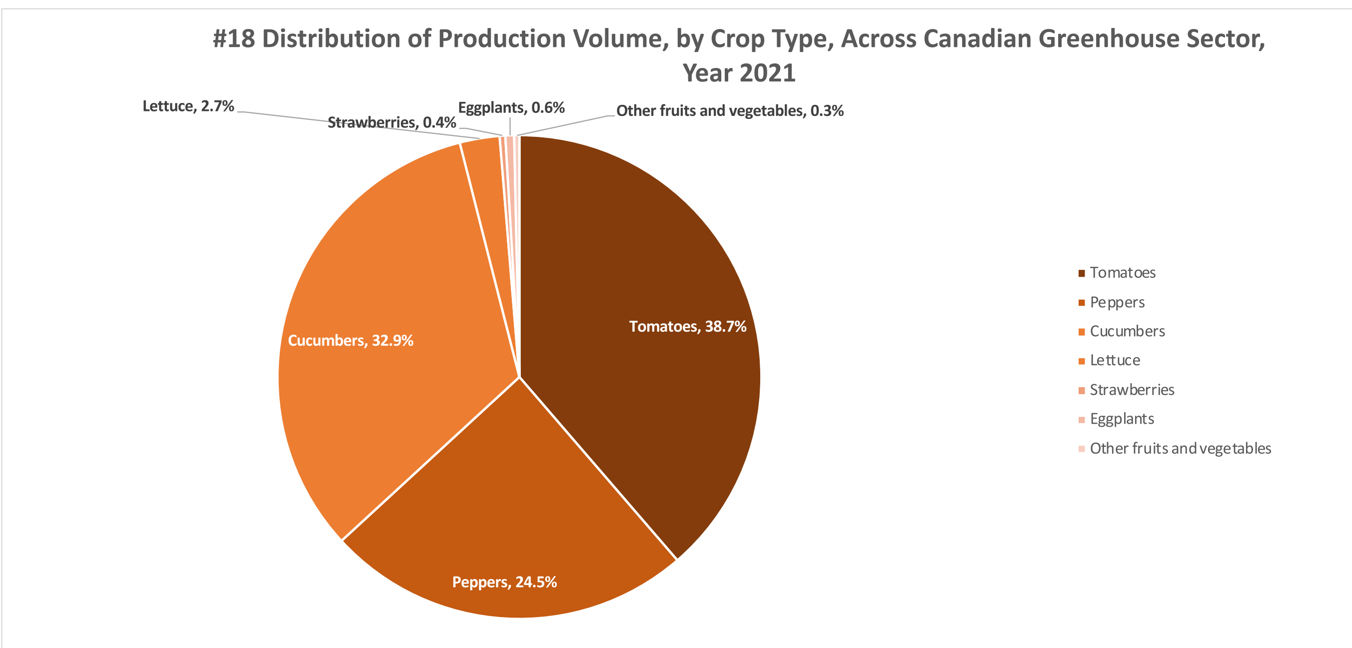
Distribution of Harvested Area (sq metres), by Crop Type, Across Canadian Greenhouse Sector, Year 2021

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



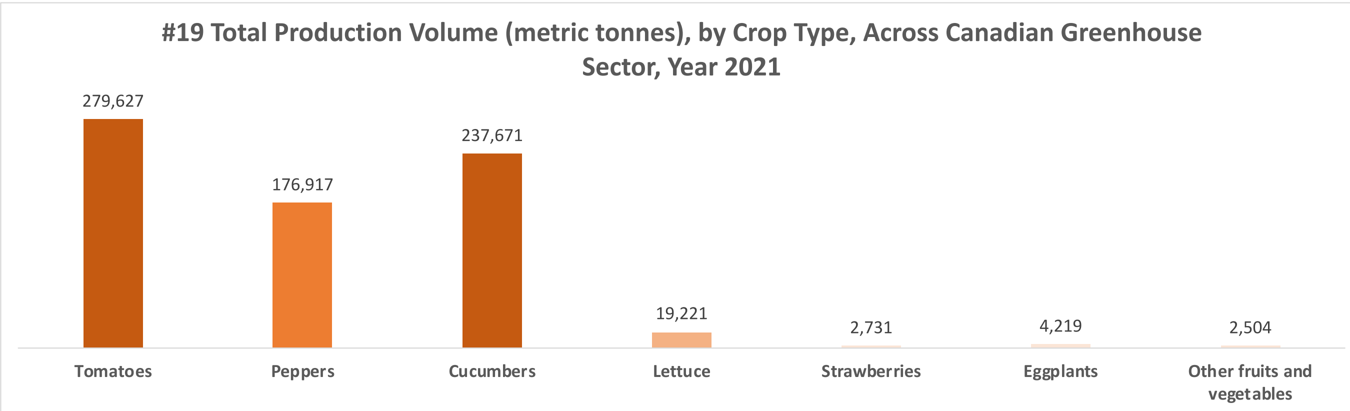
Total Harvested Area (sq metres), by Crop Type, Across Canadian Greenhouse Sector, Year 2021

