Preserving Agriculture through Wine:

Examining The Opportunity For Ontario's Wine Industry To Pioneer Agricultural Resilience In The Face Of Climate Change.

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A major research project submitted to OCAD University in partial fulfillment of the requirements
for the degree of Master of Design in Strategic Foresight & Innovation
Toronto, Ontario, Canada, 2019

Abstract

The wine industry is a globally established example of an elite agricultural and consumer business that is socially and economically important to sustain. Climate change is already negatively impacting the industry and is predicted to become even more unstable in the future. Vintners are uniquely primed for futures-thinking, and an opportunity thus exists for the wine industry to pave the way for sustainable climate leadership. Using Curry and Hodgson's Three Horizons model as an analytical framework, this project aims to explore an opportunity for the Ontario wine industry to become a leader in climate crisis resilience. First, context is set through a better understanding of challenges that live at the intersection of climate change, agriculture and the wine industry. Next, insights are drawn from examining both the current and imagined future state of Ontario's wine industry. And finally, the research closes with a discussion of proposed strategies that can possibly bring a preferred Ontario wine industry future to life.

Acknowledgements

I would like to express my profound appreciation for everyone who has contributed to this MRP project in some way. This research would not have been possible without your generous contributions.

First, to this Earth: Thank you for your unconditional love. I wish to acknowledge the land that this research was conducted on is the traditional territory of many nations including the Mississaugas of the Credit, the Anishnabeg, the Chippewa, the Haudenosaunee and the Wendat peoples and is now home to many diverse First Nations, Inuit and Métis peoples.

To Ian Clarke, the Associate Dean of Faculty of Liberal Arts and Sciences at OCAD University: I am grateful for your unwavering guidance over the last eight months. It was an honour and a privilege to work alongside you.

To Jayar Lafontaine, my secondary advisor, and colleague: Thank you for inspiring me.

To my SFI peers: Thank you for your constructive suggestions, vast expertise across disciplines, continuous exchange of ideas and above all, moral support.

To Ryan Doyle (Idea Couture), Meredith McLean (Accenture), and Howard Goldkrand (Accenture): As a full-time professional who was trying to write an MRP on the side, I could not have had better luck than to have you as my superiors at my place of work. The support you have provided to me over the last three years has not been taken for granted.

And finally, to my family and friends: it means the world to me that you are proud of my accomplishments.

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Introduction

Research Question: Can we use Ontario's wine industry as an example of how strategic foresight could be used to help the agriculture industry remain resilient in the face of climate change?

This report will place focus on the changing climate and how it might impact the wine industry of the future. The wine industry is a globally established example of an elite agricultural and consumer business that is socially and economically important to sustain. It can be argued that the wine industry is also a future-oriented industry. This is because it can take up to ten years to produce a decent wine from young vines ("The Life Cycle of a Wine Grape," 2016). Therefore, grape farmers (or, winemakers/vintners) are required to make long term plans and investments, and even innovate their agricultural practices in advance of other crop farmers ("The Life Cycle of a Wine Grape," 2016). There is an opportunity for the wine industry to leverage their unique leadership position within the agriculture sector to pioneer the discovery, testing, and validation of novel sustainable farming practices. Therefore, could the broader agriculture industry look to the wine industry for guidance on thinking with a longer time horizon in mind? Could the wine industry be used as an example of how strategic foresight could be used to help the agriculture industry as a whole remain resilient, especially in the face of climate change?

Specifically, this report will dive deeper into Ontario's Niagara Peninsula, a nascent yet booming cold-climate wine region. Climate change is already impacting the international wine industry (Pickering et al., 2015). For example, the Champagne region in France is struggling to produce fine wines due to hotter summers and warmer winters, and wineries in Spain are looking to relocate their vines at higher elevations, such as the Pyrenees mountains (Asimov, 2019). Similar to the rest of the world, the Niagara Peninsula will also experience challenges associated with anthropogenic climate change. Not only will Ontario's climate also gradually become warmer, there will be associated challenges such as changes in precipitation amounts and patterns as well as more frequent extreme weather events (IPCC, 2019). These conditions

pose potential challenges to both the wine industry and the agriculture industry as a whole. However, some research suggests that Ontario's future climate shifts might also provide opportunities for more favourable conditions for grape growth, given the geographical and latitudinal location (Pickering et al., 2015). For example, warmer winters are creating opportunities for extending Ontario's wine region more North and allowing for varietal expansion less traditionally associated with cool-climate wine regions (Pickering et al., 2015). In addition to Ontario's vintners paving the path to agricultural resilience, they also have the opportunity to get a head-start on future-proofing and growing Canadian businesses, giving them a competitive edge on the global economic and political scale.

Finally, it is important to acknowledge that this report is written for an audience who believes that climate change is real, and more importantly, that humans are in a position to act as change agents to help mitigate the effects. In a similar vein, it is also important to acknowledge that wine, as well as any alcohol-based beverage, when misused, can be dangerous to both the individual and society. This report acknowledges the negative aspects, but for the purpose of this research remains to focus on the positive aspects that wine can contribute.

Foreword

This section aims to provide a brief overview of two analytical tools used in this report: Three Horizons model and STEEP+V analysis. In addition, this section will provide definitions for key terms used throughout the report.

STEEP+V

To gain insight into the possible futures for the Ontario wine industry, a foresight trends scan was conducted wherein weak signals of change was identified. Each signal has been classified using the STEEP+V taxonomy (Social, Technological, Economic, Environmental, Political, Values). This analysis is not to be considered comprehensive, due to time limitations. In this report, the foresight trends supplement data gathered from the literature review and is considered in the analysis portion within the Three Horizons model. A list of the foresight trends uncovered for this report can be found on page 31 of this report.

Three Horizons Model

The major analytic framework of this report leverages the Curry & Hodgson's Three Horizons model. This is a strategic foresight analytical tool that illustrates three conditions of the same system, over time, against its level of viability in its changing external environment (Curry & Hodgson, 2008). First, a conceptual description will be provided, and then an overview of how the tool will be used in the context of this report will be provided. Conditions are mapped against strategic fit on the y-axis, which is measured against the conditions of the evolving external environment, and time on the x-axis. See Figure 1 below for a high-level conceptual representation.

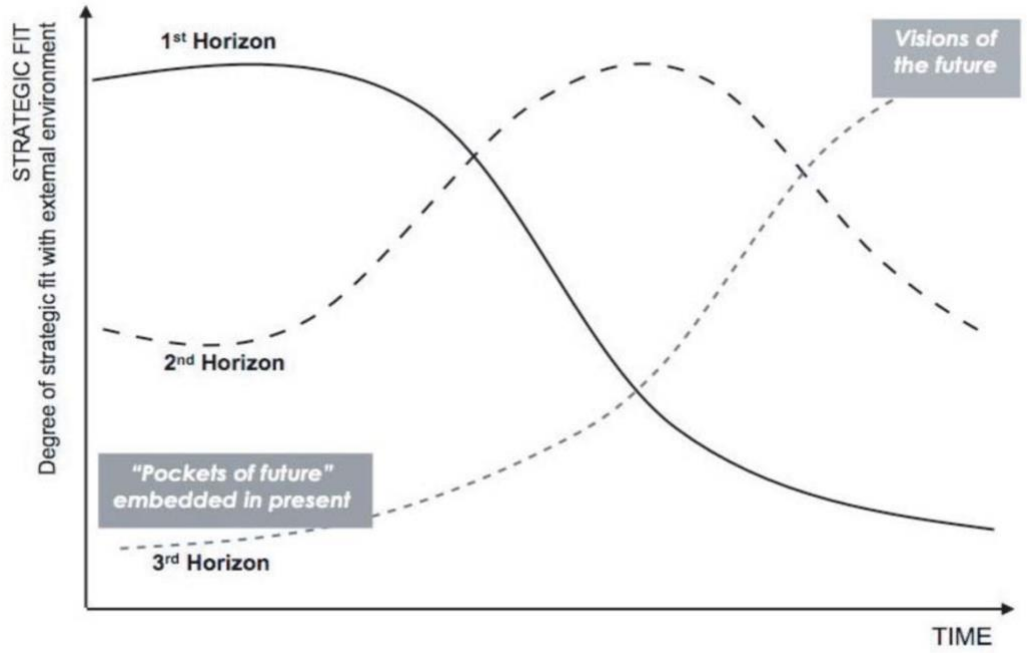

Figure 1: Representation of the Conceptual Three Horizons Model (Curry & Hodgson, 2008)

Over time, it is believed that the condition's strategic fit will change; it will either grow or fade out, and this is due to the condition's response to change in the external environment.

