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# Future-proofing the regional foodshed: Evaluating the supply of off-season produce to feed a city

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## Abstract

During the winter, in countries like Canada, there is growing reliance on fresh fruits and vegetables imported from more southerly bioregions. The transcontinental supply chains that carry these foods are vulnerable to stochastic shocks, one extreme weather event or tariff dispute away from slowing or stopping. This vulnerability raises pressing questions of national food and nutrition security. However, can countries where winter weather slows or even stops production supply their own fruits and vegetables during this season? A common assumption is that a re-localized food supply in such regions would mean a winter diet of rutabaga and

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This work received ethics approval from the University of Toronto, and participants provided oral informed consent prior to participation.

**Data Availability Statement**
Our data is confidential as per our Research Ethics Board protocol.

potato. Thus, we investigated what regionally grown produce is available for sale during the off-season at Canada's largest wholesale food market, the Ontario Food Terminal in Toronto. We conducted an interviewer-administered questionnaire with Ontario farmers and produce dealers to assess the social and environmental conditions that produce the current winter supply and the potential for scaling up local reliance on winter produce. From our findings, we argue that a winter supply can and does exist. We find that barriers that currently limit the off-season crop supply, and opportunities to expand it, are both ecological and economic. Factors influencing supply include crop varieties, storage technologies, and market characteristics. Our findings are pertinent to regions with an interest in future-proofing their food and nutrition security at a time of geopolitical realignment.

**Keywords**
urban food systems, food security, food policy, nutrition security, food sovereignty, produce supply chains, wholesale

## Introduction

In any major chain supermarket in Canada's largest city of Toronto—on any day, of any week, in any season—you are guaranteed to find fresh fruits and vegetables transported by ship, air, rail and road from around the world. More than half of vegetables Canadians consume (not including potatoes) and up to three-quarters of fruits are shipped to the country from distant growing regions (Bajaj, 2024; Bajaj & Ramankutty, 2023, 2025). For years, food systems scholars have warned that reliance on distant agroecosystems for food is vulnerable to stochastic shocks (Chavez-Miguel et al., 2024; Gaupp, 2020; Saccone & Vallino, 2025). Supply chains are just one ice storm or border closure away from coming to a halt. Now, rising food prices along with shifts in the modern economic order are raising pressing questions of national food security, as well as nutrition security, which is the availability and access to the foods needed to meet dietary standards (Moore et al., 2021). Can a food import-dependent country like Canada continue to rely on other countries to feed its people? In an increasingly urbanizing world, where should sprawling cities source nutritionally important foods, such as fruits and vegetables?

In some of the food systems literature, it has been argued that to be food secure, a city region must have capacity to produce food (Opitz et al., 2016; Steenkamp et al., 2021). Fruits and vegetables traditionally grown near cities are often identified as the type of crops best suited for re-localized urban and peri-urban production (MacRae et al., 2012; Nasr et al., 2011). However, the authors of this paper—a food systems scholar, a PhD candidate who is also a former organic farmer, along with a local-food system advocate and city employee working on food-related policy—have heard policymakers and the public say that it would be challenging, if not impossible, to re-localize production for a city like Toronto. One reason offered is the winter season that limits conventional field agriculture for at least six months of the year. This tension between a food system ideal of re-localized agriculture and a widely held perception of the limits posed by winter motivated our team to investigate. We undertook the first academic study of its kind, that we know of, to investigate what regionally grown produce is available for sale during the off-season at Canada's largest wholesale food market, the Ontario Food Terminal. We asked farmers who sell their produce wholesale at the Terminal, as well as dealers of regional produce, what produce they sell in the off-season. which stretches from late fall to early spring. Our goal was to understand what producers saw to be the limitations and possibilities of year-round production in support of a re-localized food system.

In this paper, we report on our findings and argue that an off-season supply can and does exist, contrary to oft-repeated assumptions. However, it is limited by both ecological and economic factors that we discuss in this paper (Agriculture and Agri-Food Canada, 2020; Unc et al., 2021). The research is pertinent to other municipalities in regions that experience winter with an interest in future-proofing their food security. Furthermore, our research informs urban approaches to food and nutrition security, as well as food sovereignty debates, at a particularly turbulent geopolitical time shaped by the climate crisis.

### *Different Approaches to Re-Localizing Farming Systems*

In temperate bioregions, the outdoor growing season is limited by frost that kills most commercial food crop plants and renders dormant perennial fruit and nut trees. Thus, food security historically has depended on preserving and storing food. In the area where present-day Toronto is located, prior to the imposition of the settler colonial state, Indigenous nations dried cultivated foods such as squash, beans, and corn along with foods they harvested from managed wild species of plants, mammals, and fish (Riley, 2013). As colonial food systems were established as part of the plan to take over Indigenous land, historians have documented that apples and root vegetables were central to the settler diet (Dickau et al., 2021). Regional settler food economies developed with a range of foods shipped to the region (Dickau et al., 2021). Over the next century, produce supply chains became global (Elton et al., 2025). Major chain supermarkets contributed to the changes, consolidating their supply chains by sourcing directly from farms around the world to assemble a seasonless supermarket produce aisle where consumers could find the same products every day of the year (Burch et al., 2013; Reardon, 2006). During the winter in Toronto now you can find dragon fruit from the Mekong Delta sold alongside fresh mint from Morocco and asparagus from Peru. The days of subsisting through the winter on apples and root vegetables are long gone.

Scholars and social movements alike have argued that food system sustainability involves rebuilding regional food systems. Alternative food networks (AFNs) are positioned in contrast to the global industrial food system. Their short food supply chains connect producers and consumers and provide "quality" food and place-based values through certifications programs such as fair trade or organic (Renting et al., 2003; Marsden et al., 2000). Another approach, the City Region Food System (Blay-Palmer et al., 2018, 2021), sees a food system as inherently cross-jurisdictional and aims to strengthen rural-urban linkages, develop regional coherence through collaboration, and secure livelihoods of people across the rural-urban continuum through the food system. An additional concept, the territorial food system, has emerged largely in a European context. It is a regional network, providing small and midsized food businesses along the supply chains more opportunities to participate than they would in the dominant food economy (International Panel of Experts on Sustainable Food Systems, 2024; Rastoin, 2014). By leveraging the concept of territorial provenance and socially proximate relations, the territorial approach also positions itself in opposition to the agro-industrial paradigm. Its aims are to re-localize and reconnect production and consumption on the basis of environmental, social and economic sustainability (Organization for Economic Co-operation and Development, Food and Agriculture Organization of the United Nations, & UN Capital Development Fund, 2016). While these approaches make a case for a variety of food system priorities, they all emphasize the importance of regional food systems. And any kind of regional system must provide sustenance year-round.