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



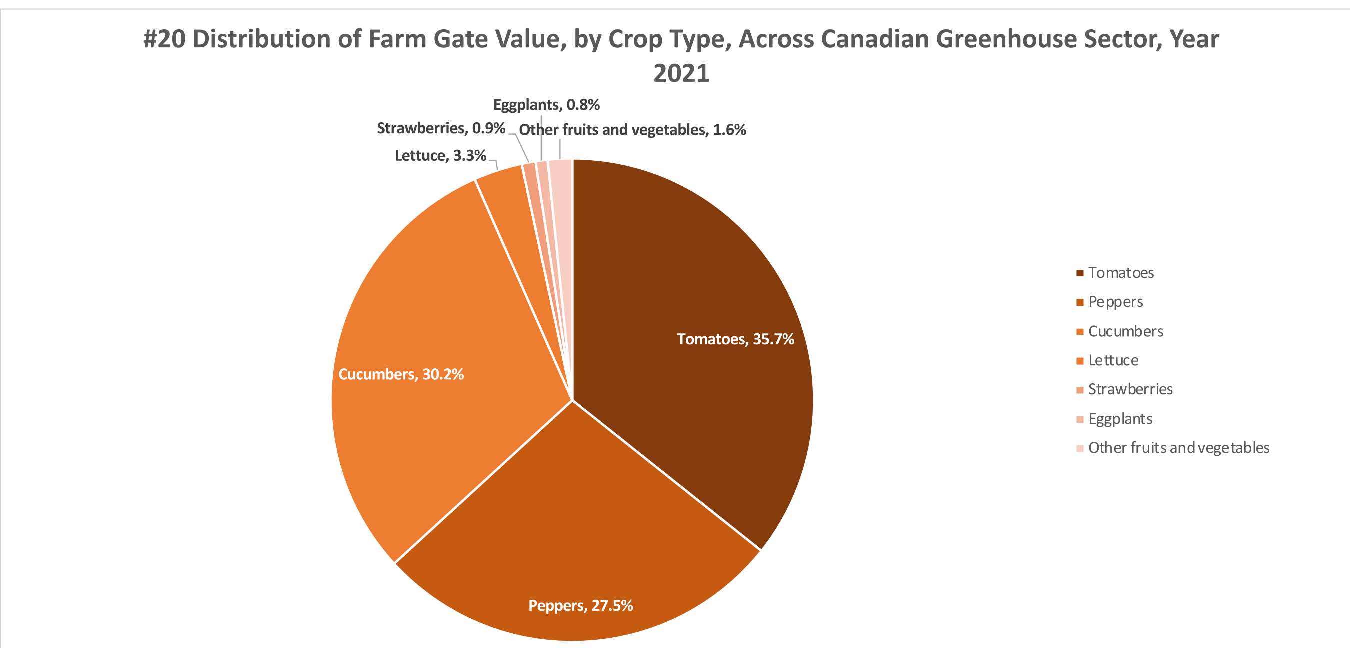
Distribution of Production Volume, by Crop Type, Across Canadian Greenhouse Sector, Year 2021

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



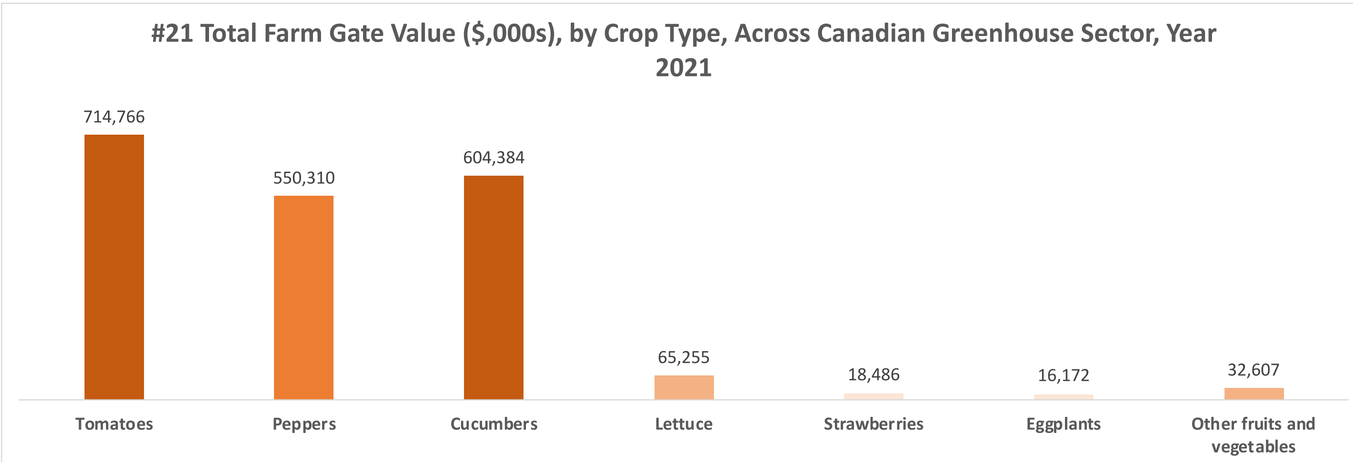
Total Production Volume (metric tonnes), by Crop Type, Across Canadian Greenhouse Sector, Year 2021