The first horizon (H1) is the most conceptually relatable as it represents current prevailing conditions. H1 can be referred to as the status quo. By tracking the fade in H1 conditions over time, it can be deduced that the current system is under strain because it loses strategic fit over time. On the other hand, the opposite can be seen when examining the third horizon (H3). H3 allows for imagining a preferred future-state and reveals trends that represent pockets of the future in the present which can grow to become dominant over time.

Finally, there is the Second Horizon (H2), which navigates tensions from the wavering status quo and reinforces trends that might lead to a preferred future-state. Reinforcement is often driven by desire for change or social alignment in vision, values, and beliefs. This unstable horizon positioned between present and future represents both the driver of positive changes that might fuel growth for future systems and challenges that must be overcome in order to replace the broken status quo.

There are a few important notes regarding the Three Horizons model that must be acknowledged: there are many possible alternative futures even though the diagram suggests that there is only one, attaining a preferred future-state might not ever be possible, and all three horizons exist in parallel with different levels of social and public influence at any one time.

While thinking about and planning for the future is complex, the Three Horizons tool simplifies the process by providing a structured model that bridge futures studies with business strategy. Strategic foresight pushes organizational thinking beyond its standard strategic planning timeframe in order to spark innovation, enable critical decision-making, and unlock hidden opportunities ("IC/ futures," n.d.). In this report, the Three Horizons model will be used to examine the state of Ontario's wine industry. See Figure 2 below for an overview of how it will be used as it pertains to this report.

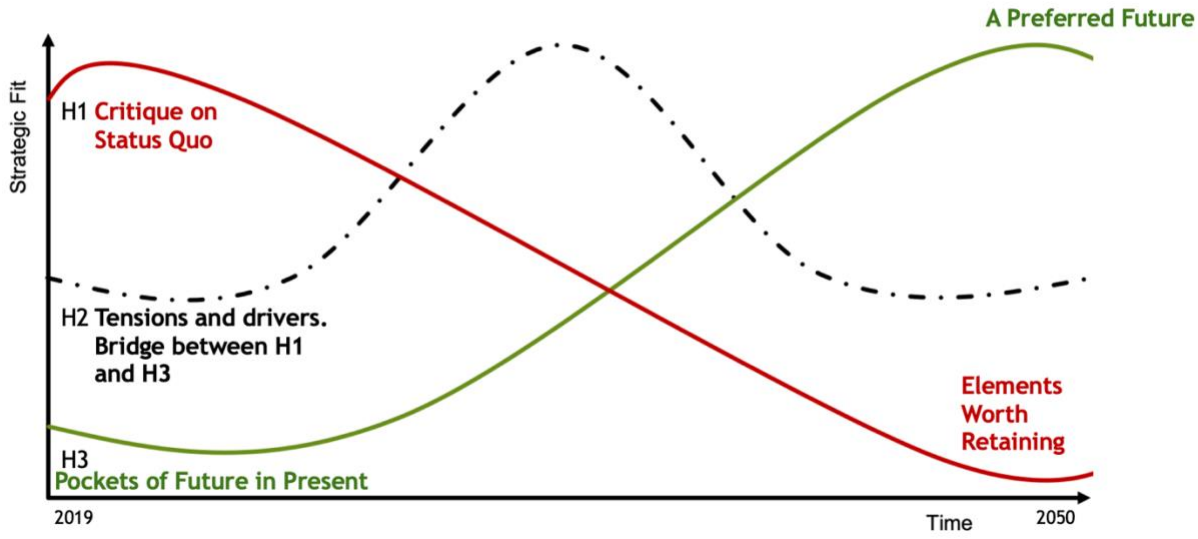

Figure 2: Three Horizons Model as Relevant to the Ontario Wine Industry (Adapted from Curry & Hodgson, 2008)

The selected timeline on the x-axis projects from present day (2019) to 2050. H1 will provide a critique on the dominant conditions (status quo) in the present and discuss certain elements that are worth retaining in the future. H3 will reveal pockets of the future that are marginally

present in 2019 and also allow for imagining a preferred future for Ontario wine industry. H2 will then be used as the basis for the discussion portion of this report, as resulting tensions and drivers are examined in greater detail.

For the Ontario wine industry, it would be beneficial to apply strategic foresight, for instance with the Three Horizons tool, in order to become better equipped to anticipate and manage change. By leveraging the Three Horizons tool, vintners could strategically discuss transformative tensions and drivers, extract exploratory insights, and devise strategies for how to bring these transformations about. Effectively, by leveraging strategic foresight tools, the Ontario wine industry can design for resiliency, and carry on those lessons to the broader agriculture industry.

As a final note, it is important to acknowledge that it is best to leverage the Three Horizons tool during a generative group activity where multiple diverse perspectives are informing all three horizons. Given the time and participatory constraints of this research, the Three Horizons analysis in this report was conducted by the author alone. It would, however, be a critical next step to validate and further ideate on this concept with a larger group of industry-relevant participants.

Definitions

- **A vintner** is a person who grows or produces wine (Vintner | Definition of Vintner at Dictionary.com, n.d.)
- **Agricultural Sustainability** is defined by three main objectives: social well-being, economic prosperity, and a healthy environment (Adapted from FAO, n.d.).
- **Resilience** is the capacity of a system to deal with change and continue to develop, spur renewal and inspire innovative thinking (Stockholm Resilience Centre, 2013).
- **Biodynamic Farming** is a method of farming that emphasizes creating a self-sufficient, biodiverse, and healthy ecosystem. A biodynamic farm is managed as a living organism, as it includes the natural environment as part of the overall farming system. While it is similar to organic farming in that it also eliminates the use of chemical pesticides, fertilizers, growth hormones and other additives for the benefit of human health, it also contributes to the environment's natural resources (Delmas, 2010).

Methodology

The methodology for this research is broken down into four parts: Discover, Define, Analyze and Discuss. First, an in-depth literature review was conducted and then the gathered information was analyzed using the Three Horizons Model framework, supplemented with a STEEP+V trends analysis. The analysis then revealed interesting insights from which a discussion was based. Finally, strategic next steps and opportunity areas were identified that aim to help further elevate the wine industry into an agricultural sustainability leadership position.

Discover: An in-depth literature review

A literature review utilizing both scholarly and popular sources was conducted to understand challenges at the intersection of agriculture, climate change, and Ontario's wine industry. Initially, this research aimed to better understand how future climate conditions might impact the agriculture industry. The scope of this initial research was too big, therefore it was decided to focus on the Ontario wine industry as it allows for investigation of the challenge area from an interesting and local perspective. In order to focus the climate research to what is valuable for the topic of grape production within Ontario only a few select climate conditions and their impact will be discussed in this report, including increased frequency and intensity of extreme events, unpredictable temperatures and precipitation levels, and increased outbreaks of pests and disease. In addition, this research was also designed to be future-oriented. Reliable scientific data on future climate conditions already exist through the United Nations' Intergovernmental Panel on Climate Change (IPCC). These experts have generated several reports that evaluate current impacts and future risks of a changing climate, and that information has been leveraged in this research to identify relevant future climate scenarios that might impact the agriculture industry.

Define: Opportunity for Ontario's wine industry to pave the way for agricultural resilience

Once there was a clear understanding of challenges that exist at the intersection of climate change, agriculture and Ontario's wine industry, the research problem was framed as follows: there is an urgent need to sustain the agriculture industry and make it resilient to the forces of climate change. The opportunity stemmed from a newfound understanding of the wine

industry and the insight that Ontario vintners might be able to pioneer the resilience movement due to their longer-term mindset and unique position in the global wine world.

Analyze: Three Horizon's model as an analytic framework

A foresight trends scan was conducted, whose inputs comprised of various weak signals of change using the STEEP+V analytical framework and were sourced from available online popular sources such as blogs. Data from the literature review were combined with the foresight scan and then analyzed through the Three Horizons model - a strategic foresight tool that helps to investigate system-level transformation at longer timeframes. This tool allowed for examining the state of Ontario's wine industry and imagining a preferred future state.

Discuss: How might the preferred future be achieved?

