



APRIL 2022

Written by:

**Minerva
Cancilla-Styles**

Leah Bauer

Kaleigh VanBokhorst

Analysis of Land Use Planning Practices Affecting Controlled Environment Agriculture

Prepared for the Ontario Federation of Agriculture

Table of Contents

1. Defining Controlled Environment Agriculture	3
2. Project Scope and Objectives	3
3. Research Methods	4
3.1 Literature Review	4
3.2 Presentations	6
3.3 Interviews	7
4. Research Results	8
4.1 Defining CEA Operations	8
4.2 Major Themes	8
5. Discussion	13
5.1 Policy Guidance	13
5.2 Implications for Rural and Urban Areas	13
5.3 Opportunities & Challenges	14
6. Research Gaps	14
6.1 Limitations	14
7. Future Research	15
8. Conclusion	16
Appendix A	19
Appendix B	20
Appendix C	21
Appendix D	23
<i>Research Results Summary from Ontario municipality interviews. (Alphabetical from left to right: Caledon, Dryden, Durham.)</i>	<i>23</i>
Appendix E	27

1. Defining Controlled Environment Agriculture

Controlled Environment Agriculture (CEA) is a form of technologically guided indoor agriculture that combines science and engineering, of which the most common forms are greenhouses, vertical farming, and hydroculture, each with their own unique components that offer a variety of benefits (Cornell University, 2015; Government of Canada, 2021). CEA operations have the potential to provide a more sustainable form of agriculture as they not only provide optimal growth conditions for a variety of crops, but they also optimize the use of resources including space, light, water, and labour (Cornell University, 2015; Engler & Krarti, 2021; UC Davis, 2021). Typical crops that are grown in CEA operations include lettuce, spinach, and other leafy greens, micro greens, herbs, tomatoes, peppers, and strawberries (Benke & Tomkins, 2017; Cornell University, 2015).

Over the last few years, as technology has improved and the implementation of CEA operations has grown, this form of agriculture is increasingly being regarded by professionals as a solution to the ever-growing demand for fresh locally produced food (S2G Ventures, 2020; UC Davis, 2021). In regions where crop production is not possible year-round because of varying climatic conditions, such as within Ontario, CEA are able to produce an uninterrupted supply of fresh produce within the highly controlled environment (S2G Ventures, 2020; University of Arizona, 2021). In countries such as Australia, the United States, and Canada, the costs and benefits of CEA operations have been examined, however research within Ontario specifically is still lacking (Benke & Tomkins, 2017; Engler & Krarti, 2021). Research surrounding the land-use planning considerations of CEA is limited, with the majority focusing on the economic viability and the environmental considerations of these operations (Engler & Krarti, 2021; New York State Energy Research and Development Authority, 2022; S2V Ventures, 2020).

Although greenhouses, vertical farms and hydroponics are all included within the broader definitions of CEA, this project focused mainly on vertical farming operations. The reasoning behind this choice is that within Ontario, greenhouse operations are generally accepted as part of primary agriculture under Ontario's provincial policy, however vertical farming operations are novel (MMAH, 2020a). Greenhouse operations can also vary widely from vertical farms in terms of input and infrastructure requirements (i.e., natural lighting versus artificial lighting) making it more difficult to study combined land use considerations.

2. Project Scope and Objectives

This project was completed in partial fulfillment of course credit for the Master of Science in the Rural Planning and Development program at the University of Guelph. The project aims to stimulate a conversation surrounding the growing field of CEA. In particular, the project seeks to introduce municipalities to the concept of CEA, investigate how municipalities approach CEA from the land use planning perspective, and identify gaps in the literature, including within provincial policy, to guide municipalities in their approaches to permitting CEA in the future.

For this project, vertical farms (including aquaponic operations) established to grow food, were included within the research. Greenhouse operations, mushroom farms and cannabis operations were omitted from the research as the land use considerations for these types of CEA can vary widely and did not align with the scope of the project. The goal of this project was to explore a sample of emerging policies and guidelines surrounding land use considerations for CEA operations. Greenhouses, although important, are already included as an example of an agricultural use in areas zoned and designated for agriculture under the provincial land use planning framework and therefore may have more clarity regarding their establishment. On the other hand, vertical farms are not explicitly referenced within the provincial definition of *agricultural uses*, however their functions would fit under the PPS definition which stipulates *agricultural uses* include “the growing of crops, including nursery, biomass, and horticultural crops [...] and associated on- farm buildings and structures” (MMAH, 2020a). To assist in further defining the scope of the project, the term 'vertical farm' included warehouse and shipping container operations (which may not necessarily be 'vertical' in their built design, but still apply many of the principles of vertical farming to their operations). Based on initial research, this report will show that CEA policy and guidelines are largely still in the development and design phase in many municipalities.

The objectives of this project were:

1. To explore Ontario's current land use framework and the policies that apply to CEA operations.
2. To determine if existing land-use policies and guidelines within Ontario are sufficient for promoting various types of CEA.
3. To identify land-use planning best practices for CEA employed by municipalities in Ontario
4. To initiate further discussion among Ontario municipalities and the agricultural community about land-use planning provisions regarding CEA
5. To highlight next steps and recommendations for future research surrounding the land use planning considerations for CEA in Ontario.

3. Research Methods

Two main methods of data collection that were used throughout this research, including a literature review of relevant literature surrounding CEA operations and semi-structured interviews with municipalities who have designed and implemented land use policies permitting CEA. Initially it was intended that surveys would be sent out to municipalities that had established land use policies or guidelines for vertical farms, however due to time limitations, efforts were focused on interviews because of the greater detail that could be identified in participants' responses and experiences, relative to the high-level data that could be derived from a survey.

3.1 Literature Review

A review of relevant literature revealed that CEA within Ontario is an emerging field; therefore, there is a lack of literature surrounding land use planning considerations within an

Ontario context. A scan of Ontario’s Provincial Policy Statement and corresponding provincial plans also revealed that although CEA is permitted as an *agricultural use*, there is currently a lack of guidance that exists on land use control for CEA operations at a provincial level (MMAH, 2020a). To provide clarity the following table includes the provincial definitions (as stated in the Provincial Policy Statement) for terms that are relevant to this study and how/where CEA may be classified.