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



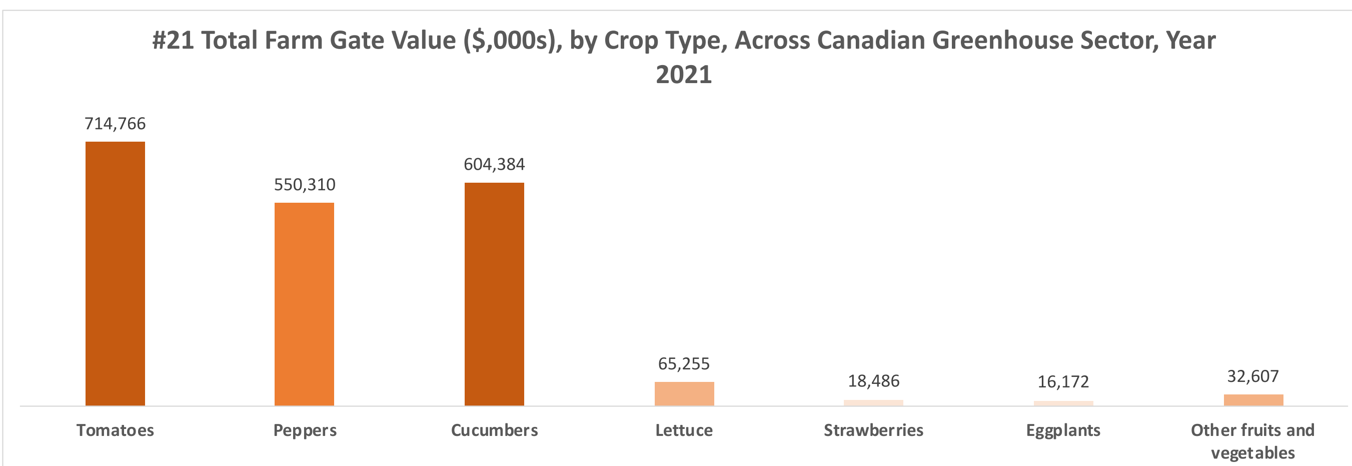
Distribution of Farm Gate Value, by Crop Type, Across Canadian Greenhouse Sector, Year 2021

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



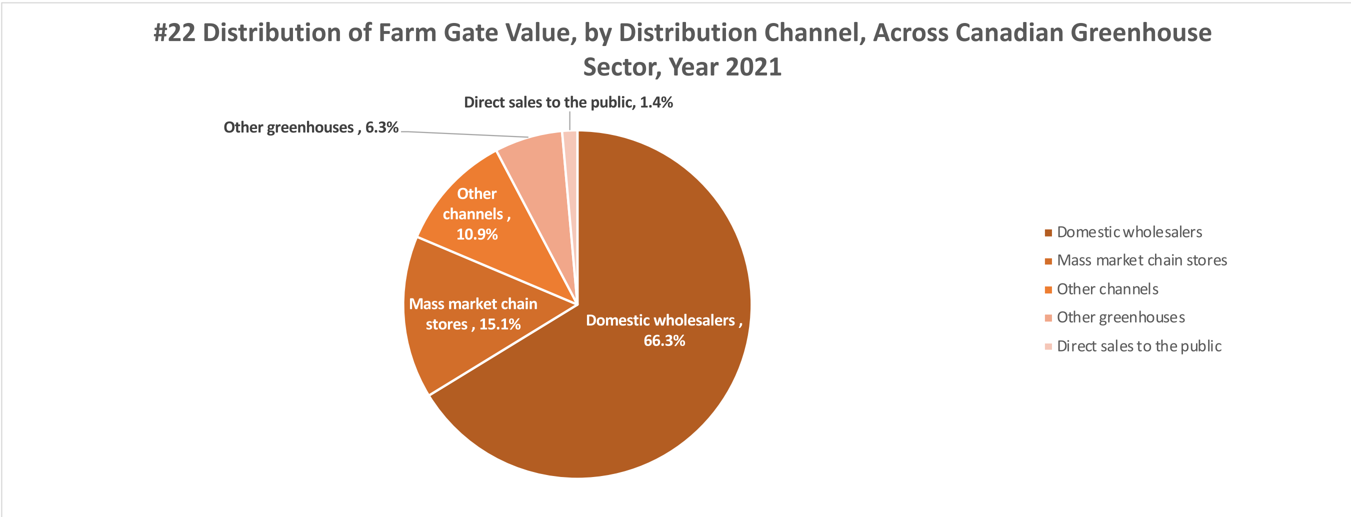
Distribution of Farm Gate Value, by Crop Type, Across Canadian Greenhouse Sector, Year 2021

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



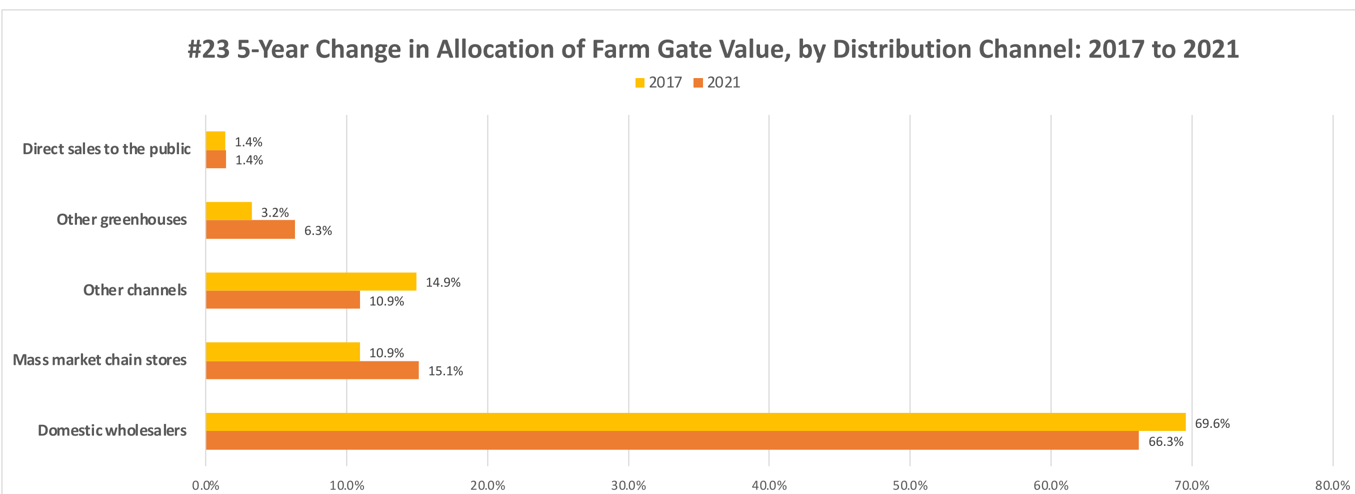
Total Farm Gate Value ($,000s), by Crop Type, Across Canadian Greenhouse Sector, Year 2021