The Three Horizons model revealed certain tensions and drivers that need to be overcome or reinforced (respectively) should a preferred future state be achieved. At this stage of the research, proposed strategies and ideas for how to bring these strategies to life were discussed.

Considering the timing constraints for the submission of this report, the information gathering was limited to a literature review. Without time constraints, it would be optimal if the literature review could be supplemented with in-person interviews or generative and participatory dialogue around how all three topics intersect within the Niagara Peninsula region in Ontario. This type of research is especially interesting when investigating a topic such as wine, that is best explored with the senses - physically amongst vineyards, tasting, touching and learning from experts.

Part 1: Agriculture and Climate Crisis Context

The modern agriculture industry has earned much financial success, but not without a price. While many farmers were preoccupied with increasing yields and profits, the planet suffered as environmental health was neglected. The agriculture industry has come to an inflection point, as it must start to operate more sustainably in order to survive amongst the rapidly changing climate. Ample evidence exists to support that the planet is already experiencing a climate crisis, brought on in part by human influence, which has created chaos to the ecosystem. Further, it is predicted that these chaotic climate conditions will only become amplified in the future (IPCC, 2019). This section will provide detail into current and future climate impacts in Canada and explore the relationship between agriculture and climate.

Agriculture

Hunter-gatherers brought the concept of agriculture to life during the Neolithic Revolution when they exchanged their nomadic lifestyle for a more domesticated and sedentary one (Svizzero & Tisdell, 2014). This stationed way of life became one of the most prominent drivers that elevated human society. The knowledge to grow plants and crops was a prominent factor in forming high-density settlements, creating jobs, and introducing trade relations ("History of agriculture," n.d.). Over time, farmers developed and passed on knowledge from generation to generation, paving the way for modern agricultural methods and technologies such as the use of fossil fuels and equipment, plant breeding, monoculture, and invention of genetically modified organism foods (FAO, n.d.). Today, agriculture is an entire industry of its own - and a profitable one at that, contributing over $1 Trillion to the United States Gross Domestic Product (GDP) in 2017 ("USDA ERS - Ag and Food Sectors and the Economy," n.d.). It is a very important system responsible for feeding the many billions of people on this earth (FAO, n.d.).

However, the modern agricultural industry has focused on economic success at the expense of environmental sustainability. Agricultural practices that prioritized increasing yields and profits often times rely on high-carbon energy and thus produce negative impacts on natural resources (FAO, n.d.). Industrial farming generates approximately 8% of Canada's greenhouse gas emissions, stemming from a variety of sources such as the use of gas-powered machinery, livestock operations, and fertilizers (Agriculture and Climate Change | Climate Atlas of Canada, 2019). Unsustainable farming practices such as those have contributed to approximately one-third of Earth's farmland being degraded (FAO, n.d.) and resulted in soil erosion, prominence of

monoculture farming, and loss of biodiversity (Wanza, 2018). The ultimate impact of unsustainable farming practices is that it degrades natural resources at a time when they are becoming increasingly rare and when the demand for food security is increasing rapidly due to population growth (FAO, n.d.).

Looking to the future, care must be taken to ensure that agricultural methods remain in harmony with the environment ("History of agriculture," n.d.). As part of the United Nations' 2030 Agenda for Sustainable Development Goals, there is a need to further promote sustainable agriculture of all crops - including wine grapes (UN, 2019). To be sustainable, agriculture must meet the needs of present and future generations, while ensuring social well-being, economic prosperity, and a healthy environment (FAO, n.d.). Some farmers have already begun to explore innovative ways to reduce emissions and pursue land-use practices that might help mitigate climate change (Agriculture and Climate Change | Climate Atlas of Canada, 2019). Strategies include different crop cultivation and rotation strategies, transitioning to lower-carbon fuel sources, improving fertilizers and fertilizer application approaches, improving soil carbon sequestration, and using gas-capture systems for livestock and manure (Agriculture and Climate Change | Climate Atlas of Canada, 2019). In addition, agricultural systems must design for resilience so that they are able to better withstand unforeseen changes and shocks, such as a climate crisis (Stockholm Resilience Centre, 2013). Significant evidence exists to support that a global climate crisis is already underway, as proven by global warming, unpredictable temperature and precipitation levels, and increased occurrences of extreme weather events (Canada's Changing Climate Report, 2019). And from what experts at the IPCC are speculating, future climate conditions will only become more chaotic, putting the agriculture industry at risk (IPCC, 2019). The agricultural sector is ripe with innovation opportunities to ensure that the industry continues to provide food security for billions of people while ensuring economic prosperity and possessing the potential to mitigate climate change.

Climate

The Intergovernmental Panel on Climate Change (IPCC) is an organization of the United Nations responsible for providing scientific data-led information about anthropogenic climate change, from both a historical and futures-oriented perspective. The IPCC has published reports stating that the climate is changing and that human activities are likely to have caused it. An average of 1°C of global warming since the industrial revolution has already occurred, and the temperatures will increase at least another 1.5°C between 2030 and 2052 if global warming continues to increase at its current rate (IPCC, 2019). In Canada, climate change impacts have caused disruptive changes in temperature levels, precipitation levels, freshwater availability, sea levels, and resulted in catastrophic in extreme climate conditions (Canada's Changing Climate Report, 2019). With a pending warming increase, climate conditions are predicted to be even more chaotic (IPCC, 2019).

Canada's climate has warmed and it will continue to warm further in the future (Canada's Changing Climate Report, 2019). Since 1950, the estimated temperature increase is 1.7ºC for Canada as a whole, which almost doubles the global average. This means that, on average, Canada is warming almost twice as fast as the rest of the world. While a significant driver of the warming is attributed to Northern Canada, annual and seasonal temperature increase has been observed throughout the country and is also projected to increase everywhere throughout the country as well (with greater warming poleward). In a future-oriented high emission scenario, temperature increases could reach more than 6ºC by the late 21st century (Canada's Changing Climate Report, 2019). The projected intensified effects are likely to result in more extreme heat, less extreme cold, longer growing seasons, and shorter snow and frost seasons (Canada's Changing Climate Report, 2019). For agriculture, this current and speculative future warming has many implications (Agriculture and Climate Change | Climate Atlas of Canada, 2019). While hotter summers, warmer winters, and longer growing seasons might appear to be positive impacts for growing crops, it also exposes the industry to high temperature events, such as the

case of hundreds of dairy cattle dying in Ontario between 2010 and 2012 due to extreme heat (Bishop-Williams et al., 2015). On the other hand, these changes might allow for new crops to be experimented with and successfully grown as length of growing season, average temperature, and timing and severity of hot and cold surges are all factors that determine what crops can be grown (Agriculture and Climate Change | Climate Atlas of Canada, 2019).

Linked to warming, precipitation patterns are also changing in Canada. Precipitation has increased in many parts of Canada, and there has been a shift toward less snowfall and more rainfall (Agriculture and Climate Change | Climate Atlas of Canada, 2019). Winter and spring precipitation is projected to increase, while summers are projected to be drier with an increase in short-lived yet intense rainfall events (Canada's Changing Climate Report, 2019). Precipitation is a climate condition that directly affects natural ecosystems as it is the ultimate source of water for the land, and shifts in precipitation variability could have profound impacts on the agriculture industry (Agriculture and Climate Change | Climate Atlas of Canada, 2019). For example, changes in precipitation patterns can increase likelihood of flooding and drought (Agriculture and Climate Change | Climate Atlas of Canada, 2019). In 2019, farmers across Canada said they could have bought both flood insurance and drought insurance in the same growing season. Western farmers experienced especially tough growing weather with conditions that were either too dry in the spring or too wet in the fall. For those who managed to collect a yield during harvest season, it was recorded as their worst-ever year, and for those who didn't complete harvest in 2019 did so in 2020 (Canada, 2019). In addition to floods and droughts, another climate extreme that could be brought on by anthropogenic climate change is wildfires. In Canada, there have been more extreme hot days and fewer extreme cold days — another trend that is projected to continue in the future (Canada's Changing Climate Report, 2019). This will increase the severity of heatwaves and contribute to the increased wildfire risks (Canada's Changing Climate Report, 2019).

In summary, the climate is changing and will continue to change at a more amplified scale in the future. Impacts of the changes have already been observed globally - Canada included, and are slated to become even more disruptive to ecosystems if kept up at the current rate of change.