### *Year-round Food and Nutritional Security*

In countries that experience cold winters, there are material obstacles to a year-round supply of produce. Freezing temperatures challenge crop production in Canada (Brown & Blackburn, 1987). Nevertheless, there are ways to ensure that there is fresh produce for sale during the winter months. For example, a farm can grow large volumes of storage crops, such as pomme fruits, root vegetables, nuts, grains and pulses, to keep and sell over the winter. Farms can also extend the growing season. High- and low-tunnels are simple constructions of steel and plastic that cover and insulate field crops from frost. Some farms may heat the structures while others choose frost resistant crops, such as leafy greens like kale, that can withstand temperatures around freezing. Other indoor growing environments, such as greenhouses and mushroom facilities, provide and control all inputs that crops require indoors, such as temperature, light, and fertility.

Season extension is supported by specialized equipment and crops bred to perform optimally under different growing conditions (Ampim et al., 2022; Neri et al., 2012). These adaptations have provided ways to mitigate climate risk and improve

resource-use efficiency. However, energy costs are significant, mainly attributed to the lighting and heating systems of indoor growing environments, as are the capital costs of new technology. There is also the high risk of failure during the early period of application (Ampim et al., 2022; Kalantari et al., 2018). In the province of Quebec, the government reimburses farmers up to 40% of electricity costs. The provincial government has also invested in doubling the province's greenhouse operations while expanding rural electrical networks (Wheeler, 2023).

There are other ways to ensure year-round access to regional produce in a winter climate. Summer crops can be processed and frozen, dried, canned, fermented, or smoked. These techniques require different infrastructure, from processing facilities to storage at a commercial scale. In Canada since 2000 what has been called the local food movement has fostered interest in traditional foodways, at an individual level, in canning and root cellars where people can keep their own storage crops over the winter (Elton, 2010b; Llana, 2021; Pinchin, 2012). However, these approaches are about behavioral change as opposed to food policy or food system change, and only work for people who have space to store food. For society-wide access to regionally produced food all year round, this issue must be approached at a wider scale.

Nordic countries are taking steps to strengthen year-round production through national aid programs that respond to the significantly higher production costs of northern climate agriculture (Government of Finland, 2017). Quota and compensation programs are used to manage the wholesale prices of dairy and meats, while trade barriers and tariffs keep domestic product competitive relative to imported product (Selten, 2021; Yu & Jensbye, 2024). For instance, many Nordic countries are members of the EU's Common Agricultural Policy, which relies heavily on import tariffs and other trade barriers to protect its internal agricultural market and make non-EU goods more expensive (Jelliffe, 2025). In Canada, supply management exists for poultry, eggs, and dairy, which extends to milk products such as cheese. The produce industry is not covered by supply management. Under the iteration of the Canada-United States-Mexico Agreement (CUSMA) that was in place at the time of submission of this study, there is free trade for fruits and vegetables. Thus, Canadian-farmed produce competes with internationally grown produce.

### *Study Context*

We conducted our research at the Ontario Food Terminal, the largest wholesale terminal in Canada and one of the largest on the continent. The Terminal was founded in 1954 by the provincial government to reduce produce waste, modernize and organize the sale of fresh fruits and vegetables, and to connect farmers to the urban market (Cavicchia et al., 2019; Elton et al., 2025). The Terminal is exclusively a wholesale market serving only businesses such as grocery retailers, food service, and institutional buyers; members of the public cannot enter to buy food. Since its founding during a period of urban change after the Second World War, the Terminal has become a wholesale hub for both regional and international produce. Relevant to our study, there are two distinct selling areas at the Terminal (Ontario Food Terminal Board, n.d.). In the main complex, wholesale businesses sell food they import from the U.S., Mexico, and around the world alongside produce they buy regionally and nationally. Outside under the parking arcade, there is a second business area, the Farmers' Market, where Ontario farmers sell their produce directly to wholesale buyers alongside dealers of Ontario produce. Our research for this paper focussed only on the Farmers' Market because it is where exclusively regional produce is supposed to be sold. The wholesale Farmers' Market is thus public food system infrastructure that operates as part of a regional food system.

## Methods

Our research questions were**:** What produce is available for sale at the Terminal in the off-season? What is the capacity for scaling up winter availability? Is there interest in scaling up? What are the hurdles? We were provided with a list of farmers and food dealers who sell at the Terminal, which we checked and added to using publicly accessible data online (e.g., business names and phone numbers). This information is not currently available in

any public repository. There is no official list of farms and dealers who sell at the Terminal, nor is the exact number of farmers' market sellers known. This is in part due to the varied nature of small and midscale farming in the province, with some farms growing hundreds of acres of mixed vegetables and others operating a few acres of specialized production. We do not claim that our findings are representative of all growers and dealers at the Terminal. However, our research offers insight into many of the foods produced and sold in Southern Ontario during the winter months.

### *Interviewer Administered Questionnaire*

We wrote our questionnaire in partnership with a grassroots network founded by Queirolo[1] that promotes public markets. We also sought input from people who work at the Terminal. Questions probed the growing and selling of produce during the off-season (See Appendix A for the full list of questions). Everyone on the contact list was phoned between January 29 and March 21, 2025. Gregory would go through the questionnaire with the participants while sitting at a computer. They would type up their answers to each question, either verbatim when brief or using shortform to record the language and phrasing of participants, as answers were not voice recorded. Interviewer-administered questionnaire sessions would last 15 minutes to one hour, with an average of roughly 30 minutes. Directly after each session, Gregory reviewed and fleshed out the notes, ensuring that participant language was captured. Subsequently, reflexive notes were written to record noteworthy ideas or reactions. Gregory conducted a total of 40 participant interviews ($n$ = 32 farmers; $n$ = 8 dealers) and generated two summary documents to organize and visualize the results. Answers to open-ended questions were coded inductively using NVivo 12 Pro software to summarize the range of responses. The first round of coding generated a descriptive summary of the answers that were provided to the open-ended questions. This entailed grouping very brief answers (yes and no) into the same code and for every other unique answer, then assigning a representative code to summarize and condense the response into fewer words, so that the full range of responses could be easily reviewed. This was shared with Elton, who grouped child codes into parent codes. This produced two major thematic groups: ecological barriers and enablers and economic barriers and enablers. Data were deductively coded, organizing them into these four categories. As this study was part of a larger 5-year investigation into Toronto's produce supply chains, analysis also drew on our other research into the Terminal and the larger food system. Fieldnotes from visits to many sites along the supply chains, including farms, warehouses, and a packing house, provided context for the questionnaire data.