Table 1: Provincial Definitions

Term	Provincial Policy Definition	How/Where CEA can be Classified
<i>Agricultural Use</i>	<i>“means the growing of crops, including nursery, biomass, and horticultural crops; [...]and associated on- farm buildings and structures, including, but not limited to livestock facilities, manure storages, value-retaining facilities, and accommodation for full-time farm labour when the size and nature of the operation requires additional employment.” (MMAH, 2020a, Section 6.0)</i>	<p>Although CEA operations are not specifically referenced within the provincial definition of agricultural use, the definition is broad leaving room for interpretation.</p> <p>Greenhouse crop production (a form of CEA) is promoted as an agricultural use within section 2.1.2 of OMAFRA’s Guidelines for Permitted Uses in Ontario’s Prime Agricultural Areas document (OMAFRA, 2016a).</p>
<i>Agriculture-Related Use</i>	<i>“means those farm- related commercial and farm-related industrial uses that are directly related to farm operations in the area, support agriculture, benefit from being in close proximity to farm operations, and provide direct products and/or services to farm operations as a primary activity” (MMAH, 2020a, Section 6.0)</i>	This definition could include retail storefronts for selling crops produced by CEA operations as outlined in section 2.2.2 of OMAFRA’s Guidelines for Permitted Uses in Ontario’s Prime Agricultural Areas document (OMAFRA, 2016a)
<i>Prime Agricultural Area</i>	<i>“means areas where prime agricultural lands predominate. This includes areas of prime agricultural lands and associated Canada Land Inventory Class 4 through 7 lands, and additional areas where there is a local concentration of farms which exhibit characteristics of ongoing agriculture. Prime agricultural areas may be identified by the Ontario Ministry of Agriculture and Food using guidelines developed by the Province as amended from time to time. A prime agricultural area may also be identified through an alternative agricultural land evaluation system approved by the Province” (MMAH, 2020a, Section 6.0)</i>	<p>Section 2.3.3.1 of the PPS states that in prime agricultural areas, agricultural, agriculture-related uses, on-farm diversified uses and normal farm practices are allowed as permitted uses. CEA, although not specifically mentioned within the PPS could be developed to conform with these permitted uses (MMHA, 2020a).</p> <p>Section 2.3.3.2 of the PPS also states that “<i>all types, sizes and intensities of agricultural uses shall be promoted and protected</i>” (MMAH, 2020a) meaning that industrial-type CEA such as vertical farms could be permitted.</p>

Research has revealed that CEA has the potential to grow as a profitable economic sector within Ontario however land use guidelines at the provincial level are lacking and municipal considerations are difficult to assess through a preliminary review (MMAH, 2020a; MMAH, 2020b). Although CEA is permitted as an agricultural use under provincial guidelines (MMAH, 2020; OMAFRA, 2016a), municipal authority has different guidelines within their land use planning tools, making it difficult to summarize consistent policies at the municipal level. It is unclear through the literature review as to whether municipalities have begun to develop specific policies surrounding CEA and how they review and consider these types of applications. Identifying key gaps within the current research surrounding CEA operations helped to inform the development of the research's interview questions.

The following key gaps were identified through the literature review:

1. There is little academic research conducted within an Ontario-specific context of the land use policies that apply to CEA.
2. Most North American research focuses on the implementation of CEA in urban areas rather than rural regions (Beacham et al., 2016; Benke & Tomkins, 2017; S2G Ventures, 2020; Zboraj, 2021).
3. Provincial policy surrounding agricultural uses does not specifically describe CEA operations as a permitted use (other than the Growth Plan for Northern Ontario), however the definition of agricultural used is fairly open-ended and seem to allow for CEA operations within agricultural areas, especially in rural regions (MMAH, 2020a, Section 2.3.3.1 & Section 2.3.3.2; MMAH, 2011, Section 2.1, 2.2.2, and 2.3.3).
4. It is difficult to review and summarize guidelines for CEA within Ontario municipal planning tools as each municipality has different policies and guidelines within their Official Plans and Zoning By-laws.

3.2 Presentations

To increase interest in the project, the researchers began promoting the project in early February through multiple channels, targeted to both municipal planning staff and agricultural producers engaging in vertical farming. To encourage Ontario municipalities and CEA operators to participate in the study, the researchers attended two meetings and a webinar where presentations were given on the background of the study and researchers' contact information was distributed to prospective participants.

The research was first presented on February 17th, 2022, during the Vertical Farming 101 Webinar Series (co-hosted by Durham Region, York Region, and the Ministry of Agriculture, Food and Rural Affairs) to introduce the project to municipalities and CEA operators in attendance (Durham Region et al., 2022). Recordings of the four webinars within this series can be found on the York Link YouTube channel (<https://www.youtube.com/channel/UC-CnZSj1AkotjlkzwGnFvew>). This was followed by a presentation for the Golden Horseshoe Food

and Farming Alliance working group to promote the research in the municipal and agricultural sector.

Next, the researchers presented at the Region of York's Regional & Local Agriculture and Agri-Food Portfolio virtual meeting with planners, and economic developers from the lower-tier municipalities within York region. The researchers leveraged these opportunities to recruit interview participants and initiate a discussion regarding CEA in Ontario. While it was apparent that municipalities are interested in the potential of CEA the results show that there are few municipalities with experience in designing land use guidelines for the implementation of CEA operations.

3.3 Interviews

To gain a complete understanding of land use planning best practices for Ontario municipalities, two groups of stakeholders were originally identified to participate in interviews for the project. The first was professionals who have experience navigating the approval process for establishing a CEA operation in Ontario and the second was representatives from Ontario municipalities who currently have policy on land use considerations for CEA. Municipal representatives could include planners or other members of the municipal authority such as engineers, or economic development officers. Unfortunately, because of time limitations and limited interest amongst CEA operators to participate, the research did not end up including perspectives from the CEA operators.