The Agriculture-Climate Relationship

Based on the findings on agriculture and climate, it can be concluded that a destructive reinforcing relationship exists between the two (Brinkman, R & Sombroek, W.G, 1996). Agriculture is heavily dependent on climate conditions, yet the industry has neglected the planet's well-being for many years in order to advance financial success. In turn, climate conditions, while always changing, have proven to become more uncertain and chaotic since the mid-20th century. (Brinkman, R & Sombroek, W.G, 1996). If the agriculture industry continues to harm the environment, climate change will be worsened through reinforcement, which will result in more and more challenging conditions for growth, making it harder for the agriculture industry to remain financially viable and provide food security. This negative feedback loop needs to disrupted by adding sustainable agriculture practices and designing for resilience. For an industry that hinges on climate reliability, the agriculture sector has attempted to keep traditional ways of working for too long, and now, as more chaotic climate conditions approach, it is time for the industry to change as well.

Part 2: The Opportunity - In Vino Veritas

This section will provide context on the wine industry and describe the opportunity that the wine industry can bring to help the agriculture industry remain resilient in the face of climate change.

Wine Within the Agriculture Landscape

Based on Howard Buffett's autobiography 40 Chances, on average, a healthy farmer can expect forty growing seasons (Buffett, 2013). This means that an average farmer has only forty chances to grow a great season, and this is no different for growing wine grapes.

Wine is an alcoholic beverage that is made from the fermented juice of wine grapes, which differ from the table grapes some consume as a snack ("What is Wine?," 2015). Vintners are wine grape farmers and wine producers (Trevisan, 2011). The goal of a vintner is to produce a high quality and high yield wine grape harvest which will then be expertly processed to achieve desired flavour. What is interesting about winemaking, in the context of this report, is the timeline. Winemaking is a long term and complex process. Wine grapes take an entire season to ripen, and thus wine is harvested only once a year ("What is Wine?," 2015). After the harvest, the wine grapes undergo a manufacturing and processing process, which can add several years to the timeline before the wine is available for consumption ("The Life Cycle of a Wine Grape," 2016). While other crop farmers might see results in a matter of months, the path to harvest and consumer readiness is longer for wine. Further, it can take up to half a decade for newly planted vines to produce a significant crop ("The Life Cycle of a Wine Grape," 2016). More information on the life cycle of a wine grape is provided in the section below. The significance of wine being a long-term crop is that vintners cannot simply make changes to the crops spontaneously or at random, the way they might with other crops. Once a vintner plants the vines, they will wait, at times years, to reap the benefits. There is a long-term and futures-thinking mindset that is inherently embedded within the wine industry, and that is the type of mindset worth leveraging for climate leadership.

From Vine to Table: A Lengthy and Laborious Process

To demonstrate the considerable time and effort involved in the winemaking process, a more detailed overview is provided. The winemaking process consists of growing grapes and then manufacturing and processing of the wine before it becomes available to consumers ("The Life Cycle of a Wine Grape," 2016). Assuming no vines have been planted yet, first, a vintner will spend months planning for the vine plant - assessing microclimates and designing what kinds of grapes will be planted and in which orientation ("The Life Cycle of a Wine Grape," 2016). Once young vines have been planted, vintners must demonstrate considerable effort to nurturing, prune, and protect the vines from pests and disease during all seasons over the next several years so that the roots may dig deep into the soil ("The Life Cycle of a Wine Grape," 2016). Vines are dormant in the winter, and assuming they are not damaged by frost, fruit sets will start to appear in the Spring. This part of the grape growing process is especially fragile as cold air can damage the sets and significantly impact the crop yield ("The Life Cycle of a Wine Grape," 2016). Vintners will rely heavily on appropriate weather conditions to allow the grapes to grow throughout the Spring and Summer so that they are ready for picking during the Autumn harvest (Jones, 2014). The ideal weather conditions would be that there are no extreme weather conditions, and a sunny, warm and dry summer season with enough soil replenishing rainfall (Jones, 2014). The process after that varies upon the desired outcomes, but generally, the grapes would be processed and undergo fermentation for up to 18 months before they are finished and bottled for the consumer ("The Life Cycle of a Wine Grape," 2016). This cycle continuously repeats itself so that the vintner is always preparing for the next year's grape. It is worth noting here that there is a chronic labour shortage within the agricultural sector. In Canada, the shortage is driven by a combination of aging workforce, temporary and seasonal employment structure, intense working conditions, and negative perceptions about working in the sector (Meyer-Robinson & Burt, 2016). There has also been cases of migrant worker exploitation (Keung, 2019).

Wine and Climate

Just like other crops, the cultivation of wine grapes is also heavily influenced by climate. And just like the agriculture industry, the wine industry is also at risk. So much so that some of the world's largest wine producing regions (Italy, Greece, and France) may become completely inhospitable to grape production by 2050 (Asimov, 2019). Climate change impacts to the wine world can be seen today. Rising summer temperatures have the power to change grape and wine quality by increasing alcohol concentration and reducing aromas (Pickering et al., 2015). Rising temperatures may also disrupt the grape wine growing process by altering intervals between growth and harvest, forcing vintners to pick grapes earlier (Pickering et al., 2015). Globally, the rising temperatures are causing climate zones to shift poleward in many regions (IPCC, 2019). In an effort to reduce vulnerability to the effects of climate change, winemakers globally are relocating their grape farms more north in the norther hemisphere and more south in the southern hemisphere (Asimov, 2019). Such is the case of the Champagne region moving some of their farms north to England, and some Spanish wineries arriving at new settlements at the base of the Pyrenees mountains (Asimov, 2019). In the case of heavy rainfall, vintners are left with reduced yields and off-flavours in the wine, with nothing but crop insurance to help them manage the response (Pickering et al., 2015). It is worth briefly noting here that the insurance industry is also impacted by climate change (USDA ERS, n.d.). If agricultural losses keep rising, the insurance industry will either have to increase the cost of insurance to farmers or discontinue insurance of certain losses. In either case, the farmer is negatively impacted (USDA ERS, n.d.). Droughts, on the other hand, could lead to unripe fruit, and demand an expensive irrigation response from the vintner (Pickering et al., 2015). Increased pests and disease outbreaks will ultimately quantity and quality of the yield, and sometimes require intense treatment with pesticides to resolve (Pickering et al., 2015).

In summary, climate impacts to the wine industry revolve around reducing quality and quantity of the yield, as well as demanding new methods and techniques from the vintner to

help mitigate the changes. Thus far, vintners have viewed climate change conditions as being unusual and intermittent. But short-term and one-off crisis management strategies are not sustainable responses to the enduring effects of climate change (Agriculture and Climate Change | Climate Atlas of Canada, 2019). As the future approaches, and more chaos ensues, vintners will need a resilience plan.

In this report, the focus lies in the New World wine region of Ontario (discussed in more detail in section titled “Ontario Wine Industry”). Vintners are already strategically planning years ahead of an anticipated harvest, and while they can control how they care for the vines and the crop, vintners can not control the climate and weather conditions. Given that the climate crisis is predicted to bring more chaotic conditions in the future, there is an opportunity and necessity to leverage vintners’ future-oriented mindsets to design for resilience in the face of climate change. These learnings can then be shared amongst the broader agriculture industry as best practices for sustainable farming.

Ontario Wine Industry

In 2011, Matt Kramer, a US-based wine critic and contributing editor to the distinguished wine magazine Wine Spectator, claimed Ontario to be “the world’s least-known great wine zone.” (Kramer, 2011). Home to over 180 wineries, spanning approximately 6900 hectares of vineyards, Ontario is a cool climate growing country, similar to northern France and Germany (“Ontario’s Grape & Wine Industry |,” n.d.).

There are three major wine regions in Ontario: The Niagara Peninsula, Prince Edward County, and Lake Erie North Shore. See Figure 3 below, illustrating the three regions.