## Research Findings

### *Off-season Produce Availability*

We define the off-season as the period between fall and early spring when few annual crops grow easily in Ontario fields. This period typically starts after Canadian Thanksgiving in October, which previous to recent climate change was around the time of the first crop-killing frosts (Ontario Government, n.d.). The farmers we interviewed described growing and/or selling 34 different types of produce during the off-season. The five crops most frequently mentioned by farmers were: cabbage (9), peppers (5), tomatoes, (5), onions (4), and winter squash (4). The only fruits mentioned were apples. The full range of farmers' responses is in Table 1.

The produce dealers we interviewed described selling 15 different types of products, including fruits, vegetables, and maple syrup. The three most frequently mentioned products the dealers have for sale after Thanksgiving were: cucumber (5), winter squash (5), and tomatoes (4). Unique to the dealers' list of items, compared to those sold directly by farmers, were wild blueberries, maple syrup, and

[1] Queirolo founded marketcityTO, an organization in Toronto that brings together the city's public markets to collaborate and strengthen the sector. It was in her capacity at marketcityTO that Queirolo began to collaborate with Elton to design the questionnaire that generated the data for this paper. Queirolo is an economic development officer at the City of Toronto, working on small businesses and public markets.

hydroponic lettuces. The full range of dealers' responses is in Table 2.

### *Barriers and Opportunities for Ontario Off-Season Supply*

We looked for what participants considered to be the barriers they perceive that prevent them from offering an all-year-round supply of produce, or that limit their off-season supply. We also considered how participants described their interest in *increasing* what they sell in the off-season. We then categorized these answers under two themes: ecological barriers and opportunities as well as economic barriers and opportunities. We define "eco

**Table 1. Products that Farmers Have for Sale After Thanksgiving at the Ontario Food Terminal**

| Farmer Participant ID # | Products |
|---|---|
| 1 | Sprouts |
| 2 | No products available after Canadian Thanksgiving |
| 3 | Beans; zucchini; squash; leeks |
| 4 | Broccoli |
| 5 | Pumpkins; winter squash |
| 6 | Arugula; cilantro; curly and flat parsley; red and gold beets with tops; carrots with tops; red and green Swiss chard; black, red and green kale; collard greens; bunched spinach; bunched methi leaf (fenugreek) |
| 7 | Mushrooms |
| 8 | Cabbage; tomatoes |
| 9 | Cabbage |
| 10 | Tomatoes; peppers |
| 11 | Potatoes; onions |
| 12 | Nappa cabbage; bok choi |
| 13 | Apples |
| 14 | Cabbage; green beans; green peppers; rutabagas |
| 15 | Specialty "exotic" mushrooms (Shiitake, Chestnut mushrooms, Black Oyster, and King Oyster) |
| 16 | Cabbage, celery root, beets, carrots, onions, parsnip, shallots, leeks, watermelon radish, turnip |
| 17 | Greenhouse tomatoes (clusters, Roma, grape, heirloom, and other varieties); greenhouse cucumber (full size and mini) |
| 18 | Cabbage; squash; pumpkins |
| 19 | Fresh harvested heirloom carrots and potatoes; winter squash |
| 20 | Roma tomatoes; green peppers |
| 21 | Grapes; Bosc pears |
| 22 | Flowers |
| 23 | Cabbage |
| 24 | Apples (> 20 varieties) |
| 25 | Greenhouse cucumbers; greenhouse tomatoes; greenhouse peppers |
| 26 | Carrots (orange, red, and mixed); beets (red, gold, candy); parsnip; onion; turnip; parsley root; sunchokes |
| 27 | Cabbage |
| 28 | Hydroponic greenhouse bell peppers (red, yellow, orange); hot peppers; eggplant (purple, white, Sicilian and striped) |
| 29 | Oyster and shiitake mushrooms |
| 30 | No products available after Canadian Thanksgiving |
| 31 | Potatoes (17 varieties) |
| 32 | Cabbage (red, green, savoy) |

logical" following the Oxford English Dictionary (2008), encompassing factors such as materiality of fresh produce, including the amount of time one can store a food before it starts to rot, differences in crop varieties that enable or impede long-term storage, and also seasonal conditions such as temperature and climate. We use the term "economic factors" to describe the business and monetary factors that impact sales. For example, the characteristics of a customer base, the marketplace itself including competition, and the availability of capital to invest in technology such as greenhouses. A summary of the barriers and enablers to off-season crop production and sales in Ontario that farmers and dealers discussed with us is in Table 3.

*Ecological Barriers*

The primary ecological barrier that limits Ontario off-season produce production and sales is the winter. Many participants described the colder seasons as an enduring barrier to local food production and sales. In the words of one vegetable farmer: "All product is grown by directly seeding into the soil. So it's limited by the seasons." Dealers also regarded importing fresh produce over the colder months as necessary because, as one said, "we can't grow everything year-round here." However, storage and forms of winter production were said to be possible. We found that off-season supply is determined by crop variety, the amount of food an individual farm can produce, and the nature of the season itself as a period of dormancy.