Interview requests were sent by email to five regional municipalities and to all the County Planning Directors (via membership listserv) within Ontario (full list of municipalities that were invited to participate attached as Appendix A). Of the requests sent, three municipalities accepted the invitation to participate in virtual interviews. Each interview was approximately thirty minutes in length and questions followed a semi-structured interview guide (see Appendix A for the full list of questions). The three municipalities that were interviewed for the project include the City of Dryden (single-tier), the Town of Caledon (lower-tier municipality), and the Region of Durham (upper-tier municipality).

Interview questions were developed in response to gaps identified within a preliminary literature review that was performed by the researchers. An advisory committee made up of staff from the Ontario Federation of Agriculture and the Ontario Ministry of Agriculture and Rural Affairs provided guidance in creating and reviewing interview questions to address key knowledge gaps. Participants were provided with a copy of the interview guide in advance of the interviews. This interview guide used for municipalities is available in Appendix B. While no interviews with CEA operators were conducted, the interview guide drafted for CEA operators is available as Appendix C.

Although participation amongst municipalities was low, each municipality represented a different municipal structure and offered unique insights into the varying issues associated with CEA in different geographic regions, providing a critical perspective on guidelines for CEA implementation at the municipal level. The Region of Durham was interviewed to provide an urban lens on guidelines for CEA development at an upper-tier level; the Town of Caledon shared experience managing infrastructure development in a rural setting at the lower-tier level; and the City of Dryden offered insight into the considerations for establishing CEA operations in Northern Ontario at the lower-tier level.

4. Research Results

4.1 Defining CEA Operations

Through the interviews, municipalities indicated that there was no specific definition of CEA, or vertical farms, within their municipal planning documents (i.e., the Official Plan or Comprehensive Zoning By-law). Municipalities also stated that they felt the definition of agriculture, and *normal farm practices* as defined in the *Farming and Food Production Protection Act, 1998* do not appear to apply to CEA (City of Caledon, personal communication, March 17, 2022; City of Dryden, personal communication, March 17, 2022; Region of Durham, personal communication, March 22, 2022). However, one municipality indicated that they see vertical farming fitting within the definition of an industrial use because this form of agriculture involves the packaging and storage of goods, reflecting the intersection of agriculture and industrial practices within vertical farming.

While the municipalities interviewed did not have a specific definition of CEA, the three municipalities articulated that the definition of agricultural use within their planning documents is very broad and could include vertical farming, dependent on interpretation of the definition and use. Applying a broad definition of agriculture may afford municipalities more flexibility in managing a diversity of agricultural development applications. For example, one municipality stated that when planning policy emphasizes the importance of supporting agriculture and agricultural innovation, this broad definition of agriculture may support the development of CEA. Nonetheless, in the absence of a definition, CEA can present difficulty for municipal planning staff who must interpret whether CEA proposals align with existing zoning provisions and policy guidelines. A summary of the research results is available in Appendix D, Table 3.

4.2 Major Themes

The following section identifies key themes that emerged during the interviews with the City of Caledon, City of Dryden, and Durham Region (City of Caledon, personal communication, March 17, 2022; City of Dryden, personal communication, March 17, 2022; Region of Durham, personal communication, March 22, 2022). Although the objective of this

research was to identify land use planning best practices for CEA operations, none of the municipalities that were interviewed had concrete policies guiding CEA development. Instead, the interviewees provided insight regarding their lack of policy, challenges and opportunities of CEA implementation in rural, urban, and suburban areas, special considerations for CEA implementation in Northern Ontario, and future goals and opportunities for CEA in Ontario overall.

4.2.1 Lack of CEA Specific Policy

Throughout each of the three interviews, it was clear that policy and guidelines surrounding CEA operations are lacking. When asked if policy or guidelines to regulate CEA development existed, the City of Caledon (Caledon), City of Dryden (Dryden), and Durham Region (Durham) all expressed that they had no formal policy regarding CEA development within their jurisdictions. As the municipal representatives explained, CEA is a relatively new field and although the policy is in the process of being developed, proposals for the development of CEA operations are addressed as they arise with no specific planning tools to assess the land use planning concerns associated with CEA. Durham also expressed that the approval of CEA operations happens at the lower-tier municipal level, and as an upper-tier municipality they are not involved in regulating planning approvals for individual CEA operations (Region of Durham, personal communication, March 22, 2022).

The representatives from Caledon, Dryden and Durham all noted that although there are no concrete policies to guide CEA development, Official Plan policies and Zoning By-Law provisions are broadly in support of agriculture and could therefore be adapted to support the development of CEA operations. Moreover, Dryden, Durham and Caledon all expressed that the development of CEA operations, including vertical farms, is supported through other planning-related documents such as agricultural and economic development strategies. In Dryden strategies to encourage the development of CEA to include updates to the City of Dryden Community Improvement Plan to include grants for Urban Agriculture (City of Dryden, personal communication, March 17, 2022). Durham expressed their continued efforts to encourage investments in innovative agricultural operations through the Invest Durham initiative supporting the Agri-Business sector and promoting vertical farming (Region of Durham, personal communication, March 22, 2022). Caledon also expressed that CEA development, including vertical farming operations, could be encouraged through their 2020-2030 Economic Development Strategy welcoming innovative agricultural technologies to increase local food security (City of Caledon, personal communication, March 17, 2022).

In the absence of formal policy through the Official Plan, or Zoning By-Law, municipalities stated that much of the work surrounding CEA development is left to the interpretation of municipal planning staff. The municipalities noted that the role of CEA in the agricultural system has not been clarified at the provincial level, making it increasingly difficult to create municipal level policies and guidelines.

4.2.2 Provincial Guidance

Greater guidance from the province to clarify ‘grey areas’ of CEA development was requested by all three municipalities. It was suggested by Caledon, Dryden, and Durham, that further direction at the provincial level on how and where CEA should be implemented would help to support a municipal approach to CEA development. A lack of formal policy at the provincial level to express the government’s interest in CEA leaves municipalities with questions on how they should approach CEA development. Dryden and Caledon both expressed that updating the PPS to include CEA within the definitions of *agricultural uses* and *prime agricultural areas* would help to better support the implementation of CEA at the municipal level (City of Caledon, personal communication, March 17, 2022).