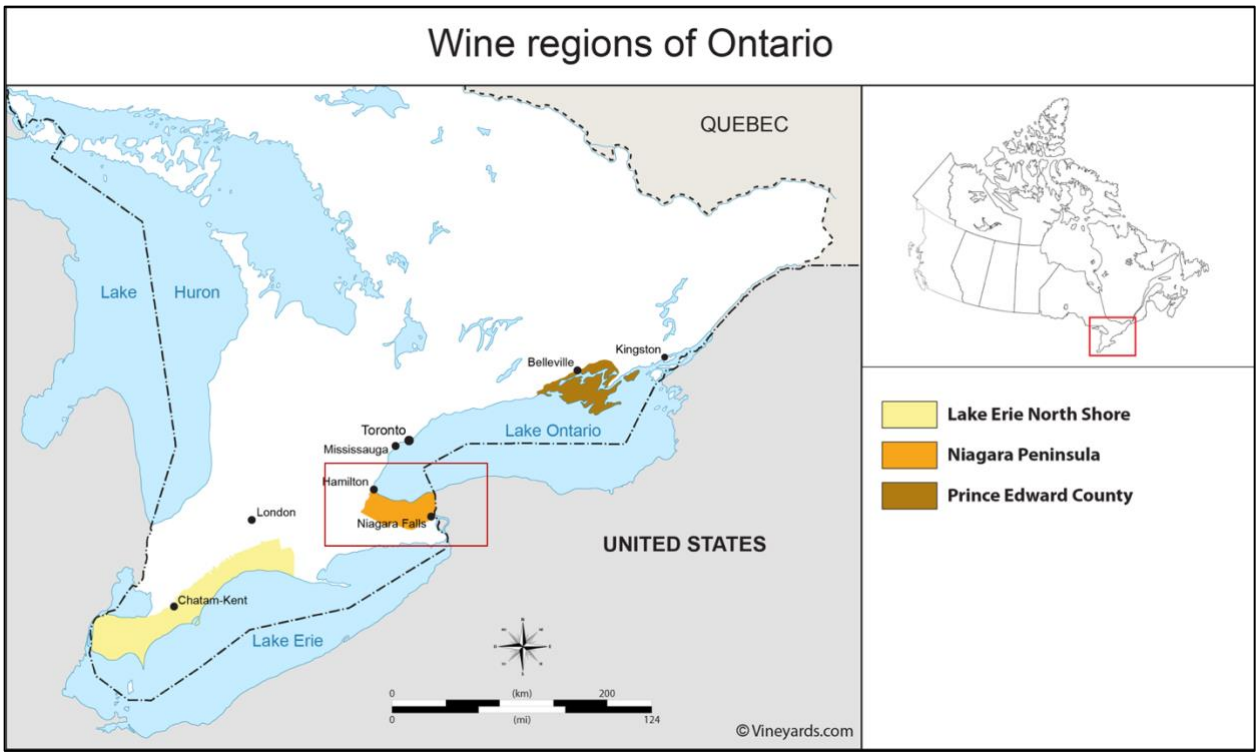

Figure 3: Wine Regions of Ontario (*Ontario map of vineyards wine regions*, n.d. Retrieved from https://vineyards.com/wine-map/canada/ontario)

A deeper dive into one of the three regions is provided below. The Niagara Peninsula is responsible for over 90% of Ontario's grape. The Niagara Peninsula is uniquely situated between the Niagara Escarpment and Lake Ontario, which greatly influences the quality of wine produced (WGAO, n.d.). The Escarpment provides generous sunlight exposure, slopes and elevations while the lake moderates cold winter temperatures and cools the hot growing season ("Wineries of Niagara on the Lake," n.d.). Niagara Peninsula is graced with good soil structure for growing grapes, thanks to the residual limestone and sloping from the Escarpment. Soil structure is generally more important than soil fertility when it comes to growing grapes. Good soil structure will allow for retaining moisture during dry periods and drainage during heavy rainfall, as well as adequate development of root systems ("Wine Grape Production Outside Traditional Areas In Ontario," n.d.). Common grape varietals produced in the Niagara Peninsula are Riesling, Chardonnay, Merlot, Cabernet Franc, and Pinot Noir ("Pillitteri Estates Winery," n.d.).

The wine industry in Ontario has demonstrated that it is a driver of positive economic growth for the province. Based on the latest available data from an Economic Impact Report published in 2017, the Canadian wine and grape industry contributed to over $9 Billion CAD in total economic impact, which includes contribution to and from wineries, suppliers, wages, and taxes. This is an increase of $2.2 Billion since 2011. Ontario, the largest wine-producing province in Canada, is responsible for approximately half of Canada's total economic impact from wine, with tourism being a significant economic driver (Rimerman, 2017). Further, Ontario is the world's largest producer and exporter of ice wine, profiting approximately $21.3 Million on ice wine annually ("Industry Statistics," n.d.). In addition, the Economic Impact Report from 2017 revealed that Ontario's wine industry supported 18,000 full-time jobs both directly and indirectly (Rimerman, 2017). Wineries promote a reciprocal relationship between the community and its natural capital, and this, in turn, maintains an image that attracts customers and tourists (Bellos, Fox, & Upton, 2003). It has become clear that wine in Ontario is a profitable and growing business.

Ontario has taken appropriate measures to become an established wine region. For example, Ontario has its own regulatory body called the Vintners Quality Alliance (VQA) whose role is to ensure high quality of wine production, similar to France's AOC regulatory body (Agriculture and Agri-Food, 2015). However, when compared to the global wine world, Ontario's wine industry is considered nascent. The challenge many vintners face with grape growing in Ontario is that the harsh winters damage the tender vines and tender fruit sets, which could negatively impact both yield and quality of the vintage (Shaw, 2017). Conversely, Ontario's humid summers invite fungus, pests, and diseases (Shaw, 2017). Both conflict and opportunity arise when future climate conditions are factored in. To restate the climate projections: Canada's Changing Climate Report states that hotter summers, warmer winters and longer growing seasons are on the horizon. These appear to be positive benefits that might lead to an increase in agricultural food production in Ontario (Shaw, 2017). For Ontario wine, the evolution

from a cooler climate to a warmer climate that could positively affect quality of wine and allow for experimentation of new varietals (Shaw, 2017). Conversely, for the profitable ice wine business, these future conditions bring about more problems. Due to climate change, ice wines are increasingly having a hard time getting reliable, cold enough, winters for natural ice wines (Shaw, 2017). In attempt to take guidance from the Old World wine regions, ice wine farms have started to relocate north to Quebec (Rose, 2016).

In summary, Ontario's nascency could be viewed in a positive light and could present a budding opportunity for Ontario's wine industry to innovate, experiment, and take risks, whereas more established wine regions cannot afford to do so. With a mandate to practice more sustainable agriculture, and an already-primed mindset for futures-thinking, Ontario vintners could pave the way for climate leadership and help the agriculture industry remain resilient in the face of climate change.

Part 3: Analysis – The Three Horizons Model

This section will present the analysis resulting from testing the opportunity using the Three Horizons analytical tool. In addition, as part of the analysis for Horizon 2, a foresight trends scan is included in this section.

This report aims to answer the following research question: Can we use Ontario's wine industry as an example of how strategic foresight could be used to help the agriculture industry remain resilient in the face of climate change? As such, we the relevant context surrounding agriculture and climate change has been presented, as well as the opportunity involving Ontario's wine industry. Now, it is time to put the thinking to the test by applying the gathered data and findings through Curry and Hodgson's Three Horizons model. The Three Horizons model is a strategic foresight analytical tool that illustrates three conditions of the same system, over time, against its level of viability in its changing external environment (Curry & Hodgson, 2008). For the purpose of this report, the tool will be used to examine the state of the Ontario wine industry and project out 30 years into the future to imagine a preferred future state. The selected timeline on the x-axis projects from present day (2019) to 2050. This specific timeframe has been selected because of the data points collected on climate projections made available by IPCC. Notably, the projection that temperatures will increase at least another 1.5°C between 2030 and 2052 if global warming continues to increase at its current rate (IPCC, 2019). This hypothetical reality provides enough structure and inspiration to imagine both utopic and dystopic foresight scenarios.