*Crop Variety*

The variety that a farmer chooses determines whether it can be stored, and there is an enormous array of possibilities. For example, there are hundreds of varieties of carrots to choose from, including seeds developed by multinational seed companies such as Bayer Ltd. and ones produced by smaller companies such as Ontario-based William Dam Seeds. There are also heirloom or heritage seed varieties, gene lines for vegetables grown outside of the commercial seed industry (Dwivedi et al., 2019). The farmers we spoke to explained that there are trade-offs in the seed selection process relevant to our research. For example, a farmer can choose either to plant a carrot variety that has a thick skin, conducive to storage, or a thin-skinned variety that is sold within days of harvest, bunched with its green leaves attached, and regarded in the market as having premium quality and flavour. The same trade-off applies to bunched beets. The value of the bunched carrot or beet sold with its green tops appears to outweigh the value of growing a variety that stores better. A vegetable farmer stated: "Because we are fresh market producers, the crops we grow are varieties that do not keep and are not meant to be stored…So we sell products within days of being harvested, for the best quality and flavor." Thus, whether a particular crop is suitable for storage is determined as early as seed selection. We assume that this determination also has repercussions for farm income, since perceived higher quality and flavour could in theory attract a higher price.

**Table 2. Products that Dealers Have for Sale After Canadian Thanksgiving at the Ontario Food Terminal**

| Dealer Participant ID # | Products |
|---|---|
| 1 | Cucumbers (seedless and mini); tomatoes (full size and cherry) |
| 2 | Cucumbers, tomatoes, and some peppers |
| 3 | Wild blueberries; maple syrup |
| 4 | Hydroponic microgreens; hydroponic Boston head lettuce; squash; beets; carrots |
| 5 | Cucumber; colored bell peppers; pears; tomatoes |
| 6 | Apples |
| 7 | Cucumbers; lettuces; squash |
| 8 | Carrots (orange and red); onions (yellow and red); shallots; potatoes; cabbage; beets; winter squash (butternut, acorn, spaghetti); apples |

Participants noted that some varieties hold their quality longer in storage than others. With the right conditions, some kinds of vegetables and fruits, such as apples and cabbage, have the capacity to be stored until the following year, when the next crop is grown and harvested. We visited an apple packing facility where apples are stored for more than six months. The multimillion-dollar facility keeps the apples under no oxygen conditions and yields a high-quality product even in the spring. However not all crops can be stored this long, regardless of variety. Participants reported that pumpkins only hold until October or November while some winter squashes can generally hold until February or March. We note that none of our participants described technology used to store squash that was as investment-intensive as apple storage.

*Limits to Production*

Farmers discussed how there is a limit to how much one farm can produce in the summer to store while also producing for the fresh market. Some described an overlap between the current and the previous year's harvests, such as with cabbage. However, most storage crops, such as potato, onion, squash, and leek ran out by mid-winter. An apple dealer said that some varieties may store as long as 12 months, if the supply doesn't run out or diminish in quality: "I'm always up against quality

**Table 3. Summary of the Barriers and Opportunities to Off-Season Crop Production and Sales in Ontario Cited by Farmers and Dealers**

| | Barriers | Opportunities |
|---|---|---|
| **Ecological** | *Crop Variety*<br>• Choosing crops and varietals that cannot be stored without rotting.<br>*Limits to Production*<br>• Running out of supply of product before end of season.<br>• Different knowledge and equipment requirements for field-growing vs. greenhouse-growing.<br>*Winter as Dormancy*<br>• Traditionally a time of slower pace for plants and farmers in field crop agriculture. | *Winter Production and Best Practices*<br>• Choosing crops and varietals that store well over the winter.<br>• Continued plant breeding for optimizing winter sale period.<br>• Access to best practice guidelines for crop production, harvest, and post-harvest handling of winter crops.<br>*Technology & Equipment*<br>• Access to advanced cold storage technology (e.g., atmosphere-controlled).<br>• Use of season-extension growing equipment (e.g., high and low tunnels).<br>• Growing crops entirely indoors. |
| **Economic** | *Business Models and Relationships*<br>• Planning farm sales for spring, summer, and fall only.<br>• Planning an operation shut-down phase during winter months.<br>*Market Competition*<br>• Domestic competition on volume.<br>• International competition on price.<br>• Customer demand for a wide variety of food.<br>• Major chain supermarket dominance in buyer-seller relationships.<br>• Reduction in small/medium-scale packing facilities.<br>*Financial Constraints*<br>• Prohibitive cost of expanding into winter greenhouse-growing infrastructure.<br>• Energy costs of light and heat required for winter production. | *Demand and Markets*<br>• Increasing domestic demand for Ontario-grown product during the off-season.<br>• Targeting specific sales markets with particular corresponding crops (e.g., the "late potato market").<br>• Shifting to different buyers across the season (e.g., farmers' markets, then retail stores and restaurants).<br>• Maintaining sales relationships with multiple buyers at once.<br>*Wide Variety of Buyers*<br>• Selling to a wide variety of buyers (e.g., restaurants, food processors, packing houses, wholesalers, food service suppliers, small grocery stores and large grocery chains). |

and supply." Season extension can be restricted by lack of know-how. In a region such as Ontario, where fresh produce has been imported for generations, there has been little impetus to develop season extension programs. Participants emphasized the difference between farming outdoors in fields versus farming in highly controlled environments like greenhouses. They pointed out the different expertise, practices, and resources required. It would not be possible for a farmer to casually add a winter greenhouse to a field-growing operation, for example. A farmer described how they once attempted to extend the zucchini season and grow it in a greenhouse. It was only after their crop failed entirely that they realized the type of plastic they used to cover the plants had blocked the bees from pollinating them.

*Winter is a Period of Dormancy*

The materiality of the winter season is a challenge for farmers. The colder months have traditionally been a period when the pace of work slows down. The days are shorter because the sun sets early at this latitude, and plants become dormant. Some farmers are even able to take a holiday. During the more active months of the year, farmers often work long hours, waking before dawn to ensure their produce arrives at the Terminal in time for the first buyers. The sun does not set until late in the evening, and some farmers described having to work in the twilight periods due to increasingly severe heat conditions for field workers. Throughout the growing season, farmers who sell at the Terminal often oversee cultivation of hundreds of acres, working with a range of people in the sector, including crews of highly skilled guest agricultural workers. They must coordinate their planting schedule with the demands of the market and their customer base, as well as contend with the many uncertainties presented by the weather and climate. Like everyone else, they need a break. Some farmers told us they valued the downtime they associate with winter as an offseason, as a way of balancing out the heavy day-to-day workloads of farming from spring to fall; as one farmer said:

> We push it during the growing season, working 80–90 hrs per week, so we can take down time during the off season. However, because we start growing seedlings for the field in February, we're only really off about two months of the year.