Statistics Canada. Table 32-10-0456-01 Production and value of greenhouse fruits and vegetables (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210045601)



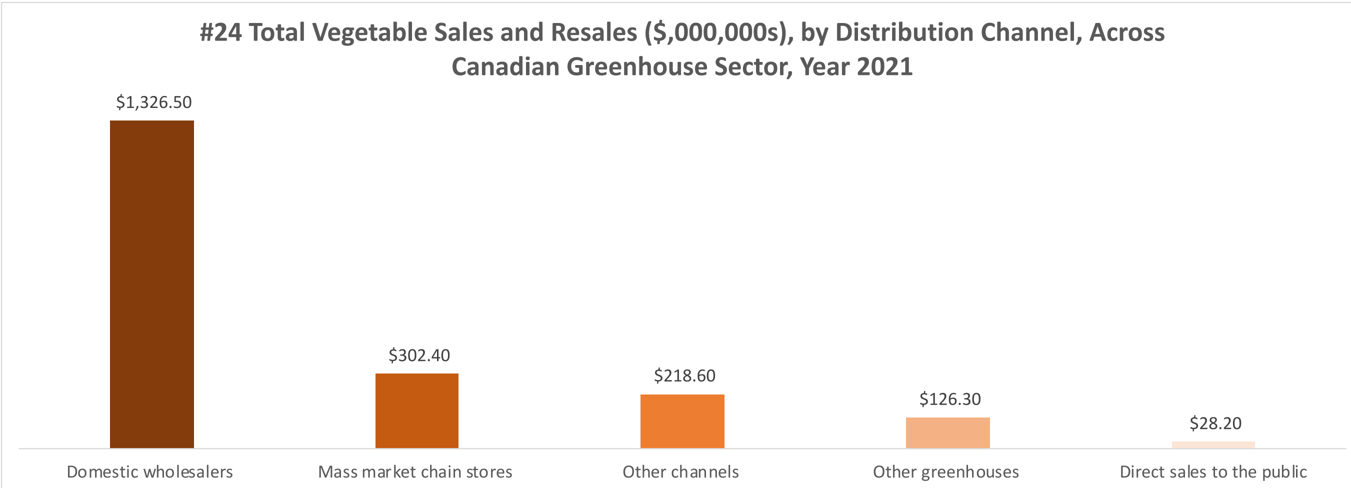
Distribution of Farm Gate Value, by Distribution Channel, Across Canadian Greenhouse Sector, Year 2021

Statistics Canada. Table 32-10-0022-01 Channels of distribution for horticulture product sales and resales (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210002201)



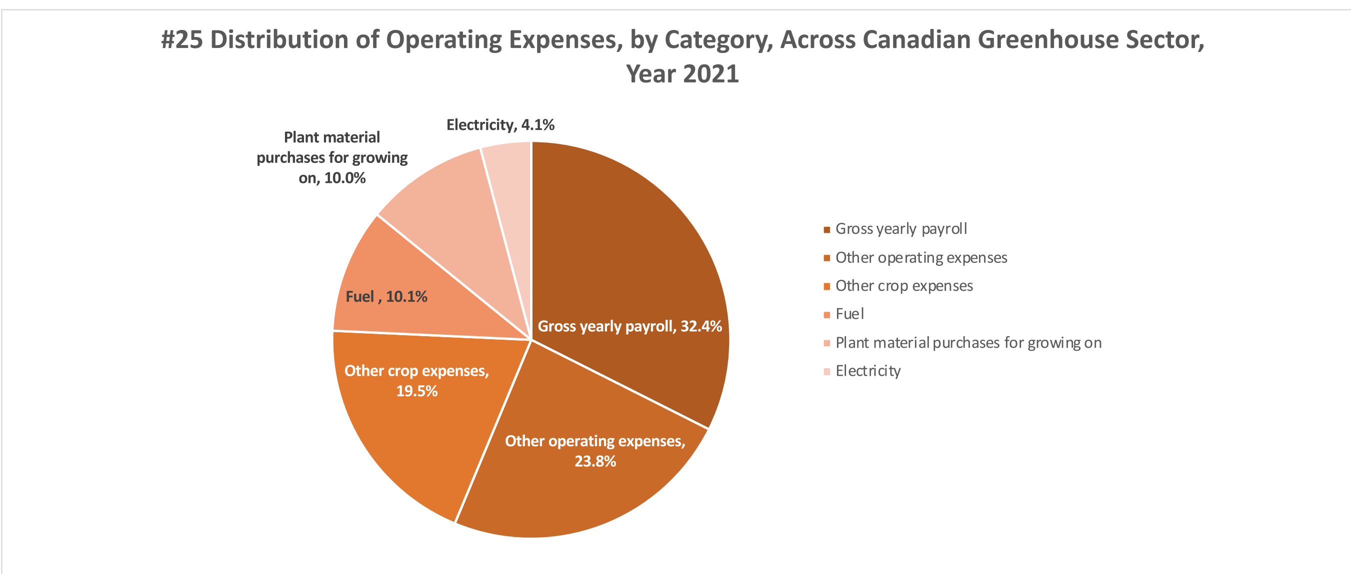
5-Year Change in Allocation of Farm Gate Value, by Distribution Channel: 2017-to-2021