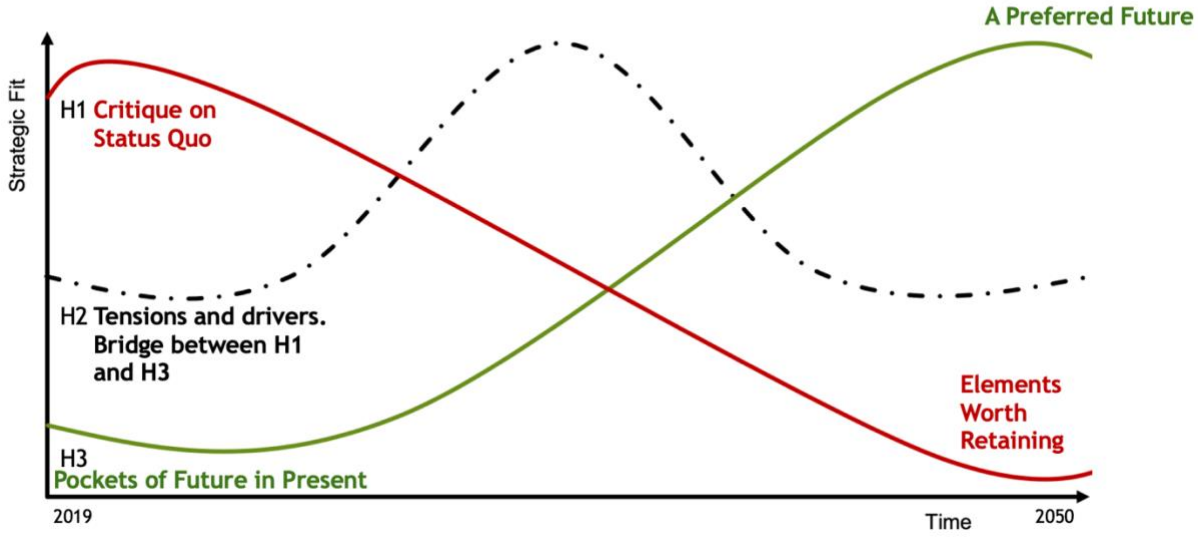

Figure 4: Three Horizons Framework for Examination of Ontario's Wine Industry (Adapted from Curry & Hodgson, 2008)

The analysis is broken down horizon by horizon. First, Horizon 1 (H1) will provide a critique on the dominant conditions (status quo) in the present and discuss certain elements that are worth retaining in the future. The gap between H1 in present day and H1 in the future will reveal challenges and tensions that must be overcome in order to achieve a preferred future. Next, Horizon 3 (H3) will uncover pockets of the future that are marginally present in 2019 through a foresight trends scan. After that, H3 will allow for imagining a preferred future for the Ontario wine industry based on an agriculturally sustainable and climate change resilient world. The gap between H3 in the present and H3 in the future will invite discussion on possible drivers that could be reinforced in order to achieve a preferred future state. And last and most importantly, Horizon 2 (H2) will then be used as the basis for the discussion portion of this report, as resulting tensions from H1 and drivers from H3 are examined in greater detail.

Horizon 1 (H1)

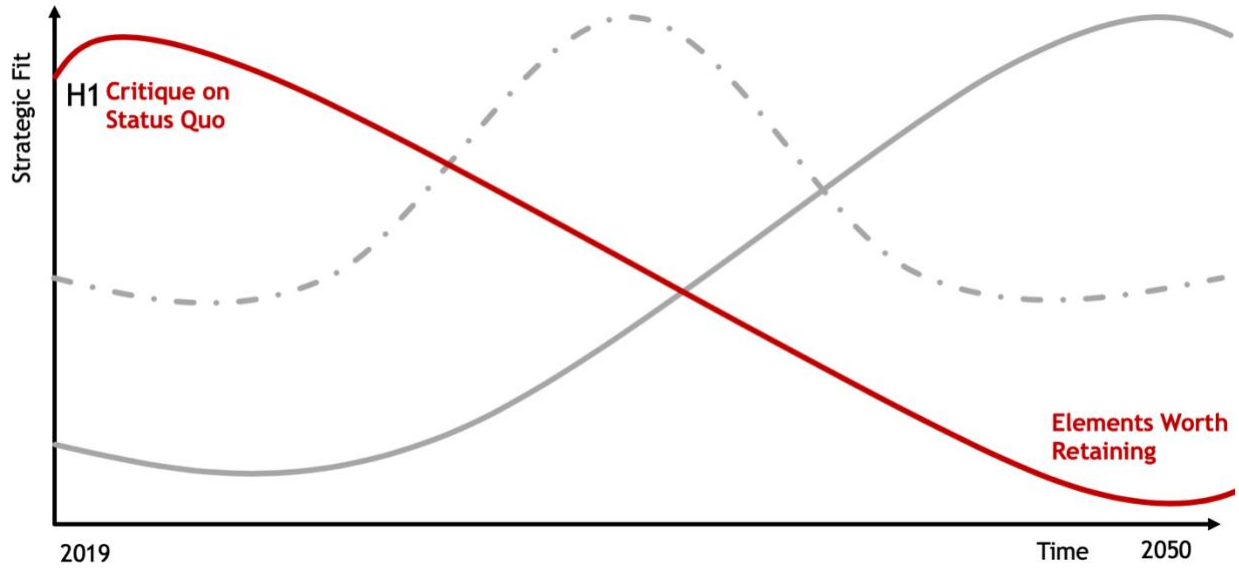

Figure 5: Representation of Horizon 1 (Adapted from Curry & Hodgson, 2008).

H1 represents current prevailing conditions, and can therefore be referred to as the status quo. As demonstrated by the fade in H1 conditions over time in the figure above, the current system is under strain because it loses strategic fit over time. To support this, H1 will focus on a critique of elements from the status quo to demonstrate what is broken within the current system. This will also reveal which elements from the status quo are beneficial and worth retaining into the future. See Table 1 below for details.

Critique on Status Quo (Present)	Elements Worth Retaining (Future)
Focusing on advancing financial success left planet health behind and spurred harmful consumer habits • Unsustainable farming practices have negative impact on natural resources and reinforce climate change, as evidenced by impacts noted in Part 1 & 2 of this report. • Disruptive changes in temperature levels, precipitation levels, and catastrophic extreme climate conditions • Aiming for higher yields in pursuit of financial reward resulted in overproduction of food stuffs, which created a consumer habit of overconsumption and food waste	**Financial success from wine industry is an important component of Canada's livelihood** • Positive economic impact of wine industry to Ontario as a province and Canada as a country • Tourism from wine industry

Many vintners need to shift their perspectives to view climate change as a long-term and constant condition • Vintners are knowledgeable on climate crisis management techniques and apply them when necessary. These resolutions currently stem from a short-term and one-off mentality, which is not an effective enough response to the enduring effects of climate change	**Leverage expertise of vintners to effectively manage climate crises** • Perhaps the current resolutions are overly short-sighted, but at least there are mitigation methods that exist • Knowledge is being shared across the vintner community
Labour challenges exist • Chronic labour shortage in Canada • Working conditions are intense and often rely on temporary and seasonal migrant workers.	**Job creation** • Keep posting open positions on multiple channels
Lack of action towards meeting 2030 Sustainable Development Goals • Sustainable agriculture is a relatively new concept. While the research to support it exists, ample practical demonstrations on how to transform industrial agricultural practices to more sustainable practices do not exist.	**Policies** • Global agreement and a plan of action on future world goals and visions, similar to the United Nations' 2030 Agenda for Sustainable Development Goals • Land use policies
Current climate growing zones rapidly shifting • Industry focused on current markets, varietals and growing regions may not be adapting fast enough to climate crisis • Industry needs to be planting now for the growing conditions of 2030-2050 because of the long lead time associated with grape crops	**Optimized land use** • New uses for land that was previously considered not suitable for growing crops
	Good soil structure in Ontario • Unique composition of good soil structure, Escarpment slope, and lake effects that promote grape growth in the Niagara Peninsula

Table 1: Analysis of 'Critique on Status Quo' vs. 'Elements Worth Retaining'

Tensions

Based on the data from Table 1, insights can be drawn to outline the challenges and tensions that must be overcome in order to close the gap between present and future conditions of Horizon 1. The major tensions are as follows:

1. The climate is a vital component to a successful agriculture yield, yet is increasingly shifting and unstable
2. While more sustainable futures are desired, there is not a lot of practical education around how to transform industrial agriculture practices to more sustainable practices.
3. The wine industry in Ontario needs to remain financially viable and produce enough yield but be more sustainable while doing that

4. There is an opportunity to leverage the expertise vintners carry for climate crisis management, but there needs to be a perspective shift from one-off techniques to designing resilient vineyards
5. The wine industry creates jobs for rural communities but there is a lack of workers who are willing to endure the intense conditions

Horizon 3 (H3)