Both Durham and Caledon noted that the consultation process undertaken by OMAFRA for Value Added ventures was beneficial and recommended that a similar process be undertaken to clarify the benefits, challenges, and role of CEA at the municipal level (City of Caledon, personal communication, March 17, 2022). Durham also suggested that OMAFRA create a document similar to the *Guidelines for Permitted Uses in Ontario’s Prime Agricultural Areas* (2016a) that would provide municipalities with specific recommendations on how to implement CEA within their jurisdictions. This would support municipalities in establishing parameters to encourage CEA development, make informed choices, and coordinate with other tiers of government and the Region on CEA implementation (Region of Durham, personal communication, March 22, 2022).

4.2.3 Implications for CEA location in Rural, Urban and Suburban Areas

Each municipality reported similar concerns regarding locating the best area for CEA to be developed. The optimal location for CEA is dependent on a variety of features including the municipality’s land cost and availability of key services such as water and sewer. In Durham, both Mighty Harvest Produce and BioFresh Farms, vertical farming operations in Oshawa and Whitby, are located within the urban area of the region. Similarly in Dryden, AgriTech North, a vertical farm currently in development, is in the urban center of the city within a residential neighbourhood. Durham expressed the appeal of building CEA operations near their main highways (401, 412 and 407) for easier distribution and suggested that food CEA operators could collaborate with grocery store terminals that currently exist along these transportation corridors. Durham stated being close to large markets for distribution was the primary reason that CEA were better suited in urban areas (Region of Durham, personal communication, March 22, 2022). Caledon expressed that knowledge of agri-food innovation available across southern Ontario was an important factor for CEA to be established near urban areas within ‘the Whitebelt’ (City of Caledon, personal communication, March 17, 2022).

The loss of prime agricultural land in southern Ontario was a concern outright stated by Durham, swaying their decision to focus on implementing CEA in urban areas rather than *prime agricultural areas* or *rural lands* (Region of Durham, personal communication, March 22, 2022). The loss of prime agricultural land was not a concern expressed by Dryden, however, access to local food was, highlighting the differing considerations for the location of CEA operations in the far north compared to southern Ontario. Caledon noted that CEA may be well suited to suburban areas where farmers are reporting increased difficulty supporting traditional agriculture, due to increased residential development in the vicinity of their operations. In these

cases, CEA may offer a solution that balances the needs of the agricultural system, and residents, that mitigates land use planning conflicts (City of Caledon, personal communication, March 17, 2022). Through the interviews, it was made clear that policy suggestions and guidelines should be place-specific, and considerations should reflect the varying needs of municipalities in southern and northern Ontario.

4.2.4 Special Considerations for Northern Ontario

The interview with Dryden yielded interesting insight into the differing considerations for CEA development in Northern Ontario. For example, Northern Ontario experiences difficulties in producing certain crops as a result of its sub-arctic climate that interferes with traditional agriculture. Dryden expressed that innovative CEA operations may fill a gap in Northern Ontario by providing residents with year-round access to high-quality, locally produced food, suggesting that vertical farming could create an opportunity to increase the agriculture sector in Northern Ontario where arable land is sparse.

Additionally, it was suggested that the cost of real estate is generally lower in northern Ontario compared to southern Ontario meaning that CEA operators may see developing in the North as a more affordable option. However, the representative from Dryden shared that expertise in CEA is currently concentrated in southern Ontario, so crews to implement and advise vertical farms and hydroponic operations may not be located within the vicinity (City of Dryden, personal communication, March 17, 2022).

4.2.5 Staffing

The participating municipalities indicated that staffing for CEA operations is likely not a concern as staffing requirements for CEA operations are minimal, especially compared to traditional field-based agriculture. Typically, there is sufficient staff available to support CEA operations in both urban and rural areas and the municipal representatives indicated that they were not aware of challenges in recruiting staff. Dryden offered increased insight by explaining that for the AgriTech North vertical farming operation, only four employees were needed to run the operation. At AgriTech North the number of people who are exposed to the crops is limited as pesticides are not used within vertical farming (City of Dryden, personal communication, March 17, 2022).

4.2.6 Infrastructure Requirements for CEA

CEA are considered to be a servicing-heavy industry namely in the water, energy, and sewage requirements that are required for operation. These considerations mean that the infrastructure to support CEA operations expands beyond the footprint of the building into the servicing requirements and impacts of the community. The participating municipalities expressed that the infrastructure requirements of CEA, including the availability of water and energy supply, were a concern when determining the location for CEA. Concerns included the difficulty of selecting a location for CEA development based on if the operation will rely on independent water drawing as opposed to municipal infrastructure in rural lands, and if wastewater is to be managed in-house or by community treatment plants. Dryden provided insight into the northern context, expressing that servicing for energy and water beyond the city

boundary is limited, meaning that infrastructure for CEA operations is mainly available within the urban boundary (City of Dryden, personal communication, March 17, 2022).

Another infrastructure consideration that was brought up during the interviews was the capacity of roads to handle an increase in transportation traffic from CEA developments. The increase in traffic on municipal roads as a result of transportation for CEA was expressed as an issue by Caledon, however as a non-issue by Dryden. Concern over the possibility of large trucks, particularly during construction and distribution, using municipal roads was brought up by the representative from Caledon (City of Caledon, personal communication, March 17, 2022). Alternatively, the representative from the Dryden shared that only small delivery trucks were used to transport materials and produce to and from their vertical farming operation (City of Dryden, personal communication, March 17, 2022).

Sound and light pollution were only vaguely considered, however, Dryden indicated that most vertical farms have special window covers to block light and have little to no noise pollution, so these were not issues that needed to be addressed (City of Dryden, personal communication, March 17, 2022).

4.2.7 Opportunities Created by CEA

Some of the key opportunities for CEA that were brought up by the municipalities during interviews included increased food security, run-off free agriculture, and land redevelopment. The increase in food security through CEA was a benefit acknowledged by all municipal representatives. It was noted by Caledon, Durham, and Dryden that CEA could create shorter “field to fork” distances by growing produce closer to consumers, increasing the quality of food offered and reducing waste. Dryden expressed that in the north this is particularly beneficial as long transport distances are a barrier to food security, affecting the quality, accessibility and variety of food that is available to residents. Being able to provide food at a market price similar to southern Ontario was particularly appealing, and equitable access to quality food for Indigenous communities near Dryden was emphasized by the municipality (City of Dryden, personal communication, March 17, 2022).