Statistics Canada. Table 32-10-0022-01 Channels of distribution for horticulture product sales and resales (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210002201)



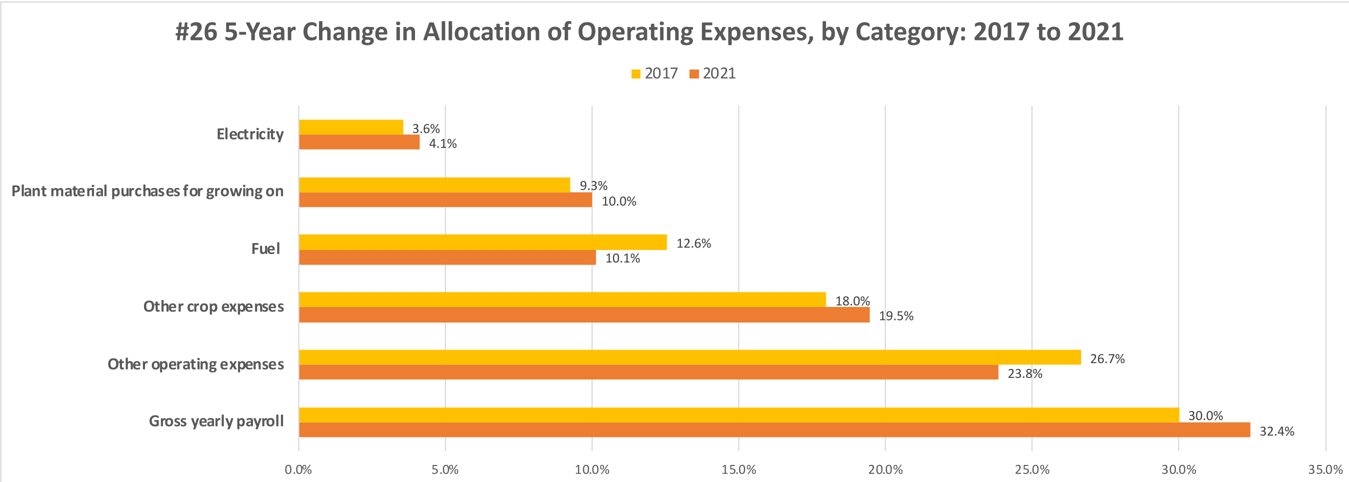
Total Vegetable Sales and Resales ($,000,000s), by Distribution Channel, Across Canadian Greenhouse Sector, Year 2021

Statistics Canada. Table 32-10-0022-01 Channels of distribution for horticulture product sales and resales (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210002201)



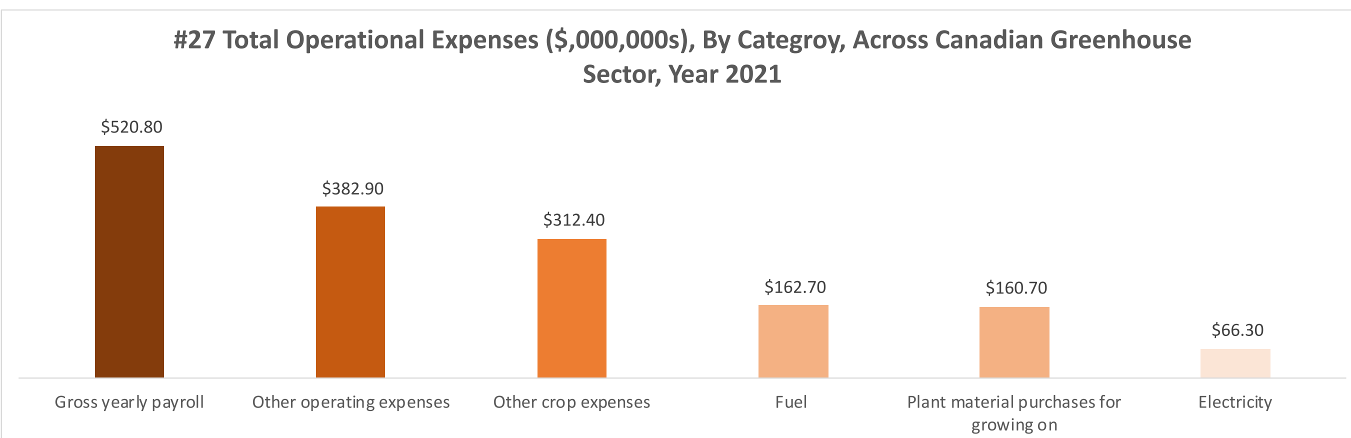
Distribution of Operating Expenses, by Category, Across Canadian Greenhouse Sector, Year 2021

Statistics Canada. Table 32-10-0025-01 Specialized greenhouse producers' operating expenses (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210002501)