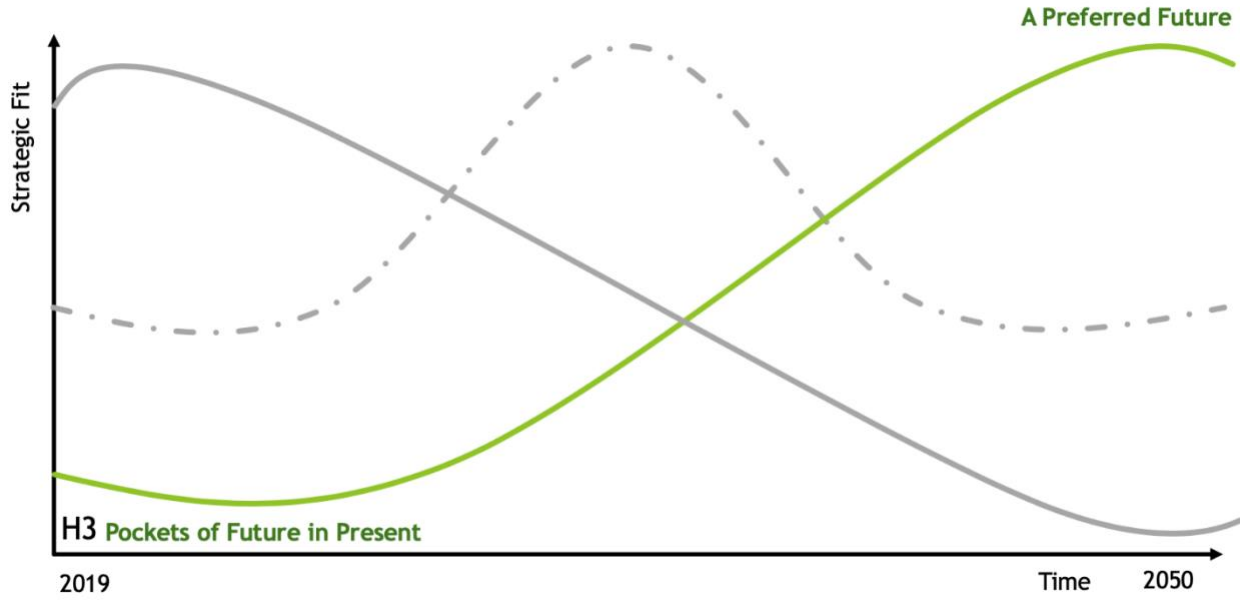

Figure 6: Representation of Horizon 3 (Adapted from Curry & Hodgson, 2008).

H3 is the opposite of H1, as it allows for imagining a preferred future-state and highlights trends that represent weak signals of change which can grow to become dominant over time. In order to discuss H3 in the present, a high-level foresight trends scan will be presented in Table 2 below.

Foresight Trends Scan: Pockets of the Future in the Present

STEEP+V Classification	**Brief Trend Description**
Social	Increased wine education and programming is offered in Ontario, such as the Niagara College Food and Wine Institute and Brock University Cool Climate Oenology and Viticulture Institute. This is taking a step towards guiding future generations to more sustainable practices (Research and Innovation—Niagara Economic Development, n.d.).
Social	Ontario's rural communities, such as Prince Edward County, are thriving. With local festivals, like the annual lavender festival, job opportunities, and year-round tourism, the wine industry in Prince Edward County adds to the livelihood of this town ("Events," n.d.).

Technology	Wine bottles are becoming obsolete as they contribute to landfill and are heavy to transport. In attempt to be more sustainable, many wineries are creatively packaging their wine either in less heavy glass or aluminum cans. Technologists have even proposed edible bottles made from sugar substitutes (8 Technology Trends That Will Impact the Future of Wine, n.d.)
Economic	Approximately 450 grocery stores across Ontario can sell beer and cider – including about 150 that can sell wine. There are regulations to selling alcohol at these retailers, and social responsibility standards remain (i.e., not sold to anyone under legal age of consumption). This is an example of how alcohol sales in Ontario are expanding, after many years of stagnancy due to the LCBO monopoly (Alcohol sales in retail stores, 2015).
Economic	A Malbec wine, traditionally grown in warmer climates such as Argentina and south of France, has been produced in the Niagara Peninsula. Peninsula Ridge Estate Winery is uniquely located along the Escarpment and in 2016 experimented with growing a new grape variety. A few years later, they produced their first Malbec wine, which is a pleasant surprise for the region. Due to the local rarity, the wine can be priced at a higher price range (*2013 McNally Vineyards Reserve Malbec*, n.d.).
Economic	Sustainability sells. There is a significant marketing value for sustainable wines, as sustainability can be said to resonate emotionally with consumers (Abernathy, 2019).
Environment	Some farmers are reverting back to the biodynamic agriculture method that originated in the 1920's. This technique takes the farming system and makes it a self-sustaining bio-environment, thereby decreasing pollution from agriculture and increasing biodiversity (Shaw, 2017).
Environment	As modern coffee plantations have been replacing wildlife habitats, an alternative method of coffee farming has risen. Shade grown coffee leverages natural canopy such as trees to promote a reversal in chemical trend, which in turn results in healthier environment, sustained rainforests, improved biodiversity (Shade Grown Coffee, n.d.).It can be useful to adapt this concept to viticulture, as canopy management is an active labour process all throughout the grape growing cycle. Not only can this help with reducing need for fertilizers, it also retains soil moisture and increases pollinators (Shade Grown Coffee, n.d.).
Politics	Alternative pricing models are in demand. Since the province of Ontario ultimately controls the price of wines sold at the LCBO and everywhere else, there is a need to rethink who has the power to price wines (Luciani, 2017).
Values	A similar concept to micro-breweries, micro-wineries are also becoming more popular amongst consumers. The market is reporting increased sales for small-medium sized wineries (Mullen, 2018).
Values	Consumer trends are stating that Canadians have become increasingly interested in local wines (Jenkins, 2019).
Values	Niche preferences amongst beverage alcohol consumers are more prevalent than ever. There is budding interest in low alcohol wines, natural wines, and Cannabis infused wines (Burrell, 2019).

Table 2: Signals of Change

A Preferred Future

A preferred future for the Ontario wine industry is rooted in sustainable farming practices and has been designed to be resilient in the face of climate change. Agricultural sustainability is defined by three pillars: a healthy environment, social well-being, and economic prosperity (Adapted from FAO, n.d.), and therefore all three components have to be met in a preferred future.

In a preferred future, there are no trade-offs between economic prosperity and planet health, both win. Natural and human systems are self-sustaining and bio-diverse. Focus will be placed on designing for and creating resilient ecosystems that are able to withstand climate change. Sustainable farming is championed by Ontario's farmers. There is farming of different crops, polyculture, innovative rotation strategies, and a transition to lower-carbon fuel for machines. Additionally, in this preferred future, vintners have a decreased risk of complete yield loss and heavy financial burden associated to climate change as systems are better designed with biodiversity in mind, which refers to the variety of plants, animals and microorganisms above and below the soil within an ecosystem (Delmas, 2010). It is the biodiversity of the farm, organized so that the waste of one part of the farm becomes the energy for another, that results in an increase in the farm's capacity for self-renewal and ultimately makes the farm sustainable (Delmas, 2010). Further, soil health is high as the composition of fertilizers has been modified to not be as harmful to the environment, and farmers are moving away from fertilizer application approaches all together. And finally, there are far less greenhouse gas emissions stemming from agricultural practices, which might lead to policy creation for optimized land use in favour of sustainable agriculture.

From an economic perspective, financial success is still vital in a preferred future for the Ontario wine industry. Thanks to the warmer climate conditions, wine quality will improve and different grape varieties can be experimented with and niche wines can be produced to satisfy

consumer needs. Consequently, there might be a boom of increased tourism brought in part by the fine and interesting wines Ontario can produce and sell at reasonable prices. With more people visiting the area, new sustainable tourism ventures lay on the horizon. This allows Ontario to be at the forefront of sustainable tourism innovation as an indirect value addition.

In terms of social well-being, a preferred future for the Ontario wine industry involves improving the well-being of farmers and farm workers. Community building and knowledge sharing is an important aspect of well-being (Pickering et al., 2015), and should continue to be fostered. This might help elevate Ontario from a nascent region to a renowned global wine region. Additionally, it will be important for the government to give vintners more power over pricing their wines and expanding into various sales markets. In this preferred future, both consumers and vintners would be pleased if local wines were more affordable. Consumers will also have a preference for local wine consumerism and demand more sustainable wines from the market.