Municipalities shared that the ‘controlled’ part of CEA enforces the idea that closed systems such as vertical farms require no pesticides which may have positive effects on water and air quality. Dryden and Durham both emphasized that there is a reduction in soil and fertilizer loss through CEA as all input remains in the system. Durham also shared that because CEA is completely contained the *Food and Farming Production Protection Act* and Normal Farm Practices guidelines have no implication on CEA operations (Region of Durham, personal communication, March 22, 2022).

Lastly, the redevelopment of brownfields and vacant urban space was highlighted by Durham and Caledon as an opportunity for implementing CEA operations, as vertical farms do not use soil the same way that conventional agriculture does meaning brownfields could be suited for these types of operations (City of Caledon, personal communication, March 17, 2022; City of Dryden, personal communication, March 17, 2022; Region of Durham, personal communication, March 22, 2022).

5. Discussion

5.1 Policy Guidance

Unfortunately, none of the municipalities that were interviewed had existing policies designed specifically to address CEA. Instead, planners and economic development professionals in these municipalities assess CEA projects and review proposals on a case-by-case basis once an application has been received by the municipality. It was suggested by project participants that additional guidelines from the Ontario Ministry of Agriculture, Food and Rural Affairs through their *Guidelines on Permitted Uses in Ontario's Prime Agriculture Areas* document (OMAFRA, 2016a) would help municipalities and could be particularly beneficial for municipalities lacking the resources to develop comprehensive policy.

5.2 Implications for Rural and Urban Areas

CEA present distinct challenges and opportunities in rural and urban areas. The cost of real estate in urban municipalities raises concern regarding the financial viability of CEA operations (Despoina & Xydis, 2020). As real estate is generally less costly in rural locations, CEA may be more appropriately located in rural areas, from a financial standpoint. In terms of infrastructure, locating CEA such as vertical farms in urban areas are more viable as there is increased access to water, electricity and sewer requirements, as opposed to rural lands which may not have the proper infrastructure to support these operations (Benke & Tomkins, 2017).

There are also distinguishing factors between agricultural operations in southern Ontario and those in the far North that may contribute to the viability and suitability of CEA in both regions. Unlike southern Ontario, which has most of the province's prime agricultural land, in the far North there is less arable land, meaning that agricultural operations need to be adaptive to climate and soil concerns, leaving room for CEA operations to be integrated within the larger agri-food system (MMAH, 2011). OMAFRA's Northern Ontario Agri-Food Strategy highlights the importance of agricultural innovation in supporting the growth of agriculture in Northern Ontario (OMAFRA, 2016b). CEA could represent a type of innovation that could enhance agricultural output in the far North. Conversely, in southern Ontario there is debate on whether CEA should be located in rural areas as they may be developed on prime agricultural lands which should be reserved for conventional farming (OMAFRA, 2016b; Region of Durham, personal communication, March 22, 2022).

The need for further study regarding the attributes of rural, urban and suburban areas, and the energy requirements and financial support required for CEA was a common theme that emerged during consultations with municipalities. CEA may contribute to food affordability, and access, in urban areas where there is demand for local agricultural, however, urban areas typically experience higher real estate costs (Despoina & Xydis; Engler & Krarti, 2021). Consequently, the lack of information surrounding the cost of energy and servicing inputs required to support CEA, and the unknown profitability of CEA, is a risk to the financial

viability of CEA operations in urban areas (Despoina & Xydis, 2020; Engler & Krarti, 2021). The emergence of CEA in rural areas may also pose unique challenges. For instance, there is insufficient literature regarding the efficiency and sustainability of CEA. CEA may require more resources to produce less food, than traditional agricultural operations, particularly those on prime agricultural land (Engler & Krarti, 2021; S2G Ventures, 2020). Considering the lack of literature comparing CEA to traditional agriculture in Ontario, it is likely premature to recommend CEA development on prime agricultural land.

5.3 Opportunities & Challenges

Despite the lack of policy guidance or consistency in defining CEA, all municipalities interviewed expressed interest in integrating CEA within their communities. As CEA brings food closer to the consumer, municipalities, particularly those in northern Ontario, may benefit from more options in accessing quality produce. CEA also offers agricultural opportunities to farmers with agricultural operations near the urban-rural fringe, who are increasingly facing land-use conflicts from urban sprawl into rural areas. Municipalities also noted the economic opportunities arising from CEA. For example, CEA provide local jobs and reduce the cost associated with food wastage from produce that has spoiled after travelling long distances to be sold in Ontario grocery stores. CEA may have the potential to improve food affordability (Benke & Tomkins, 2017).

Moreover, as CEA are a burgeoning field anticipated to grow in the face of climate change (Despoina & Xydis, 2020), the pursuit of CEA and CEA policy development may help put Ontario at the forefront of this innovative type of agricultural operation. Nonetheless, future research is needed to determine the cost of agricultural production within CEA, including the cost of real estate, energy costs, and servicing costs. Future effort to include CEA operators within the research is essential in exploring these associated costs through operator's experiences.

6. Research Gaps

6.1 Limitations

The number of municipalities available to participate within the research timeline was limited. Most municipalities who answered the invitation to interview indicated that they had not yet established concrete land-use guidelines for vertical farms or other CEA operations. None of the vertical farm operators contacted responded to the request for an interview, therefore their perspectives on land use considerations are missing from this research.

For this project, the research focused mainly on vertical farming, as this type of CEA is not explicitly referred to in provincial policy unlike greenhouse operations and mushroom farms that are considered as agricultural uses. If other CEA operations such as greenhouses and

mushroom farms were included in the project scope, there may have been more participation from municipalities who had established policies or guidelines surrounding these types of CEA operations. Cannabis production was also omitted from the project scope as the land use considerations for these types of operations tend to be very different from operations that focus on growing food. During the interviews, two of the municipalities indicated that they were developing guidelines surrounding cannabis production, however this was not within the scope for this research.