These annual rhythms, however, are distinct from year-round indoor operations, such as greenhouses and mushroom facilities, where work cycles are more disconnected from the seasons.

Despite these ecological barriers, the data reveal that it was not the length of the growing season, nor limits to storage that constrain year-round access to some regionally grown produce that necessarily limits the food system. Still, winter is winter.

### *Economic Barriers*

The economic barriers that farmers and dealers discussed with us involve business models, market competition, and financial constraints.

*Business Models*

Whether a farm has produce that it can sell in the winter is determined in part by how they plan sales. Participants identified two models of farm sales: "pick-and-pack" farms grow produce meant to be sold immediately after harvest, and "pick-and-store" farms grow crops suitable for storing and selling over a longer period. If a pick-and-pack farm were to have produce available for sale in December, it would mean their sales had been poor. Then there are the production systems that can produce year-round: greenhouses, mushroom farms, and sprout operations. However, some large-scale greenhouses noted that they could continue to produce and sell their products into the winter months, but doing so would delay the next season's production, as the months of November to March are spent cleaning their facilities and growing new plants for the upcoming season. Each of these economic models sets a farm up for either selling into an off-season market, or not.

*Market Competition*

Farmers offered economic reasons for choosing the pick-and-pack model over pick-and-store: selling in the off-season is not necessarily lucrative. Competition from domestic and international growers were economic barriers that limit profita-

bility of off-season sales. A farmer said they did not grow crops meant for storage because other farms nearby were doing so. Another shared that they only grow enough winter squash to store and sell for four weeks after harvest, even though they could grow more and could store it for much longer, because squash grown in Mexico is sold in Ontario, starting four weeks after the local harvest, for the duration of the off-season at a significantly lower price. Another farmer described how they grow a variety of red carrot that is highly valued by the South Asian market in Ontario. But at the time in the season when the same product is imported from overseas, Ontario farms can no longer sell theirs because the imports undercut them so steeply on price. The prices that farmers obtain for crops were also a barrier to winter production. In the case of a "pick-and-pack" farm model, one farmer described that the premium prices they are able to fetch in the fresh product market generated sufficient profit during the growing season to last their family across the whole year.

Dealers also spoke to us about the limited variety of Ontario products available during the winter months that reduces the consumer appeal of a strictly local diet. One dealer said, "We can produce cukes [cucumbers] all year round, but people want more options." As a result, wholesale dealers—even those who specialize in local products—may purchase imported products during the winter months to keep their businesses going. This particular dealer's observation speaks to the ways that food choices and habits are imbricated in these questions. Why would you want to eat greenhouse cucumbers all year round if you can access a wider variety of fruits and vegetables from all around the world regardless of season?

The market factors that influence what is available for sale in the off-season are not only global. The major chain supermarkets have transformed the produce industry by requiring suppliers to conform to their company standards (Burch et al., 2013; Wilmers, 2018). Among our respondents, farmers in particular described the influence of the major chain supermarkets on their business opportunities. One apple grower described how he occasionally sells to a packer that supplies one of the large grocery chains. Packing facilities are intermediary businesses that take raw bulk product (such as loose apples in large wooden crates) and wash, sort, and package them for retail sale. He told us that selling to a packer has become harder for small and medium-size growers because the chains will only purchase large volumes above what he can produce. He said that smaller packing houses have also closed. He described what he saw as work created by the major grocery chains and downloaded onto farmers: "The large chains can also stipulate what size fruit they want [usually only a medium size], which means you have to find other places to sell the other sizes." He expressed shock at the high prices of apples at their stores: "I can't believe what they charge." Thus the influence of the major chain supermarkets on the regional food system, that operates in tandem to the global supply chains, contributes to constraining winter supply from small to mid-scale Ontario farms.

*Financial Constraints*

To boost supply, growers can produce indoors or extend production into the shoulder season. When asked whether they would be interested in winter production, many farmers responded that costs were prohibitive. For those who do not already have necessary facilities, they said that building a greenhouse is too expensive. "Those already in the (winter greenhouse) game can expand, but to start into it costs about a million per acre," said one vegetable farmer. Another vegetable farmer said, "We don't have greenhouses, nor the capital to invest in them (but) if someone gave them to us, or gave us access to one, we would use it!" Additionally, because of the reduced sunlight and cold temperatures during Ontario winters, growing during these months generally requires significant light and heat supplementation. Several farmers spoke about the associated energy costs: "The limiting factor is energy," said a fruit and vegetable farmer. They pointed out that when the price of supplemental energy was added to the cost of production, the sale price would not be competitive against global market pricing.

### *Ecological Opportunities*

The facts of winter at a northerly latitude—cold temperatures, snow, plant dormancy, plant cells

that rupture when frozen—underlie the ecological barriers we have identified in our data. Nevertheless, we sought to consider details offered by participants that could be framed as enablers, or opportunities, for boosting off-season produce supply. These include crop varieties and appropriate technology and equipment.

*Crop Varieties for Storing*

To produce a good product to sell in the off-season requires a farmer to consider not only storage but also the flavour and quality of their product at the time of sale, which are determined in large part by the kind of carrot, cabbage or apple chosen to plant. Over centuries of plant breeding, thousands of different varieties of food plants have been developed to improve or change qualities including taste, texture, storage, and pest and drought resistance, among innumerable other aspects (Kingsbury, 2009). Some breeding has involved genetic modification, but the vast majority of plant breeding involves less invasive methods, such as hybridization. Over the last several decades, large seed companies that develop different seed lines have bought up smaller companies, leading to a consolidated marketplace (Howard, 2015). This means fewer varieties on the market for farmers to purchase (Howard, 2020). However, smaller companies do remain that specialize in older seed lines, often called heritage or heirloom crops.