Drivers

Based on the foresight scan and imagined state of a preferred future for the Ontario wine industry, there is a gap between H3 in the present and H3 in the future. In order to bridge the gap and allow positive trends to grow into a preferred future, there needs to be a values-based reinforcement of certain trends so that they become a driving force towards a preferred future. Trends worth reinforcing include:

1. Education and research on sustainable practices
2. Biodynamic farming
3. Experimenting with new grape varietals
4. Local and sustainable consumerism and tourism
5. Working with governments to influence policy in favour of local and sustainable wine production

Horizon 2 (H2)

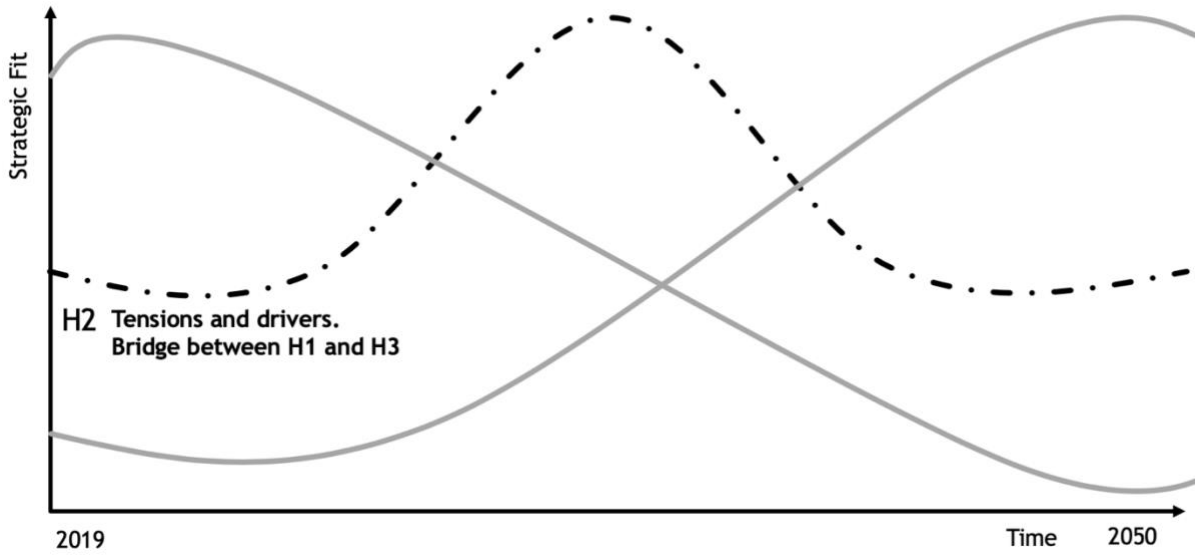

Figure 7: Representation of Horizon 2 (Adapted from Curry & Hodgson, 2008).

Finally, there is Horizon 2 (H2). This unstable horizon positioned between present and future represents both the driver of positive changes that might fuel growth for future systems and challenges that must be overcome in order to replace the broken status quo. This section will summarize the uncovered tensions and divers from H1 and H3, respectively. Further discussion on how these elements come together follows in Part 4 of this report.

Tensions (challenges that need to be overcome)	Drivers (trends that need to be reinforced)
1. The climate is a vital component to a successful agriculture yield, yet is increasingly shifting and unstable	1. Education and research on sustainable practices
2. While more sustainable futures are desired, there is not a lot of practical education around how to transform industrial agriculture practices to more sustainable practices.	2. Biodynamic farming
3. The wine industry in Ontario needs to remain financially viable and produce enough yield but be more sustainable while doing that	3. Experimenting with new grape varietals
4. There is an opportunity to leverage the expertise vintners carry for climate crisis management, but there needs to be a perspective shift from one-off techniques to designing resilient vineyards	4. Local and sustainable consumerism and tourism
5. The wine industry creates jobs for rural communities but there is a lack of workers who are willing to endure the intense conditions	5. Working with governments to influence policy in favour of local and sustainable wine production

Table 3: Summary of Tensions and Drivers

Part 4: Discussion - How might the preferred future be achieved?

The Three Horizons model revealed certain tensions and drivers that need to be overcome or reinforced (respectively) should a preferred future state be achieved. This section will discuss proposed strategies for how to bring a preferred future to life.

A preferred future for the Ontario wine industry is rooted in sustainable farming practices and has been designed to be resilient in the face of climate change. Therefore, for example, in order for the wine industry to remain financially viable but adopt more sustainable practices, sustainable practices first need to be taught and socialized. Increased education and research on sustainable practices, grape varietals and climate, as seen in Niagara College and Brock University, could be a driver. Education could be the first step to expertly designing a framework for agricultural resilience in the face of climate change, and then having local Ontario vintners champion it and pave the way for climate leadership. Perhaps biodynamic farming could be an offered area of specialization, wherein more practical and hands-on demonstrations are taught. This might inspire more vintners to move towards self-sustaining bio-environment farming models, thereby inherently shifting mindsets towards the long-term. Resilient systems would be bio-diverse, and this would allow for experimentation of growing new and different grape varietals. As a result, vintners would supply local and sustainable wine products to satisfy consumer demands. Tourism increases with rising popularity, and this might invite new settlements to rural communities. There would be plenty of job opportunities in the wine sector, and perhaps the conditions won't be as intense due to the self-sustaining model of farming. When rural communities thrive, well-being of farmers is improved. Tourism also opens to door for sustainable innovation opportunities. For example, in the Niagara region, many tourists like to enjoy the proximity of multiple vineyards by biking from one to another. Reinforcing low (or zero, in the case of bicycles) carbon transportation networks can bring this preferred sustainable future to life. Finally, it will be important to partner with governments and policy-makers directly, as they have the power to create policies that favour sustainable agriculture. For example,

vintners and policy-makers can collaborate on an updated financial and business models where prices for local wines are subsidized by the LCBO, making it easier for both consumer and vintners to produce and enjoy. Also, policies could be put in place to impose costs for actions that deplete natural resources.

Conclusion

Research Question: Can we use Ontario's wine industry as an example of how strategic foresight could be used to help the agriculture industry remain resilient in the face of climate change?

This report has furthered thinking around the opportunity that Ontario's wine industry can pave the way for agricultural resilience. It was found that resilience is possible should certain challenges be overcome, like shifting vintner mindsets away from short-term thinking about climate change, and certain trends, like the rise of wine and sustainable agriculture education, be reinforced. It has become clear that diversification of farmland is a large component of resilience, and can be achieved through polyculture, crop rotation, and experimenting with new varietals. And, this report has revealed that governments and consumers, along with vintners themselves, can proactively push the sustainable agriculture agenda. The Three Horizons tool was used as an analytical model to establish a perspective on what a preferred future of the Ontario wine industry could look like and to provide a critique on what is currently broken within the prevailing system. The analysis allowed for a deeper understanding of the context that lives in the intersection of agriculture, climate change, and the wine industry.

Still, in the present day with the rapid pace of change and increased uncertainty, it can feel almost impossible to spearhead a movement towards sustainability. It is important to remember that sustainability is a process, and requires the support of governments, research and technology, funding, and cooperation of many individuals within the agricultural sector. And of course, even in an ideal world where sustainable agriculture is a norm, this still will not be enough to completely mitigate climate change. It is now clear that this research is not limited to the context of wine, but can be applied externally, not limited to other types of farming, but to society more broadly. Mitigation is a society-wide challenge, and resolutions developed in any one sector will benefit everyone.

Next Steps

If it were not for a strict time constraint, this research could have been made more comprehensive through a more immersive wine education and a deeper analysis of adaptation approaches. It would have been interesting to spend some months on a vineyard to receive a wholistic and immersive perspective. In addition, this research was conducted through a literature review and the author brainstormed strategies alone. More time would have allowed for a Research Ethics Board approval to conduct research that would enable a better understanding of vintner's mindsets on topic of climate change, as well as co-creation with vintners, policy makers, and key social influencers on possible futures of the wine industry in Ontario.

This research aimed to explore an opportunity for Ontario's cool climate wine region to become a leader in climate crisis resilience. It was hoped that by testing this thinking, this project might contribute to the imagination of new solutions to the truly complex problem of climate change. An international conference called Tasting Climate Change takes place annually, and it would be interesting to share these findings there in 2020.

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