All of the municipalities that were interviewed for the project noted that, although there were currently no formal guidelines or policies on land use considerations for vertical farms, they were currently in the process of their Municipal Comprehensive Review and would be including more guidance on these types of CEA within their Official Plans and By-laws. Two of the three municipalities also indicated that they had not considered creating land-use policies for vertical farms until they had interest from operators to establish an operation within their jurisdiction. As a result, this could mean that as the interest in vertical farming increases, policy guidance at the municipal level may follow suit. There could however be problems associated with a more reactive approach to land use planning for CEA as municipalities may bypass guidelines to streamline development.

7. Future Research

As a result of the short timeframe available for this research project, the findings of the study are limited. The current project, however, will act as a background for future research, demonstrating what has already been explored and identifying gaps within the project. Future research should focus on broadening information by surveying and interviewing more municipalities. Future studies should consider ways to encourage the participation of CEA operators within the research to provide their experiences with navigating the land use planning and approval process while establishing their operation. Inclusion of OMAFRA staff in interviews may also provide greater depth into background policy in terms of high-level considerations for the province of Ontario.

Some municipalities that were originally highlighted as areas of interest for the research who were not able to participate in the project include Essex County (the Towns of Kingsville and Essex), Loyalist Township, York Region, Niagara Region (City of Welland), City of Ottawa, City of London, and City of Thunder Bay. Future studies should attempt to explore the land use planning considerations for CEA within these identified municipalities. The definition of CEA in the literature and among municipalities appears to differ depending on geography and the context of the research, therefore insight from other municipalities would be of value. To help inform future research, a set of questions were developed based on the shortcomings of this project, which are included in Appendix E.

8. Conclusion

CEA present an opportunity to adapt agriculture in a manner that is accessible, affordable, and responsive to the needs of residents and the demand for local food. CEA are particularly relevant when considering the threat of climate change to the traditional agricultural system. While there is a lack of research surrounding CEA development in Ontario, it appears, through the research, that there is a demand for guidance, and municipalities appear interested in exploring this innovative agricultural system. This research explored Ontario's provincial policies that apply to CEA and explored whether the policies were sufficient in guiding and promoting CEA within municipalities. The research found that overall, most municipalities within Ontario have yet to develop concrete policies surrounding CEA development as the topic is still emerging. Although the research was not able to identify land use planning best practices and provide municipalities with exemplary guidelines to follow, the project successfully furthered the discussion surrounding CEA within Ontario municipalities.

While the municipalities that were interviewed expressed their support of CEA, further guidance and information are needed from a provincial level to determine the optimal locations for CEA and identify their infrastructure requirements. This project supports further research regarding CEA, facilitates discussion on the challenges and opportunities of CEA, and provides the foundation for future research and policy development. While CEA may effectively respond to challenges confronting the agricultural sector, how municipalities navigate the land use challenges that arise from CEA development still remains unclear.

References

- Beacham, A. M., Vickers, L. H., & Monaghan, J.M. (2019). Vertical farming: a summary of approaches to growing skywards. *Journal of Horticultural Sciences and Biotechnology*, 94(3), 277-283. <https://doi.org/10.1080/14620316.2019.1574214>
- Benke, K., & Tomkins, B. (2017). Future food-production systems: Vertical farming and controlled-environment agriculture. *Sustainability: Science, Practice, and Policy*, 13(1), 13–26. <https://doi.org/10.1080/15487733.2017.1394054>
- Cornell University. (2015). Controlled Environment Agriculture. <https://cea.cals.cornell.edu/about-cea/>
- Despoina, D. D., & Xydis, G. (2020). Indoor Vertical Farming in the Urban Nexus Context: Business Growth and Resource Savings. *Sustainability*, 12. <https://doi.org/10.3390/su12051965>
- Durham Region, York Region, Ontario Ministry of Agriculture, Food and Rural Affairs. (2022, February 17). Vertical Farming 101: Navigating Approvals Process and Permits for Vertical Farming. <https://www.youtube.com/watch?v=mWi0yyerO-s>
- Government of Canada. (2021). *Enhancing automation in controlled environment agriculture farming*. Innovation, Science, and Economic Development Canada. <https://www.ic.gc.ca/eic/site/101.nsf/eng/00125.html>
- Engler, N., & Krarti, M. (2021). Review of energy efficiency in controlled environment agriculture. In *Renewable and Sustainable Energy Reviews* (Vol. 141). Elsevier Ltd. <https://doi.org/10.1016/j.rser.2021.110786>
- Ministry of Municipal Affairs and Housing. (2020a). *Provincial Policy Statement*. <https://files.ontario.ca/mmah-provincial-policy-statement-2020-accessible-final-en-2020-02-14.pdf>
- Ministry of Municipal Affairs and Housing. (2020b). *A Place to Grow: Growth plan for the Greater Golden Horseshoe*. <https://files.ontario.ca/mmah-place-to-grow-office-consolidation-en-2020-08-28.pdf>
- Ministry of Municipal Affairs and Housing. (2011). Growth Plan for Northern Ontario. Government of Ontario. <https://www.ontario.ca/document/growth-plan-northern-ontario>
- New York State Energy Research and Development Authority. (2022). CEA Ongoing Projects. Government of New York. <https://www.nyserda.ny.gov/Business-and-Industry/Agriculture/CEA-Ongoing-Projects>

- Ontario Ministry of Agriculture, Food and Rural Affairs [OMAFRA]. (2016a). Guidelines on Permitted Uses in Ontario's Prime Agricultural Areas. Government of Ontario. <http://www.omafra.gov.on.ca/english/landuse/facts/permitteduseguide.pdf>
- Ontario Ministry of Agriculture, Food and Rural Affairs [OMAFRA]. (2016b). Northern Ontario Agri-Food Strategy. <http://www.omafra.gov.on.ca/english/northernagrifood/noas.pdf>
- S2G Ventures. (2020). *Why the Potential for Controlled Environmental Agriculture Continues to Grow*. Greenhouse Grower. <https://www.greenhousegrower.com/production/what-a-top-100-grower-can-teach-you-about-switching-to-wood-fiber-media/>
- UC Davis. (2021). *What is Controlled Environment Agriculture*. College of Agricultural and Environmental Sciences. <https://caes.ucdavis.edu/research/initiative/controlled-environment-agriculture>
- University of Arizona. (2021). *Controlled Environment Agriculture Centre: Research*. <https://ceac.arizona.edu/research/uag-vertical-farm>
- Zboraj, M. (2021). Indoor Vertical Farm to Spur Agri-Food Innovation in Canada. *Progressive Grocer*. <https://progressivegrocer.com/indoor-vertical-farm-spur-agri-food-innovation-canada>