Farmers carefully choose crop varieties because different plants have different qualities. Farmers spoke about the importance of choosing varieties with good storage capacity; for example, certain cabbage and potato varieties are meant for longer storage because they peak in flavor and quality for the winter market. Farmers highlighted the need for plant breeders to develop new varieties to improve storage crops. But the variety was not the only important characteristic to consider. To maintain and extend shelf life, farmers and dealers also stressed the importance of good farming practices that produce high-quality crops in the first place. Mishandling crops leads to bruising and nicking, which can accelerate the natural breakdown process. They emphasized that coolers can only preserve and slow down the degradation of fresh produce. "A cooler is a cooler, not a hospital," said an apple dealer.

*Technology and Equipment*

Major advances in cold storage technology are another enabler reported by farmers and dealers for winter crop storage. Historically, coolers were constructed underground or in barns, and were made from wood. However, current practices can involve 50,000-sq ft insulated rooms with R-values of 50 or more, equipped with ventilation systems that almost entirely remove the oxygen from the air inside and clean the remaining atmosphere with ethylene filters. Several participants described these atmosphere-controlled systems as dramatically changing their capacity to store their crop, often for months longer than previously. The technology also preserves quality, preventing "shrinkage" compared to wood-built coolers. Preservatives added to produce at the washing and packing stage, such as the SmartFresh™ treatment often used on apples (AgroFresh, 2026), were noted as vital to long-term preservation.

Other equipment was noted as important for extending harvest both earlier and later in the season, such as low tunnels built over rows of field-grown crops and blankets to insulate against minor frosts. Alternatively, some crops can be grown entirely indoors, in highly controlled environments, such as sprouts, mushrooms, and a number of fruits and vegetables, such as strawberries, cucumber, and tomatoes. Due to the number of variables that need to be precisely taken into account for optimal productivity, knowledge of growing methods is vital to widespread success. This can differ from crop to crop. For instance, one farmer shared that tomato greenhouse growing methods have become more established, such as lighting levels, fertilizers, and seed varieties, while by contrast, greenhouse pepper growing methods are much less developed, with farmers still using trial and error to learn and establish best practices under expensive overhead and operating costs.

### *Economic Opportunities*

The economic enablers that participants shared with us involve market demand and diversity of buyers.

*Market Demand*

One participant noted a steady increase in demand for Ontario products during the fall and early winter season over the last five years, and consumer interest in buying local produce rose in general during the COVID-19 pandemic (Elton et al., 2023) . Participants reported that this trend is continuing. A farmer who grows melons, sweet corn, and peppers that they sell alongside produce from other Ontario farms, along with a broker at the Terminal, remarked that they had increased their production in response to year-over-year increases in demand. Participants further identified what they saw as a need to encourage and expand domestic demand for Canadian produce to reduce the need to export to the U.S., some expressing concerns about selling due to on-going corporate concentration in grocery retail.

Farmers also noted the importance of being attuned to specific consumer market demands through retail channels. Produce farmers spoke about designing their farm production to align with specific times of the year. While being first to market with a given crop is often rewarded with a premium price and guaranteed sales, a farmer who grows a variety of vegetables described timing their growing schedule to produce peak volumes for the end of the growing season in early fall. He was "targeting the late market for Roma tomatoes and green peppers" for when those crops are often purchased by the bushel for home canning. Similarly, we heard from a potato farmer who strategically selected certain potato varieties for winter sales. Targeting different kinds of customers across the seasons was also noted, such as shifting from farmers markets during the summer and fall to retail stores and restaurants over the winter.

Both farmer and dealer participants described how they were dependent on several different buyers, including during the winter. Farm businesses noted that they needed to sell to different grocers, large and small. Some relied on small independent grocers while others sold to some or all the major supermarket chains. Some farmers sold directly to the public at year-round farmers markets or through their own on-farm stores. One dealer noted that while they sell product at the Terminal, they also broker sales to the major supermarket chains. These stores run growing programs for farmers, determining terms of production from start to finish, including price. Working for the chains, they said, led to fewer price fluctuations. Emphasizing the appeal of guaranteed sales, the dealer said, "By the time you're putting a seed in the ground, you've invested millions." Several farmers also sold wholesale in the U.S., one explaining that he sells 70% of their cabbage, green beans, green peppers, and rutabagas in the U.S. to generate sufficient income: "Ontario's capacity for production way exceeds the local demand. This is why exporting is vital to farming viability."

*Diversity of Buyers*

Toronto is one of the largest food and beverage manufacturing clusters in Canada and the U.S. (Waterloo EDC, 2023) where there are many potential buyers of produce. Participants reported selling to major food companies as well as to restaurants. One participant described selling potatoes to a potato chip company that is a subsidiary of a multinational food and beverage corporation. These sales were organized outside of the Terminal. Other food processors purchase produce at the Terminal, including companies that make ready-to-eat bagged salads. A farmer who specializes in Asian greens sells to a Chinese community wholesaler that supplies a Chinese-Canadian restaurant chain. Another participant described selling 420,000 lbs of potatoes a week to a fast-casual Canadian chain restaurant. Dealers shared that they also sell their product directly to food service suppliers, including large American multinational corporations that sell, market, and distribute food products to restaurants, healthcare, educational, and sports facilities. Business flowing through the Terminal also includes sending produce to packing houses that size, clean, sort, and package produce wholesale. In the context of selling to these major buyers, farmer and dealer participants told us that the Terminal was crucial to profitability. One farmer described that while they primarily sell to the major supermarket chains outside the Terminal, the institution "takes the monopoly edge off" by providing them with an alternate sales avenue, should they

not wish to accept the offer being made by the supermarket chain. This variety of buyers supports the produce industry's profitability.

## Discussion and Policy Recommendations

From these data, we conclude that there are capacity and interest among produce farmers and dealers at the Terminal to expand off-season stock, with potential to improve winter production and storage. Participants have noticed that there is an increase in interest in Ontario-grown produce among consumers. Furthermore, the political climate is also favorable, with an increase in nationalism and consumers' principled move away from American products since the U.S. president began threatening to annex Canada. In June 2026, the federal government funded a National Food Security Strategy that includes boosting regional food systems. The ecological barriers to production, such as cold weather and limited seed varieties, can be circumvented with technologies such as storage-ready and winter-hardy seed varieties and greenhouses, hoop houses, and tunnels to extend the growing season. As government policy would enable these changes, our findings lead to the following policy recommendations, relevant to many jurisdictions, which are summarized in Table 4.