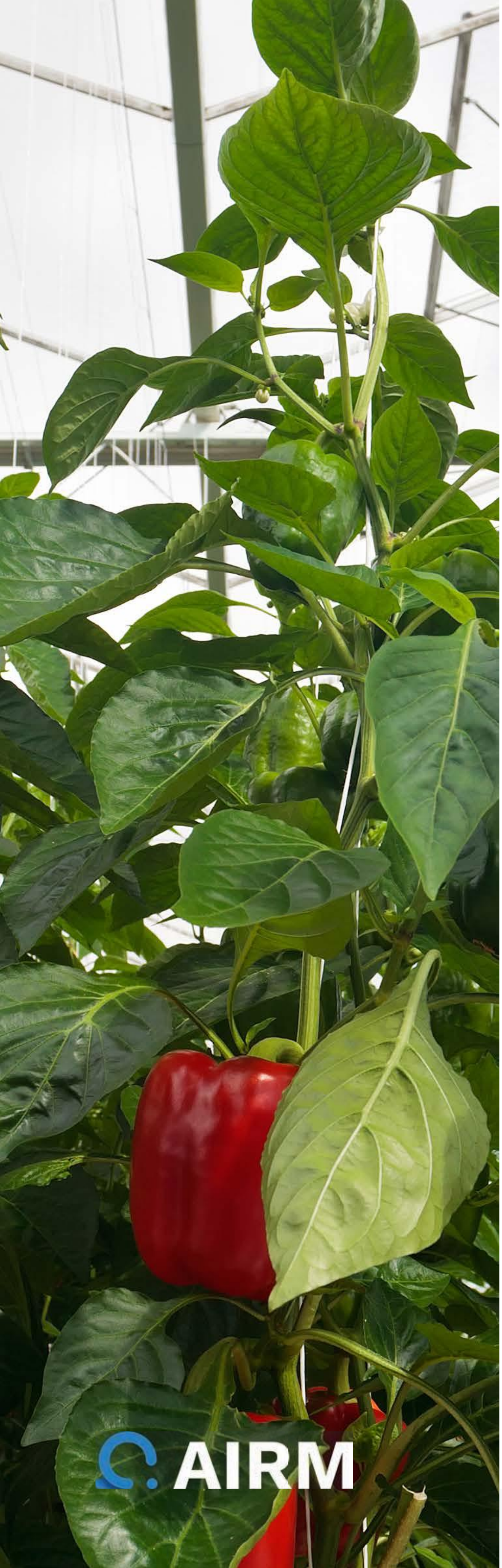
5-Year Change in Allocation of Operating Expenses, by Category: 2017 to 2021

Statistics Canada. Table 32-10-0025-01 Specialized greenhouse producers' operating expenses (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210002501)



Total Operational Expenses ($,000,000s), By Category, Across Canadian Greenhouse Sector, Year 2021

Statistics Canada. Table 32-10-0025-01 Specialized greenhouse producers' operating expenses (https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210002501)



Ontario Greenhouse Vegetable Growers Growth and Economic Prosperity Study Executive Summary

The potential for future successes for Ontario's greenhouse vegetable sector is high. There are many risks associated with the potential growth rates, and the direction of that growth. Navigating the complexities of all levels of government, community relationships, and access to necessary inputs like energy (i.e. electricity) and infrastructure (i.e. sanitary sewer systems) is critical to the successes ahead. The purpose of the study was to demonstrate the potential for high growth and profitability across the Ontario greenhouse vegetable sector; along with corresponding benefits to various stakeholders across the province.

The sector's Growth and Economic Prosperity study ultimately had 3 major goals:

1. Enhance the perception of the sector
2. Create useful content for community, government, and stakeholder engagement
3. Create an industry model to shape public policy, and facilitate justification for government investment

Ontario's greenhouse vegetable sector represents $2.3B in Gross Domestic Product (GDP) contribution, accounts for 81.6% of greenhouse vegetables exported out of Canada and is a significant employer providing more than 32,000 individuals ranging in skill level employment. A regional breakdown of the province's greenhouse operations is identified below.

Region	Acreage	GDP $	Farmgate Value	Export		Production	Jobs	
				Volume (Tn)	Value (CAD)	Volume (Tn)	Labour	Value Chain
Kingsville	947	$573,296,491	$327,632,713	91,233	$281,538,927	127,888	2,368	5,683
Leamington	1,968	$1,191,255,919	$680,789,809	189,574	$585,011,279	26,5740	4,920	11,809
Chatham-Kent	446	$269,876,202	$154,231,316	42,948	$32,532,918	60,203	1,115	2,675
Hamilton	60	$36,330,010	$20,762,206	5,781	$17,841,226	8,104	150	360
Niagara	107	$64,978,568	$37,134,545	10,341	$31,910,183	14,495	268	644
Other	271	$164,262,811	$93,874,411	26,140	$80,667,467	3,6643	678	1,628
Total	3,800	$2,300,000,000	$1,314,425,000	366,017	$1,129,502,000	513,074	32,300	

This study effectively sets those bias's aside and is agnostic of those elements. An Enterprise Risk Management (ERM) framework was developed for the sector, which is the first time in Ontario an ERM framework has been designed specifically for a segment of agriculture. The sectors' growth

contains inherent risks that impact farms differently depending on size and sophistication.