Appendix A

Table 2: List of Counties, Regions and Municipalities that were contacted for interviews

County	Region	Municipality/Former County
Bruce	Durham	Brant
Dufferin	Peel	Chatham-Kent
Elgin	York	City of Caledon
Essex		City of Dryden
Frontenac		Haldimand
Grey		Kawartha Lakes
Haliburton		Norfolk
Hastings		Prince Edward
Huron		
Lambton		
Lanark		
Leeds & Grenville		
Lennox and Addington		
Middlesex		
Northumberland		
Oxford		
Perth		
Peterborough		
Prescott and Russell, United Counties		
Renfrew		
Simcoe		
Stormont, Dundas, and Glengarry		
Wellington		

Appendix B

Interview Guide: Ontario Municipalities (30 – 45 minute interview format)

Interview Questions:

1. How does your municipality define Controlled Environment Agriculture?
2. Do you have any existing vertical farming (or other CEA) operations within your region/county/municipality?
3. Does your municipality have any existing policy or guidelines to regulate these types of operations?
 - a. If not, do you anticipate these may come forward in the near future (e.g., through Municipal Comprehensive Review, Official Plan review, or an update to the Zoning By-law?)
 - b. In absence of these policies, what tools and considerations are used for permitting CEA in your municipality? (e.g., OPA? ZBA? Site plan approval? Studies?)
 - c. Are there municipal Official Plan policies that support the development of vertical farms in specific areas (i.e., commercial, industrial, agricultural)?
4. Does your municipality currently have any strategies in place to encourage the development of CEA operations?
 - a. Where are the most appropriate areas for CEA (i.e., urban vs rural)?
 - b. Is OMAFRA's Permitted Uses Guide a useful tool for CEA? *Northern context – with no prime ag?
5. How do you think the provincial policy statement has impacted your local land use policies and decisions for CEA?
 - a. Should the Provincial Policy Statement have more specific policies for urban agriculture/vertical farming?
6. What are some of the municipality's future goals (i.e., number of operations, acres under production, job growth) surrounding vertical farms and other CEA operations?
 - a. How do you anticipate that these goals will be communicated? (Either in planning policy, strategic plans, economic development strategies, etc.)
7. What do you see as some of the challenges and opportunities of implementing CEA in rural vs urban areas? This may include differing infrastructure requirements (water, light, energy), ability to house and hire employees, and land use considerations such as compatibility with surrounding land uses.
 - a. How has your municipality achieved/addressed land use compatibility for these uses?
8. The Food and Farming Production Protection Act protects “Normal Farm Practices” – do you see this legislation applying to CEA?
9. How do you think municipal planners and economic developers can work better together to achieve common interests such as supporting CEA?

Appendix C

Interview Guide: CEA Operators (15–30-minute interview format)

Interview Questions:

1. What inspired you to enter the CEA market and start a CEA operation?
2. Where did you get your information from when planning and acquiring approvals for your operation?
 - a. Was getting information difficult?
 - b. To what degree was acquiring business planning information a barrier to your planning process?
3. What sort of land use policy or guidelines did your municipality have for constructing your operation, if any?
4. Why did you choose this particular location (rural/urban) to operate your vertical farm and why?
5. Does your municipality have any economic development strategies or supports to encourage the development of vertical farms?
 - a. If no, would these have been helpful?
 - b. If yes, were these strategies helpful to you in starting your operation?
6. What was your overall experience like with your local planning/economic development department?
 - a. In terms of ease of access and information collection, how was it approaching and meeting with your local planning department/planning services to discuss the approval of your operation? Was it difficult to find out which department(s) that you needed to consult with?
 - b. Did you have a pre-submission consultation meeting with municipal departments/staff? If yes, how did this go? Who was there? What information were you provided with (e.g., timelines, costs, required forms, studies, etc.)? What information was required of you to present (i.e., a concept, business plan, justification, etc.)?
7. Did you work with a planning consultant/firm when establishing your operation? Why/why not?
 - a. If yes, what was this experience like? Would you recommend this approach for others?
8. Can you briefly explain some of the input requirements you had to consider (lighting, energy, water/wastewater, transportation, parking, etc.) when choosing a site for your operation?

9. What were the biggest challenges that you navigated in terms of starting your operation? (ie approvals, land use designation, Zoning By-laws etc...)

a. What would you suggest to those starting out in CEA or vertical farms that you wish you knew when started? What would you do differently if anything?

10. Do you have any planning reports (planning justification reports, by-law amendments etc...) that you can share with us?

a. Do you have photos you would be willing to share?

Appendix D

Table 3: Research Results Table

<i>Research Results Summary from Ontario municipality interviews. (Alphabetical from left to right: Caledon, Dryden, Durham.)</i>			
Questions & Themes	Town of Caledon	City of Dryden	Region of Durham
<i>Is the community rural or urban?</i>	Rural and suburban.	Both, rural and urban. Urban center with rural periphery & neighbouring communities. Far north & remoteness considerations.	Both rural and urban areas as the upper-tier municipality encompasses 8 lower-tier municipalities with urban and rural lands.
<i>Is there a definition of CEA in municipal or regional documents?</i>	No. Guided by <ul style="list-style-type: none"> • agriculture & industrial polices. • Cannabis ZBL & OP parameters considered, not applicable for produce growth. 	No.	No.
<i>Does the municipality have existing CEA or vertical farming operations?</i>	No. But they do have the following which would inform future CEA projects. <ul style="list-style-type: none"> • Cannabis operations: 2. • Horticultural greenhouse facilities: 3+ (guided by rural & agriculture use parameters). 	Yes. In development: 1 vertical farming (light industrial area. Supported by bylaw amendment)	Yes. In operation: 2 Vertical farm & Durham college container farm.
<i>Does the municipality have existing policy or guidelines to regulate CEA or vertical farming?</i>	No CEA specific policy. Releasing Official Plan Draft soon; CEA area left broad to be open to opportunities.	No CEA specific policy. Agricultural Policies currently fill the gap; will develop more concrete policies on	No CEA specific policy Land use regulations for CEA is a local concern approved by lower