### *Infrastructure*

It is expensive to invest in off-season production and storage. Participants told us that the burden of investing in off-season production is too high for small to mid-scale businesses. Similarly, effective long-term storage facilities are costly, as exemplified by the multimillion-dollar apple storage facility we visited during the study. When the Ontario Food Terminal was being planned by the provincial government after the Second World War, it was recognized that food system infrastructure was too costly for the producers themselves to support (Elton et al., 2025). It was in the public good for the government to use its resources to support founding the public facility. As participants noted, a secure and consistent off-season supply of regionally grown food could be supported by public investments such as grants and interest-free loans for small and mid-scale operations for scaling up off-season vegetable production and farm extension for winter production, as well as for seed breeding, community-based storage facilities, as well as other supports for processing and public wholesale food terminals such as the Ontario Food Terminal. Food system infrastructure such as packing houses, as a farmer explained to us, needs to serve not just the major players but also small and midscale growers. Despite farmers selling their produce directly to major chain supermarkets in Canada as well as to American customers, they relied on the public infrastructure of the Ontario Food Terminal. This emphasizes the important role that government can play along supply chains.

### *Market Factors*

Global produce supply chains ensure a steady access to fresh fruits and vegetables in the winter, often at prices that are less than those of the same products grown locally. Squash from Mexico and apples from Washington State are two products that farmers and dealers described as being undercut in price by imports. In some instances,

**Table 4. Policy Recommendations**

| | |
|---|---|
| **Infrastructure** | Governments can support off-season production by reducing barriers through grants and interest-free loans for scaling up, and investing in agricultural extension for winter production as well as seed breeding. |
| | Governments can support small and midscale packing, processing, and storage in public facilities close to farms, and invest in public wholesale food terminals to facilitate farmer participation in the food economy. |
| **Market Factors** | Further study of how global price competition threatens to reduce agricultural capacity in Canada is needed. |
| | Food policy must balance current food security with future food security so that maintaining affordability today does not compromise affordability and accessibility tomorrow. |

the lower prices are the result of lower production costs in the country of origin. Squash, for example, is grown in Mexico where the wages are lower than in Ontario. A free-market logic would claim that these economic differences mean that it is rational for Ontario to import squash in the winter—the Mexican squash outcompetes the Ontario squash and therefore the market is working to keep prices low for consumers. However, as has been argued (Coase, 1960; Skolrud et al., 2020), this equation does not factor into the sale price externalities such as the emission costs of trucking the squash from Mexico (Li et al., 2022). It does not consider the fact that there are regions of Mexico where there is not enough water for the people who live there, let alone enough to irrigate export crops (Hartman et al., 2021). Low food costs in Toronto do afford food security to people with low incomes in this city. However, a focus on price above all costs is also a threat to food security. When farmers have been unable to compete on prices with imported food, they have pulled out of the competition. A farmer we spoke with said that he does not grow more squash to store over the winter because of the influx of imported squash later in the season. This withdrawal threatens to reduce agricultural capacity in Canada, which has already taken place in Ontario with two crops: apples and garlic. In 2000, 4,500 acres of garlic were grown, but farmers stopped producing it when low-cost imported garlic arrived on the market; by 2002, there were only 300 acres of garlic grown in the province (Elton, 2010a). (The province's apple industry experienced a similar trajectory (Elton, 2007)). While varying political and economic perspectives will interpret these facts differently, what we wish to highlight is that there is more at stake than just the price of food. Policymakers need to balance current food security with future food security, so that maintaining affordability today does not compromise affordability and accessibility tomorrow.

## Conclusion

As we have explored in this paper, a questionnaire administered to regional farmers and dealers at the Ontario Food Terminal found that contrary to commonly held assumptions, locally grown produce is available for sale in the off-season. Furthermore, participants reported an interest in scaling up both storage and off-season production. However, what is available for sale, and efforts to scale up, are limited by both ecological and economic factors. Temperatures below freezing and low sunlight during the winter inhibit agriculture. To store products grown in the summer over the off-season, farmers require specific crop varieties. However, these varieties must compete for growing space with ones selected for fresh sales that fetch profit at market. Ontario products then must compete with often lower-priced imports during the off-season, which is a further disincentive. At the same time, advances in storage technology may facilitate better storage of crops, and therefore provide greater and longer availability of Ontario produce over the off-season. However, this kind of season extension requires financial investments. Finally, participants reported growing interest in Canadian produce from customers who want to "buy local," while also contending with competition from global actors and challenges producing and selling in a grocery sector dominated by main chain supermarkets. As such, these research findings speak to food sovereignty debates, at a time when international trade regimes are experiencing rapid changes. With meaningful investment in building regional and sustainable agricultural capacity, this paper identifies an opportunity to shift food import dependency in the name of protecting food sovereignty and nutritional security.

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## Appendix A

*Farmer Survey Questions*

1. Are your farm products sold through the Ontario Food Terminal?
   - □ If yes, the survey continues
   - □ If no: Thank you for your interest in our survey. We are surveying Ontario farmers and dealers who sell through the Ontario Food Terminal.
2. How do your farm products move through the Ontario Food Terminal? Choose any or all that apply.
   - a. My farm sells through the farmers' market at the OFT.
   - b. My farm sells to a wholesale tenant at the OFT.
   - c. My farm sells to a dealer who sells my farm products at the OFT
   - d. A combination of above (please describe below)
   - e. Other:
   - f. (open-ended response space)
3. At what times of year do you sell your farm products at the OFT? Choose any or all that apply.
   - a. May-June
   - b. July-October
   - c. November-February
   - d. March-April
4. At what time of year do you sell the highest quantities of your product?
   - a. May-June
   - b. July-October
   - c. November-February
   - d. March-April
   - e. I sell more or less the same amount of farm products all year round
5. a) What farm products do you sell through the Ontario Food Terminal? Choose any or all that apply.
   - a. Vegetables — please list below
   - b. Fruit — please list below
   - c. Eggs
   - d. Firewood
   - e. Honey
   - f. Maple syrup
   - g. Other – please list below
   - h. (open-ended response space)