	Greenhouse #1	Greenhouse #2	Greenhouse #3	Greenhouse #4
	1 Crop	1 Crop	Multi-Crop	Multi-Crop
	< 15 Acres	15-40 Acres	< 15 Acres	15-40 Acres
Total Income (initial year)	$6,201,270	$10,291,016	$2,920,170	$44,242,206
Total Expenses (initial year)	$4,292,521	$10,168,755	$2,367,486	$38,315,506
Net Cash Flows (initial year)	$1,908,749	$122,261	$552,684	$5,926,700
Time-0 Discounted Cashflows (over 5-year projection)	$10,819,198	$2,468,549	$3,309,202	$35,338,238

The ERM identified more than 120 risks that were categorized and correlated to a distinct factor directly influencing farm operations in both optimistic (enabler) and adverse (inhibitor) scenarios. The upside (optimistic) and downside (adverse) risk-modelled scenarios resulted in the following impacts to cash flows:

Optimistic Enablers Generating Growth Opportunities			
Scenario	**Description**	**Impacted Variables**	**5 Year Gain**
1	Optimizing growing variables	Yield, pricing, input cost	+62%
2	Trade harmonization and demand	Pricing, trade & market access	+58%
3	Innovative technology implementation	Input cost/savings, yield	+39%
4	Reduced regulatory burden	Labor costs, yield	+48%
5	Climate impacts on outdoor agriculture	Yield, pricing, input costs	+49%
6	Access to and optimizing infrastructure	Input costs	+2%
7	Increased automation	Labor costs	+46%
Adverse Impacts Inhibiting Enablers			
1	Lack of labor supply	Labor costs	-27%
2	Increasing regulations	Labor costs, other costs	-37%
3	Lack of trade harmonization	Selling price	-50%
4	Oversupply of products (trade, disease)	Selling price	-89%
5	Inflationary and input pressures	Production/labor costs, selling price	-51%
6	High workforce turnover (less skilled)	Yield, quality, operating costs	-59%
7	Decreasing demand for vegetables	Selling price	-107%
8	Greater crop threats (pests, disease)	Yield, labor & input costs	-40%
9	Increased severe weather events	Production, operating costs	-53%

Key findings and recommendations concluded from the Growth and Economic Prosperity study include:

- Advances in technology (precision agriculture, climate control systems, LED lighting, integration of automation and robotics) can lead to increase in production at lower costs
- Provides competitive edge over traditional farming when confronting climate regulations
- Sector plays an increasing role in food security concerns, which is further compounded with projected population growth in Ontario
- Removal of government regulation leading to new costs and burdensome administration
- Create/expand programs that provide grants, or financial incentives, to companies and start-ups that specialize in technology applicable within the Greenhouse Sector.
- Establish partnerships with research centres and alliances between academia and industry to drive policy change while supporting innovation, such as through the Canadian Greenhouse Excellence Network (CGEN).
- Adoption of a strategy to optimize utility usage with available government support/ incentives to support implementation.
- Consideration of greenhouse labour needs within temporary foreign worker programs and/or immigration approval processes.

AIRM

AIRM Consulting Ltd. is an integrated team of scientists and engineers, building transformative solutions to solve some of the most complex challenges. Powered by a design driven innovation process, artificial intelligence (AI) is brought into the heart of day-to-day operations, delivering high-impact statistical insights, predictive models, and end-to-end business solutions. Core to AIRM's business is applying AI for applications in insurance and risk management, including specialization in the world's largest industry - agriculture.

With subject-matter expertise in areas such as actuarial science, insurance and risk management, economics, data science, and engineering, AIRM is dedicated to providing knowledge and expertise and helping clients uncover new capabilities and solutions.

Lead Researchers
Dr. Lysa Porth, MBA, PhD
Shawn Paladeau, ASA
Sheron Quereshi, MActSc, ASA
Jason Jiang, MSc, ASA

Ontario Greenhouse Vegetable Growers-Dr. Robert Petro

Undertaking Response to Commissioners

OGVG to canvass members on opportunities and roadblocks to financing.

Response:

In discussion with growers and lenders, it is our understanding that a 75% loan to value ratio is the standard for growers looking to build, expand, or purchase greenhouse farms. For financing operations, loans are based on income as a percentage of the value of goods sold by the farm. The larger expansions are understood to be driven, in part, by efficiencies available with larger farms and negligible incremental risk in the cost of financing 30 acres in place of 20 acres.

Investments in greenhouse farms can also be done through term lending with the term and interest rate of the financial vehicle predicated on the history of operations, value, income, and ability to service the debt. The standard loan to value ratio for term lending is again 75% with the grower having 25% in value (cash), but the ratio can change based on the revenues and financial position of the business.

For technological upgrades and investments, most lenders offer equipment financing through a leasing company where the equipment is leased at a 100% financing rate. The amortization rate varies based on the expected life of the technology. These investments include proven technologies that will benefit the business and include lights, generators, and pack-lines. Farms typically strive for a 2-to-5-year return on investment (ROI) for technological investments.

Lenders increasingly have “green” finance programs offering preferred (lower) rates for upgrades that provide quantifiable and demonstrable reduction in emissions that support “net zero” goals. Upgrades to lower emissions by improving farm efficiency include upgrading boilers, climate control systems, and can include cogeneration to supply electricity on farm. In general, energy technologies such as installing a 2 MW cogeneration unit may qualify for lower rates and/or green financing.

Unproven technologies would require equity financing at the current loan to value ratio due to indeterminate ROI. In the scenario where a farm is seeking to utilize an unproven, or financially detrimental technology not based on realities in the market, such as input or operating costs, the lender will work to understand the goal of the investment. Ultimately, the risk will be borne by the farm as the lender will not necessarily intervene should the farm make choices that will negatively impact the debt serviceability of the business. Generally, the interest rate on financial vehicles is dependent on risk rating of the business and not necessarily based on the Prime Rate.

Ontario Greenhouse Vegetable Growers-Dr. Robert Petro

Undertaking Response to Commissioners

OGVG to provide the cost of hydrogen used in the hydrogen blending test referred to in Dr. Petro's evidence, on a confidential basis, if necessary.