	Cannabis developments provide some guidelines, nothing for produce based farms yet.	CEA development as needed.	tier governments. Not-applicable for the upper-tier municipality. Would like guidelines to address CEA more explicitly. Suggested a CEA permitted use, policies, & guidelines document from OMAFRA.
<i>Are there strategies in place to encourage CEA or vertical farm developments?</i>	Yes. 2020-2030 Economic Development Strategy is broad yet seeks innovation & local food security leaving room for CEA operations.	Yes. Economic strategies in place that apply to all commercial, lighting, water, facade etc. Discounted price offering on municipal land to encourage investments. Urban Agriculture encouraged through Community Improvement Plan.	Yes. Vertical farms are encouraged in the region. Marketing campaign in place through Invest Durham to encourage vertical farm development & a generic ‘fill in the blank’ proposal to encourage investments.
<i>Impact of Provincial Policy Statement (PPS) & OMAFRA Permitted Uses Guidelines on land use policies and CEA development.</i>	PPS: increased guidance on navigating the “grey area.” Navigating where to implement CEA operations within the rural-urban fringe is of particular interest. OMAFRA GL: the guide is useful but needs to go further. Small lot & “hobby-farm” considerations are wanted to protect neighbours, currently	Want additions to PPS that provide improved guidelines on CEA & vertical farm operations. Do not consider PPS & OMAFRA GL for agriculture as intensely as southern Ontario as there is no prime agricultural land in Dryden.	PPS: Non-applicable. PPS & OMAFRA: Seeking larger & more specific definition on parameters in PPS & OMAFRA GL.

	does not provide guidelines for CEA specifically		
<i>Opportunities in CEA implementing</i>	<p>Food & agri-food innovation in GTA area & white belt are an encouraging factor in CEA & VF creation.</p> <p>Innovative ways to have mixed use living & food provision is of interest.</p>	<p>General:</p> <ul style="list-style-type: none"> • Food security. • Brownfield redevelopment & in non-prime agriculture areas. • Minimal to no pesticide concerns. <p>Current facility provides:</p> <ul style="list-style-type: none"> • Food security. General grocery & fresh produce for Indigenous communities. • Staffing: minimal staff needed & labour pool exists for expansion 	<p>Improved access to fresh food (Food security).</p> <p>More opportunity to locate CEA facilities and vertical farms in urban areas versus rural.</p> <p>Access to markets and consumers when built on highways 401, 412 or 407.</p>
<i>Challenges in CEA implementing</i>	<p>Large servicing intensity i.e.: wastewater.</p> <ul style="list-style-type: none"> • Large trucks & increased traffic on small rural roads. • Where to best locate CEA? Urban versus rural considerations. • Grey areas on where to locate CEA, as a result of minimal provincial policy direction. 	<p>Southern Ontario Context:</p> <ul style="list-style-type: none"> • Price of urban land will be greater challenge in southern Ontario. <p>Northern context:</p> <ul style="list-style-type: none"> • Servicing available beyond the city boundary is minimal i.e.: water & electricity. • CEA are service heavy. • Investment return can be low for yields; challenging to break even & sell at market value. • Southern Ontario crews/experts are needed to 	<p>CEA are a service heavy industry (i.e.: water & energy & wastewater)</p> <ul style="list-style-type: none"> • Traditional farming is concerned with loss of prime agricultural lands. • Questions faced & lack of consistent parameters provided by groups such as OFA or OMAFRA. i.e. Are CEA able to apply for farm tax rates?

		implement hydroponics.	
<i>Implication of Food and Farming Production Protection Act & “Normal Farm Practices” on CEA.</i>	Not applicable. Guidelines are not applicable as CEA are not a farm or covered under “Normal Farm Practices.”	Not applicable. No concerns from pumps, trucks, light from current facility. All low sound & noise, & light managed.	No. Completely contained & no soil concerns. Normal Farm Practices does not apply to these types of operations.
<i>Does the municipality have future goals for increasing CEA & vertical farming operations?</i>	Yes. Agriculture is one of 5 economic development strategies of focus. Of interest are innovative ways to compensate for land shortages that meet food security needs.	Yes. General encouragement for both. Supportive based on potential of CEA & VF to address food security & freshness, urban brownfield redevelopment & rural development.	Yes. Interested in both. Durham college container farming program & economic development campaign to targets investors and increase operations
<i>Are there future CEA projects on the horizon?</i>	Yes. More welcome & include in policy additions.	Yes. Expand current vertical farming developments & welcome more.	Yes. Interested in welcoming more.
<i>How do you think municipal planners and economic developers can work better together to achieve common interests such as supporting CEA?</i>	Increased provincial leadership to clarify the “grey areas” through groundwork. Tool similar to OMAFRA guidelines for CEA Economic development strategies to encourage CEA development as innovative form of agriculture.	More permissive zoning for Northern Ontario; supporting vertical farm applications on the grounds of reduced carbon footprint, job creation.	Increased education & policy guidelines on possibilities & updated best practices from OMAFRA & others.

Appendix E

Future Research Questions:

1. How could CEA be more consistently defined throughout policy within Ontario for municipal planning purposes?
2. How can the Provincial Policy Statement be adapted to provide more guidance on Urban Agriculture (including CEA operations)?
3. What types of strategies could be implemented to encourage the development of Vertical Farms and other CEA within Ontario's municipalities?
4. What types of policy documents or other resources could be developed to assist municipalities when reviewing CEA development applications?
5. How can OMAFRA's *Guidelines on Permitted Uses in Ontario's Prime Agriculture Areas* be updated to provide municipalities with more guidance on creating land use considerations for CEA?
6. Is there an opportunity to focus on CEA development in Northern Ontario to expand their agri-food sector?