5. b) Please describe/list the farm products you sell through the Ontario Food Terminal.
   (Open-ended response space)
6. Which of those products do you have available for sale after Thanksgiving in October? Please list them below. (For example, carrots, squash, greenhouse peppers…)
   (Open-ended response space)
7. For the products you cannot produce in the winter, how do you store them in the off-season (for example, on-farm cooler, root cellar, off-farm warehouse, dealer's warehouse, etc.)?
   (Open-ended response space)

8. How long can you store your farm products after Thanksgiving and into the off-season? Please describe which products and how long you can store them for. For example, you might grow leeks that can be harvested until the first heavy frost and then store
   (Open-ended response space)
9. (a) Can you produce any of your products all year round?
   - □ Yes
   - □ No
   - □ Other (open-ended response space)
9. b) If Yes: Please describe what you produce all year round and where you do this. If No: please explain why you cannot produce your products all year round.
   (Open-ended response space)
9. c) Have you noticed any changes over the years that make possible to sell some products later in the season? such as climate changes, increasing access to equipment or technology (hoop houses, greenhouse heating, storage facilities ), labour programs, or new plant varietals, for example?
   (Open-ended response space)
10. a) What volume of products do you continue to have available for sale after Thanksgiving, whether or not you are storing them or continuing to produce them? Please estimate a quantity in pounds, kilos, or bushels.
   (Open-ended response space)
10. b) What percentage does this represent out of your whole year's crop total?
   (Open-ended response space)
11. How do you grow your products? Choose any or all that apply.
   a. Open fields
   b. Hoop house
   c. Greenhouse
   d. Mushroom facility
   e. Other, please explain below
   f. Other (open-ended response space)
12. Is there any other place you sell your products in the winter month or off-season, aside from the Terminal?
   (Open-ended response space)
13. Are you interested in selling more farm products in the off-season?
   - □ Yes
   - □ No
   - □ Other (open-ended response space)
14. What is the name of your farm/business?
   (Open-ended response space)
15. How many acres do you grow produce on?
   (Open-ended response space)
16. How long have you been growing produce?
   (Open-ended response space)
17. Is yours a family business? If yes, how so?
   (Open-ended response space)
19. Where is your farm? Do you know the postal code for the land where you grow?
   (Open-ended response space)

20. Do you have plans to retire or leave farming in the near future? If so, when?
    (Open-ended response space)
21. How sure are you about your retirement plans? (Certain? Possible? Unsure?)
    - □ Certain
    - □ Possible
    - □ Unsure
    - □ Other (open-ended response space)
22. Thank you very much for participating in our survey! We are very grateful for the time and effort you spent answering our questions. Is there anything else you would like to mention that we haven't discussed yet about the OFT and its role in your business? Or anything else you would like to add?
    (Open-ended response space)

*Dealers Survey Questions*

1. Do you sell products from Ontario farms at the Ontario Food Terminal?
    - □ If yes, the survey continues
    - □ If no: Thank you for your interest in our survey. We are surveying Ontario farmers and dealers who sell through the Ontario Food Terminal.
2. How do you use the Terminal to do business? Choose any or all that apply.
    - □ I have a stand at the OFT farmers' market
    - □ I am a warehouse tenant
    - □ I don't show up in person at the OFT but I sell through the Terminal networks
    - □ Other - please describe below
    - □ (open-ended response space)
3. At what times of year do you sell Ontario produce at the OFT? Choose any or all that apply.
    a. May-June
    b. July-October
    c. November-February
    d. March-April
4. At what time of year do you sell the highest quantities of Ontario produce?
    a. May-June
    b. July-October
    c. November-February
    d. March-April
    e. I sell more or less the same amount of farm products all year round
    f. Other – please explain below
    g. (open-ended response space)
5. a) What Ontario farm products do you sell through the Ontario Food Terminal? Choose any or all that apply.
    a. Vegetables — please list below
    b. Fruit — please list below
    c. Eggs
    d. Firewood
    e. Honey
    f. Maple syrup
    g. Other – please list below

h. (open-ended response space)

5. b) Please describe/list the Ontario farm products you sell through the Ontario Food Terminal.
   (Open-ended response space)
6. Which of those products do you have available for sale after Thanksgiving in October? Please list them below. (For example, carrots, squash, greenhouse peppers…)
   (Open-ended response space)
7. a) Are there Ontario produce items that you sell all year round?
   - □ Yes
   - □ No

7. b) If Yes: What are they? Where do you sell these items? (Only through OFT or elsewhere too?) If No: Why? (e.g., limited growing season; storage constraints; too much competition from elsewhere to justify growing or storing the crops, etc.)
   (Open-ended response space)
7. c) Have you noticed any changes over the years that make possible to sell some products later in the season? Such as climate changes, increasing access to equipment or technology (hoop houses, greenhouse heating, storage facilities), labour programs or new plant varietals, for example?
   (Open-ended response space)
8. How are the Ontario products grown that you sell? Choose any or all that apply.
   - □ Open fields
   - □ Hoop house
   - □ Greenhouse
   - □ Mushroom facility
   - □ Other - please explain below
   - □ Open-ended response space

9. Are you interested in selling more farm products in the off-season?
   - □ Yes
   - □ No
   - □ Other (open-ended response space)

10. Is there any other place you sell your products in the winter month or off-season?
    (Open-ended response space)
11. Can you estimate how many farms you buy from?
    (Open-ended response space)
12. Where are these farms? What counties?
    (Open-ended response space)
13. How do you get the food from these farms? Do you have a truck that you drive to pick it up or does the farmer deliver to you? (If they deliver, where do they deliver to?)
    - □ I have a truck that I drive to pick it up
    - □ The farmer(s) deliver to me
    - □ If they deliver, where do they deliver to? - please explain below
    - □ Other (open-ended response space)

14. Do you have or use a warehouse of your own (aside from those at the Terminal) that you store the products you're selling?
    - □ Yes
    - □ No

- □ Other (open-ended response space)

15. How many trucks do you own for transporting produce? Or do you work with logistics companies or trucking companies?

    (Open-ended response space)

16. What is the name of your business?

    (Open-ended response space)

17. Thank you very much for participating in our survey! We are very grateful for the time and effort you spent answering our questions. Is there anything else you would like to mention that we haven't discussed yet about the OFT and its role in your business? Or anything else you would like to add?

    (Open-ended response space)