Response:

The combined cost of hydrogen generated from electrolysis depends on the cost of electricity, cost of water, interest rates, and the capital costs of the electrolyser. The HIGH energy project envisions sourcing electricity from a nearby windfarm at an estimated cost of \$50/MWh. Based on the specifications of the Cummins Hylyzer 1000[4], before capital costs, hydrogen could theoretically be produced for \$2.56/kg given electricity prices of \$50/MWh and water costs of \$2.00/m^3, consistent with the municipal cost of water in the Leamington/Kingsville area. Including capital costs and interest rates, the combined cost is estimated at \$4/kg to \$8/kg of hydrogen generated. The higher end of the estimate comes from several factors including reinforcing electrical supply from the grid at around \$100/MWh bringing the pre-capital cost of generating hydrogen to \$5.12/kg.

The current assumed cost of production is in line with European estimate for the cost of production. "Green hydrogen produced with renewable resources costs between about \$3/kg and \$6.55/kg, according to the European Commission's July 2020 hydrogen strategy."[5]

The HIGH energy project has received funding to proceed and is currently assessing data for the design and build of the project. The assumed cost is based solely on specifications of the project which has received funding to proceed. The costs of hydrogen will become increasingly determinate reducing uncertainties as the project moves forward.

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[4] https://www.cummins.com/sites/default/files/2021-08/cummins-hylyzer-1000-specsheet.pdf

[5] https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/experts-explain-why-green-hydrogen-costs-have-fallen-and-will-keep-falling-63037203

Ontario Greenhouse Vegetable Growers-Dr. Robert Petro

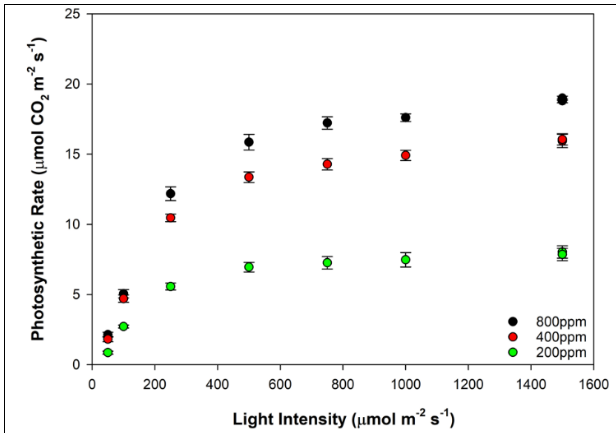
Undertaking Response to Commissioners

OGVG to file information from Agriculture and Agri-food Canada on measurements for photosynthesis and the carbon dioxide uptake at different ambient concentrations.

Response:

The most conservative estimates for aggregate biomass sequestration of CO_2 across the sector is 20% of fossil fuel emissions, but the values vary wildly based on the technological modernity of each farm. Greenhouse capture and sequestration of CO_2 is highly variable as the "rate of consumption varies with crop, light intensity, temperature, stage of crop development and nutrient level[6]". At the highest level of precision greenhouse farming, >90% of emissions can theoretically be captured by the crop.

An average consumption level is estimated to be between 0.12–0.24 kg/hr/100 m^2 but modern farming practices most specifically lighting, increase the rate to more than 0.72 kg/hr/100 m^2 (20 µmol/m^2/s)[7], see below graph from Greenhouse Production course through OMAFRA in 2022 and 2023.



400ppm is typical ambient CO_2 levels; 200ppm would represent a fully closed greenhouse on a sunny day when plants have high photosynthetic rates and the CO2 they are up taking isn't being replenished; 800 ppm is the minimum supplementation level.

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[6] https://www.ontario.ca/page/supplemental-carbon-dioxide-greenhouses, Originally Published December 2002; Updated: July 08, 2022, Republished: July 08, 2022; CO_2 numbers not updated in 2022 publication.
[7] Graph has been presented at the Greenhouse Production course through OMAFRA in 2022 and 2023, no citation available.

Many different estimates are possible for the sequestration of CO_2. Based on the 2002 OMAFRA document, “approximately 0.37 kg CO_2/100 m^2 [15 kg/acre] must be added to maintain the desired level of 1,300 ppm CO_2” to compensate for air exchange. Considering modern supplementation practices of 40 kg/acre to 60 kg/acre place the efficiency at 37.5% to 75%. Taking the assumption of CO_2 consumption from photosynthesis and air exchange being exactly replaced, the estimate of CO_2 sequestration is 24% to 66% on any given farm.

Strictly speaking, greenhouses use 100% of the CO_2 applied within the greenhouse to stimulate growth and yield. The benefits of supplementation include decreasing the time to flowering, shortening of the production cycle, biomass gain, and overall productivity of the crop[8]. It is in the interest of all greenhouses to maximize the efficiency of natural gas and minimize losses to the environment. Under Sun Acres Inc., a greenhouse operation in Staples, Ontario, worked with Enbridge Gas to offset the costs of a greenhouse insulation project by over $45,000. They now save an estimated 227,500 cubic metres of natural gas annually[9] while still maintaining the required concentration of CO_2 for proper supplementation. The aggregate efficiency gains are ongoing as farms strive to maximize their efficiency and minimize losses both economically and environmentally.

[8] https://pubmed.ncbi.nlm.nih.gov/30335803/ J. Lanoue et al., Effect of elevated CO2 and spectral quality on whole plant gas exchange patterns in tomatoes, DOI: 10.1371/journal.pone.0205861

[9] https://www.enbridgegas.com/business-industrial/incentives-conservation/success-stories/under-sun-acres